Assessment of Future Human Capital Requirements in Agriculture and Allied Sectors

National Academy of Agriculture Research Management
(NAARM, Hyderabad)

and

Institute of Applied Manpower Research
(IAMR, New Delhi)

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We gratefully acknowledge the contributions made by Dr. S.M. Ilyas and Dr. P.K. Joshi former directors of NAARM and Shri R. Sridharan, IAS, former director IAMR, Dr. Mrutyunjaya former National Director and Dr. N.T. Yaduraju former National Coordinator in different phases of the execution of the project.

Besides, a number of officials from both the organizations involved technical financial, and administrative operations have continuously helped in executing the project. Consultants at state-level were engaged for management of data collection and processing. Nodal officers from the universities helped us from time to time in collection of data. We put on record our sincere gratitude to all of them.

Project Investigators

Foreword

Indian Council of Agricultural Research (ICAR) is striving for the holistic development of agriculture and allied sectors through planning, promoting, conducting and coordinating research, education, extension and training for ensuring sustainable growth and development. ICAR initiated a number of programmes to shift focus of Indian agriculture from input-based to knowledge-based growth. In this paradigm shift, promotion of innovation in application of science and technology in agriculture and dissemination of knowledge plays a critical role. This is essential step to realize the goals envisaged in National Policy on Agriculture to accelerate growth in agriculture and also to generate income and employment opportunities to rural communities.

Over the years Indian agriculture had made tremendous progress, which in a large measure is due to its human resources who could harness the rapid developments in science and technology. Professional education in agriculture is of long gestation, and needs considerable advance planning. Development of technical and vocational skills necessary to support the practical application of knowledge commands equal attention. In the context of national demands and changing global agricultural scenario, identifying and developing quality human resources required at various levels is of strategic importance.

The ICAR has set in motion national projects, from time to time, to assess the future human capital requirements in agriculture and allied sciences in advance so as to put development of agricultural human capacity development on a rational footing. The present project is the latest in this direction, and has been executed by the National Academy for Agricultural Research Management (NAARM), Hyderabad and Institute of Applied Manpower Research (IAMR), New Delhi.

It gives me immense pleasure to present the project report jointly prepared by NAARM and IAMR. The report is timely and useful in preparing the future course of action on human resource development in agriculture and allied sectors. I complement the project team on bringing out such valuable document, and hope it is useful for policy planners and other professionals associated with agricultural education and development.

S. Ayyappan
Secretary, DARE and Director General, ICAR

Preface

Human resource planning is an essential element for achieving sustained growth in any sector. The significant role of agriculture sector in the development and growth of Indian economy is well recognized and well documented. The contribution of this sector to national GDP, food, nutritional and livelihood security has been phenomenal owing mainly to policy initiatives, advances in agricultural research and development aided and supported by an efficient human resource pool built and accumulated over the last five decades. In the wake of global competition in commerce and trade, climate change, natural disasters, population pressure, dynamic social changes in rural areas due to increased urbanization and many other challenges, there has been a paradigm shift in the way the issues confronting agriculture sector need to be addressed. One of the important components of the issues is the need for a qualitative and quantitative change in the human resource that is required to address the challenges. There is, thus, an urgent need to quantitatively and qualitatively assess the current stock size and status of the human resource in agriculture sector with special reference to requirement of personnel for various sub-sectors of agriculture and allied activities. Also, it is imperative to assess the future human resource needs in consonance with the targeted growth rates of the various sub-sectors of agriculture.

The present study attempts to assess the demand emanating from various sectors of employment and supply from educational institutions and project future demand and supply needs. Based on these, certain policy initiatives, strategies and mechanisms are recommended.

The forecasts provide insight into the right quantity and quality of the human resources required to maintain desired sector growth. It is hoped that the results will provoke discussion and further research into the complicated and fascinated area of strategic human resource planning. The study identifies educational strategies to improve employment opportunities in future. The study is useful in preparing the country's human capacity development plans in agriculture and allied sectors. I compliment the investigating team for bringing such a valuable document.

Arvind Kumar

Deputy Director General (Education), ICAR

Contents

Executive Summary

Trained human resources are needed in different sectors of agriculture for targeted growth. The sectors are to be serviced by human resources with higher skills than before to ensure technology generation, its transfer to and more importantly its application at the grass root level. Further, agricultural human resources with diverse skills is today required by a wide-ranging and fast expanding food processing industry, corporate and unorganized sector. In this context, forecasting of future agricultural human resources requirements assumes considerable significance in identifying the trends and visualizing the emerging technologies and the corresponding needs for the appropriate human resources mix. The assessment of existing human resources, the sectoral growth, capacity utilisation of qualified graduates is indispensable to envisage the future agricultural education needs. The NAIP supported project entitled "Assessment of Future Human Capital Requirements in Agriculture and Allied Sectors" was visualized in this context.

The objectives of the project are:

1. To assess the trend in supply-demand of trained human resources in agriculture
2. To evaluate institutional set up and the impact of diversification of agriculture on skill requirements
3. To develop a system dynamics model for forecasting and evolve prospective human resource development strategies

To meet the above objectives, quantitative and qualitative data was collected through nationwide surveys and by organizing Focus Group Discussions. The issues relating to employment, skills needed for employment in public and private sectors, and educational strategies to develop appropriate human resources, etc. were addressed through this approach. The survey responses were received from all agricultural universities, 4880 employees with degree in agricultural sciences, 2100 alumni, 3500 industrial organizations employing agricultural graduates. About fifty Focus Group Discussions were organized with various stakeholders. The survey data in conjunction with secondary data were used to forecast future human capital requirements for 2020 and also drew strategic plan for future educational requirements.

A system dynamics model was developed for forecasting supply-demand scenario of agricultural human resources requirement in different sectors viz. government, private, academic, financial institutes, non-governmental organizations, self-employment, and others (non-agriculture) in India. The model results have been compared with the actual values to validate the efficacy and relevance of model simulation to depict the reality.

The broad results point to a shift in demand for agricultural human resources from public to private sector. In 2010, the shares of various segments by employment are: 33 per cent in government, 44 per cent in private, 10 per cent in financial, 4 per cent in research and academic and 9 per cent in others. The major shift in the past three decades is decline in the share of public sector in employment, which may be due to freezing employment in government sector as well as expansion of opportunities in the private sector. This is in tune with the emergence of commercialisation as well as diversification.

The results show that there are at present substantial gaps between demand and supply of human resources in agricultural and allied sciences even to the tune of 50 per cent or more.

This is true across the board, though the shortfall is high in the case of rapidly growing horticulture, dairy and fisheries sectors, and less serious in others. Dairy, fisheries, veterinary and horticulture are the future engines of growth which would have a bearing on trained human resources requirements.

At present the existing education system is producing about 24,000 graduates per year with crop sciences contributing 2/3rd of it. The projections indicate that by 2020 the annual outturn required would have to be about 54,000, i.e. the demand supply gap would be 30,000. Discipline-wise, the additional annual requirements of outturns are expected to be: Agriculture 9335; Horticulture 7153; Forestry 1116; Dairy 3005; Veterinary & Animal Husbandry 4989; Fishery 2181; Agriculture Engineering 1749; and Agri-Biotechnology 305.

During the last decade, outturn of graduates and above grew at the rate of 5 per cent and in the coming decade it is projected to double the growth rate to meet the demand.

To handle a variety of day to day jobs of counselling and rendering routine assistance to the farmer, there should be 'bare foot technicians' who need to be equipped with multiple skills – not only with regard to farm practices, simple and routine veterinary services, routine testing services, and various other rural occupations but also on aspects like agro-processing, marketing, escort services, etc. Such skills need to be developed among the rural youth themselves, preferably targeting school drop-outs, as youth from urban areas or with higher education shy away from working in rural areas. Special effort is needed to promote diploma level education on the lines of engineering education. Initiatives for the future demand-driven growth in agricultural education at the diploma and undergraduate levels should be left to the private sector or should be taken in a public-private partnership mode.

An important aspect of educational planning is to ensure availability of faculty in adequate numbers and quality with institutional arrangements for systematic up-gradation of their knowledge and skills. About 40 per cent of the faculty positions in the agricultural universities have remained vacant for long periods of time raising questions about the quality of education.

Proper data base management is vital for educational planning. The data bases like NISAGENET should be updated regularly. The data base PERMISNET should be made accessible to outside researchers in a restrictive manner.

Results indicate towards the need for skill up-gradation in the light of technological innovations as well as skill development in the emerging areas in the agriculture sector. An indicative list for skills to be developed has been provided in the report.

There is a strong demand from all the stakeholders for skill-specific education with clarity of basics as well as hands-on technical expertise. In other words, there is a need to develop functional skills among the students in educational institutions almost in all the sectors of agriculture.

Agriculture has to meet the needs of the society at various levels. It has to serve the requirements of the industries as well as of farmers. It also has to keep pace with youth aspirations. It is the sole agent to ensure food security. Appropriate policy interventions for developing skills among youth needed as per labour market indicators should be given a serious thought along with a revamp in educational expansion and its structure.

Chapter-1

Introduction

1.1 Agriculture Scenario

Agriculture sector has an important position in the Indian economy as it is crucial to the nation's food security apart from providing livelihood to about 52 per cent of working population of the country. There is strong inter-dependence of industry sector on agriculture sector as it is an important source of raw materials used by industries. Notwithstanding its declining share in country's GDP from about 40 per cent in 1980-81 to about 17 per cent in 2009-10[1], agriculture continues to be the key to nation's growth and development and will remain so in the future.

Over the past fifty years, agricultural output has reasonably kept pace with the demand and has resulted in sizeable surpluses not only to ensure a measure of food security at home but to meet periodic overseas demands as well, thus becoming a valuable export-earner in the process. This was made possible significantly by the contributions of the agriculture education system in the country. However, in the last two decades, Indian agriculture has reached a state of relative stagnancy with growth rates around 2 per cent in the late nineties, which does not augur well for the food security situation in the country. The scenario requires immediate policy interventions. The XI Plan gave ample recognition to this fact and aimed at a rapid growth of agriculture at a rate of four per cent per annum and proposed a slew of policy measures to achieve this rate. However, the achievements during the current Plan are likely to miss the target and the actual growth rate may not exceed three per cent. The future Plans have to, therefore, aim at a more vigorous growth through multi-faceted approach with effective policies and efficient programme implementation in the sector.

Some important features that have an impact on and are of grave concern to Indian agriculture today are the problems of small and marginal farmers, low productivity, issues relating to transfer of technology against the background of almost collapse of public extension services, the regional disparities in modernization of agriculture, constraints on land availability, depleting ground water and deterioration of soil health, changing patterns of monsoon, climate change, commercialization of agriculture, movement of labour force away from agriculture, feminization of agriculture, post harvest losses, policies of globalization and liberalisation and so on.

Considerable efforts are needed to evolve alternative strategies to cope with the scenario outlined above including intensive problem-oriented research, transfer of solutions to the masses and skill development as well as adequate skill upgradation. **Hence, there is a need for assessment of needs, development and utilization of human resources at various levels.**

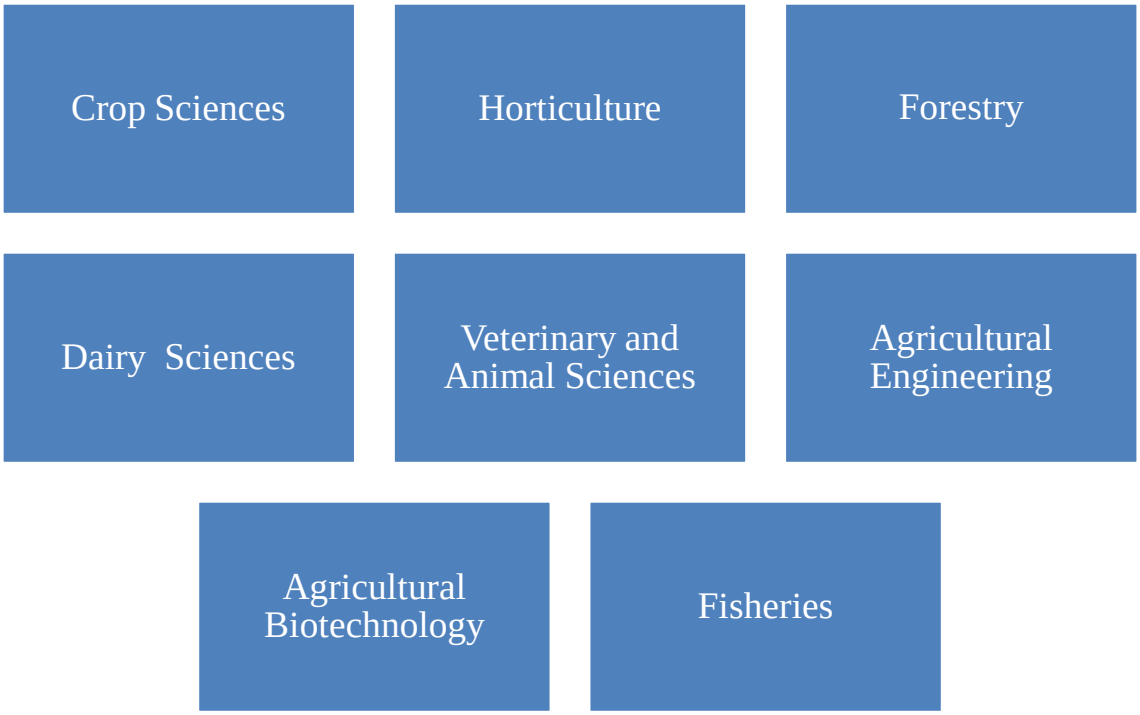
[1] Economic Survey, GOI, 2010-11

1.2 Overview of the Present Study

The present study titled 'Assessment of Future Human Capital Requirements in Agriculture and Allied Sectors' is a step in this direction which was commissioned by ICAR as a NAIP project. The project was implemented by NAARM, Hyderabad, and IAMR, New Delhi as partners during 2009-2011. The study aimed at assessment of human capital requirements in agriculture and allied sectors, which necessitated country-wide surveys and consultations with various stakeholders.

For the study purpose agriculture and allied sectors covered the following:

Coverage of Agriculture and Allied Sectors



1.2.1 Organization of the Report

The report consists of eighteen chapters. Brief contents are as follows:

Executive summary – A summary of the report is presented with major findings.

Introduction - Discusses the evolving scenario in agriculture and allied sectors and the need for the study.

Agriculture Growth and Critical Issues – Highlights the general agriculture scenario of the country emphasizing associated critical issues and challenges in agricultural education.

Present Study – Outlines project objectives, various forecasting methods and their applications in agriculture sector, and details specific methods followed for the current project.

Profile of Agriculture and Allied sectors – Reviews the growth of agriculture and allied sectors in India such as crops, horticulture, forestry, veterinary, fishery, dairy, agri-engineering and biotechnology.

Sector-wise Demand-Supply Reports - Supply and demand of graduates, employment pattern, existing stock, distribution and demand are discussed in these chapters. Perceptions of stakeholders working in various sub-sectors, students and academic information from universities and colleges, current and future demand estimates obtained through a nationwide survey are incorporated in the sector-wise results. Each sector is presented in a separate chapter.

Human Capital Requirements at Micro Level – Besides the survey and secondary information, project teams discussed with the stake holders in various sectors on current performance of agricultural human resources at various levels and skill gaps thereof. The outcomes of these in terms of micro-level requirements are presented in this chapter with a special focus on meeting the needs of the farmers. The sector-wise reports also indicate the needs of diploma holders etc. specifically to meet the needs of industries and other employers.

Supply Projections, Demand-Supply Gap – Supply projections are made based on the outturn data available for various years. Demand and demand-supply gap estimates are based on the growth in the supply.

System Dynamics Simulation Model - Describes simulation model for testing of various policy options, such as effect of sector growth and expansion of education on supply-demand scenario and strategies to improve agricultural education.

Conclusions and Recommendations - Demand-supply information and relevant issues there of that emanated from the various sectors are summarized into recommendations and action issues. Specific emphasis is laid on educational strategies to meet the future requirements.

Bibliography and Annexures are given in end. Annexures inter alia provide detailed tables of human capital requirements in various sectors under study.

Chapter-2

Agriculture Growth and Critical Issues

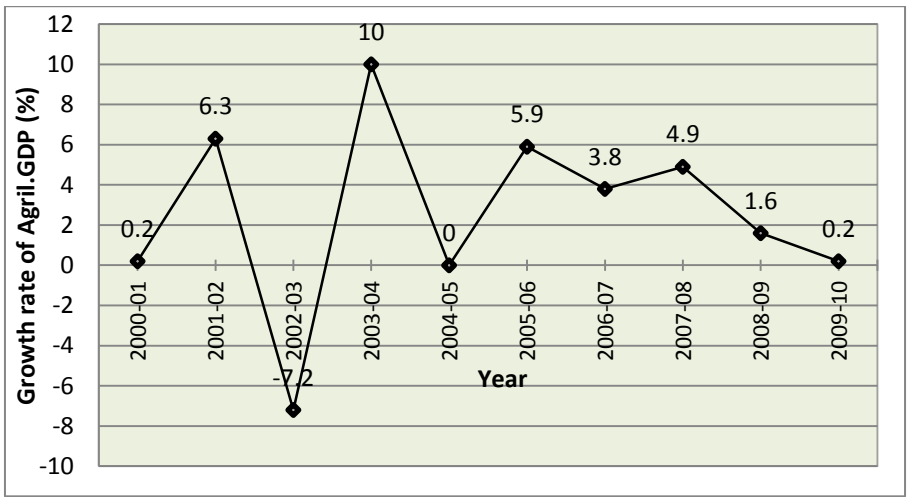
2.1 Agriculture in National Economy

According to National Accounts Statistics, contribution of agriculture to the GDP has been steadily declining over the years; from around 56per cent in 1950-51, it has fallen to 34 per cent in 1990-91 and to 17 per cent in 2009-10 and estimated to be about 14.2 per cent in 2010-11. In spite of this decline, the sector continues to be the predominant occupation of about 62 per cent of population in the country although this proportion is coming down slowly.

2.1.1 Agriculture Growth in Recent Years

The output from this sector registered a reasonable 3.2 per cent per annum growth during the Sixth, Seventh and Eighth Plans (1980 to 1996-97), but slumped to an average of just 1.5 per cent in the subsequent years (Fig-2.1). The Tenth Plan had set a target of about 4 per cent annual growth for agricultural sector, but the achievement had only been to the extent of 2.3 per cent. According to the latest National Accounts Statistics available, output from agriculture and allied sectors at constant prices had grown at an average annual rate of a mere 2.9 per cent during the period 2000-01 to 2006-07. Though the growth rate improved to 4.9 per cent during 2007-08, the next two years saw a slump again, with rates of 1.6 per cent in 2008-09 and 0.2 per cent in 2009-10. The target of 4 per cent set for the XI Plan, had been stiff particularly in the absence of any indication of a second green revolution. The 12th plan which is under preparation is likely to have the same targets as had been for XI Plan. The desired targeted 4 per cent growth in agriculture requires considerable introspection and policy interventions.

Fig-2.1: Recent Trends in Agriculture GDP Growth



Source: Central Statistical Organization, Press Releases. Growth rates for 2008-09 are based on Quick estimates and for 2009-10 on Revised Estimates released in May 2010 The estimates are on 1999-2000 prices upto 2006-07 and on 2004-05 prices thereafter. However, the rates of growth would not be affected significantly due to change in base year.

2.2 Critical Issues

2.2.1 Productivity

The productivity of Indian agriculture is far below the international levels. For example, the yield (Kilograms per hectare) was 3208 for Paddy and 2671 for wheat in India against the world averages of 4152 and 2792 respectively. The corresponding figures in China are 6341 and 4781. Several reasons have been attributed to this low productivity which includes *inter alia* technological factors as well as institutional factors. Under the technological factors irrigation facilities, use of fertilizers and high yield varieties, farm mechanisation, soil erosion, etc are included. The institutional factors include small size holdings, backward and forward linkages and transfer of knowledge from research to grass-root levels.

The Working Group of Sub-Committee on National Development Council on Agriculture and Allied and Related Issues on Region/Crop Specific Productivity Analysis and Agro Climatic Zones, constituted in 2007 has grouped the states into 15 agro-climatic zones in major five regions and identified the specific constraints to agricultural growth in each region. The details of these regions and states falling therein as well as the region specific problems are given in Table-2.1.

Table-2.1: Region-specific Constraints in Agriculture

Agro-climatic Region	States/Parts of States	Region-specific Constraints
Western Himalayan region-I	Jammu&Kashmir, Himachal Pradesh, Uttaranchal	Severe soil erosion, degradation due to heavy rainfall/floods and deforestation, low SRRs, poor input delivery, inadequate communication infrastructure and marketing.
Eastern Himalayan region-II	Assam, North-East States, Sikkim	Aluminum toxicity and soil acidity, soil erosion and floods, shifting cultivation, low SRRs, non-availability of electricity, poor road, poor input delivery system and communication infrastructure.
Lower and middle gangetic plains regions-III and IV	West Bengal, Bihar, Eastern Uttar Pradesh	Flood/water logging, improper drainage, salinity/alkalinity, arsenic contamination, low SRRs, non-availability of electricity, high population growth, poor road and communication infrastructure.
Upper and trans-gangetic plain regions-V and VI	Western Uttar Pradesh, Punjab, Haryana	Groundwater depletion, decreasing total factor productivity, micronutrient deficiency, non-availability of electricity, and high population density.
Eastern Plateau and Hills region-VII	Orissa, Jharkhand, Chhattisgarh	Moisture stress, drought, and soil acidity, iron toxicity, low SRRs, non-availability of electricity, high population growth, poor road, poor input delivery and communication infrastructure.

Many states are suffering with low productivity of agriculture production due to the constraints mentioned above. The climatic conditions, the soil type and its nutrient status, management practices, inputs consumption, etc., are factors related to productivity. Indian

agriculture in most of the regions, specifically located in Southern Region, depends upon the rain water, while Northern states are well irrigated. It has been estimated that more than 56 per cent of total food grain production comes from irrigated lands while it is considerably less in rain fed agriculture. Rain fed agriculture accounts for 65 per cent of net area sown but contributed only 44 per cent of national food grain production.

2.2.2 Natural Resources and Quality

Depletion of agriculture resources such as land and soil degradation due to indiscriminate use of fertilizers and pesticides have led to serious problems in agriculture sector. Soil health has depleted as it has lost its nutrients. Farmers are not aware of the long term implications of poor soil health. Testing of soil is hardly done on the part of the farmers due to lack of awareness about the importance of soil health on one hand and lack of testing facilities in the vicinity on the other. Land resources are limited in India which has about 18 per cent of world's population and 15 per cent of livestock population to be supported from only 2 per cent of geographical area and 1.5 per cent of forest and pasture lands. The per capita availability of agricultural land has declined from 0.48 hectares in 1951 to 0.16 hectares in 1991 to 0.14 hectares in 2001. National Bureau of Soil Survey and Land Use Planning (2005) has estimated that by 2035 it would decline to 0.08 hectares It is also reported that about 146 million hectares area is suffering from various types of land degradation which include water erosion, wind erosion, flooding, salinity, soil acidity, etc. Various types of degradation takes place from unstable use and inappropriate land management practices besides land shortage.

There is immediate need of strengthening and expanding watershed management programme, policy on fertilizer and pesticides application and mapping of areas that lack soil health. There are several programmes such as Drought-Prone Area Programme, Desert Development Programme, Joint Forest Management Programme, Watershed Development Projects, etc. which need corrective measures in their implementation and measurement of outcome and impact. Suitable policies are needed to check land degradation at macro level while knowledge dissemination and soil testing at micro level. Data base has also to be developed for mapping of land degradation and soil degradation. Advanced technology like remote sensing can help in mapping of resources.

2.2.3 Interface between Farmers and Scientists

A large number of institutions in the field of agriculture and allied sectors are contributing to research in development of high yielding varieties of crops, technological innovations and other initiatives to boost production and human resource development. The technology available has not permeated uniformly to all geographic areas of the country. The green revolution is an example. While the impact of green revolution is clearly visible in some of the States, in others it is not so significant. The National Commission of Farmers also raised the issue of knowledge deficit, which directly impinges on agriculture productivity. There are significant gaps in backward and forward linkages between the agricultural laboratories and the farmers, in so far as communication of technology is concerned. The XI plan Approach Paper also states that "in the longer run growth in agriculture productivity can be sustained only through continuous technological progress". This continuous technological progress would require high priorities not only for basic research but equally importantly, to ensuring that the results of such research percolate to the lowest echelons of the farming sector.

Apart from linkages for obtaining technology, the capabilities of the extension agency to assess and refine them for its integration in their knowledge base has been very weak, mainly due to lack of qualified staff.

The XI plan shows a concern towards the problem of transfer of technological and knowledge at grass-root level and puts forth challenges before the extension agencies. The basic issue in the transfer of knowledge is how to deliver the knowledge to the farmers and how to implement the results of the research in the farms where land holdings are very small. The XI plan points out that extension services are to be treated as a service delivery mechanism. Thus, there is a need to study the status of the extension services, the problems and the remedies.

2.2.4 Diversification of Agriculture

An important factor that has relevance to skill development, employment and productivity increases in agriculture and allied fields is diversification of crops that is taking place through global and national forces. Increasing integration of India's economy with the rest of the world has opened up avenues for diversified agricultural exports, such as in horticulture, floriculture, and aquaculture. Internally, with growing incomes and increasing urbanization (about 28% of India's population belongs to urban areas, which is expected to grow to 35% by 2020), there is a shift in the patterns of demand for agricultural products. It has been projected that the demand for these products would be almost doubled by 2025 as compared to demand in 2000. These trends would in due course induce a shift from production of food grains to commercial crops.

Traditional cropping is not remunerative to the farmers due to decreasing irrigation facilities, low quality of soil and increased cost of production. Rural economy can improve with diversification of agriculture. Production of food grains is not as remunerative for the farmers as the high value commercial crops and export-oriented production like horticulture and floriculture and crop diversification has been contributing to agriculture growth, income augmentation and employment generation (Joshi, 2005). It was observed that farmers were willing to shift towards fruits and vegetables irrespective of level of cost of production but growing of food grain is still predominant mainly due to their orientation towards food security. A number of studies on diversification of agriculture directly link to employment generation, income enhancement and sustainability of agriculture (DAC, 2007). It is essential to study the implications of these trends for skill development and employment generation in agricultural sector.

It has been projected that the demand for traditional cash crops such as oil seeds, fibers and sugarcane increase at 3 to 4 per cent per annum and livestock and horticulture at 4 to 6 per cent. Diversification towards agriculture, thus, would contribute to agricultural growth and would also increase the demands for trained human resource. The employment elasticity for these activities is high. The major thrust areas in the diversification of agriculture inter alia include the agriculture marketing, the contract farming, the food processing and packaging, livestock and fisheries development, the technological innovation in these areas as well as human resource demands. An action plan for future human capital requirement due to diversification of agriculture need to be developed in case the agriculture has to remain the backbone of the economy.

2.2.5 Women in Agriculture

Rural Women form the most important productive work force in the economy of majority of the developing nations including India. Agriculture sector employs 4/5th of all economically active women in the country. Around 48 per cent of India's self-employed farmers are women. There are 75 million women engaged in dairying as against 15 million men and 20 million in animal husbandry as compared to 1.5 million men.

The increasing involvement of women workers in agriculture is more clearly discernible in state and district level changes. According to the census data over the period 1961-2001 the percentage of rural women workers classified as agricultural laborers increased from 25.6 per cent to 43.4 per cent, compared to the increase from 16.2 per cent to 27.4 per cent for men (Census, 2001). With a rising share, female agricultural laborers now constitute 46.3 per cent of the labor force. In certain states, for instance, women constitute 53.5 per cent of the agricultural workforce in AP, 58.2 per cent in Karnataka, 56.3 per cent in Maharashtra and 50.1 per cent in Tamil Nadu (Census 2001). The data in Table-2.2 indicates the classification of workers engaged in agriculture activities and also shows the feminization of Indian agriculture.

Table-2.2: Classification of Workers Engaged in Agriculture Activities

Year	Cultivators		Agri. Labourers		Total Agri. Workers	
	Number (000)	per cent Female	Number (000)	per cent Female	Number (000)	per cent Female
1981	102839	**23.12**	64409	**44.23**	167248	**31.25**
1991	124684	**28.11**	85993	**45.31**	210677	**35.13**
2001	127313	**32.91**	106775	**46.31**	234088	**39.02**

Source: Registrar General and Census Commissioner of India: Series I part III, General Economic Tables

The data highlights the increasing concentration of female workers in agriculture in both cultivator and agriculture labour categories, and more sharply among cultivators. The percentage of females as cultivators has increased from 23.12 per cent in 1981 to 32.91 per cent in 2001 as compared to the marginal increase from 44.23 per cent in 1981 to 46.31 per cent in 2001 for females as agriculture labourers.

Several farm activities traditionally carried out by men are also being undertaken by women as men are pulled away into higher paying employment. Thus, rural India is witnessing a process of feminization of agriculture.

Keeping the above in view, the National Agriculture Policy (NAP) emphasized the need to recognize their contribution and it gave high priority to mainstreaming of women's role in agriculture. Appropriate structural, functional and institutional measures are proposed to be initiated to empower women and build their capacities and improve their access to inputs such as land, credit and agricultural technologies.

It is also noteworthy that more females are taking admissions in agriculture and allied courses in the universities. The data in Table-2.3 presents the trends of female students in agriculture education; the data reveals increasing number of female students in agriculture; the

proportion of female students has increased from 0.8 per cent in 1971 to about 16 per cent in 1991 to about 30 per cent in 2010. However, in many states (mostly in southern India), the number of female students enrolled is above 45 per cent of the total students. Thus, over the years the proportion of trained female human resource in agriculture has increased.

Table-2.3: Female Students in Agriculture Education

Year	Per cent Female Students
1971	0.8
1981	3.9
1985	6.3
1991	16.0
2001	18.2
2005	26.9
2010	30.0

Sources: 1971-1985 data from MHRD, *Education in India;* 1991 data from AGRIUNIS, 1994; 2001 data from Statistical Abstract, India; 2002 & 2005 data from Education Div, ICAR, 2010 and data collected for this report

An increasing number of female human resources in an otherwise male dominated sector need consideration of their job preferences, especially due to their traditional dual role. One area where greater structural reorganization and flexibility is needed is in trained female staff placement. Since female staff has better access to rural households, i.e. farm women, the planning in transfer of technology may be reoriented to utilize the increased percentage of trained female human resource in developmental jobs.

There is a need to gender sensitive pro-active initiatives to provide benefits of development to women. Various Ministries/Departments are working towards the goal but have often tended to function in compartmentalized manner. These fragmented efforts are not sufficient to bring about the desirable impact.

It can be observed from the above discussion that feminization of agriculture is witnessed at two levels – one at micro level due to male migration to cities or abroad and two at macro level where enrolment of females is increasing in agriculture education. This calls for a relook at policy level wherein access to various inputs, services etc. could be provided to women at their door steps and at education level where curriculum is modified to make it gender sensitive. All these factors together have an impact upon human capital requirements in agriculture and allied sectors.

Women aspiring for starting their ventures in the sector also suffer from lack of access to financial assistance from banks who insist on assets as security as land etc., is generally in the names of male folks.

Agricultural students need to be educated and informed about rural women's problems, potentials and aspirations. Raising the number of women in agricultural education and extension programmes is important as a means of reinforcing the commitment to understanding and changing the status of women.

2.2.6 Small and Marginal Farmers

According to the study of National Commission on Enterprises on Unorganized Sector, more than 80 per cent of farmers are small (1 to 2 hectares of land) and marginal (one hectare of land). There has been a steady increase in the share of marginal and small farmers in the total land owned and operated by them over time. Table-2.4 shows the changes in the distribution of ownership holdings of farmers in India over the years.

Table-2.4: Changes in Distribution of Land Ownership Holdings in India

Land Class	Per cent ownership holdings		Per cent area owned	
	1953-54	2002-03	1953-54	2002-03
Landless	23.1	0.0	0.0	0.0
Marginal	38.2	69.6	6.2	23.1
Small	13.5	10.8	10.1	20.4
Semi-Medium	12.5	6.0	18.4	22.0
Medium	9.2	3.0	29.1	23.1
Large	3.6	0.6	36.1	11.6
All Size	100	100	100	

Sources: NSS on Land Holdings 8th, 17th, 26th, 37th, 48th and 59th Rounds
Note: Landless (<0.01 ha), Marginal (0.01-1.00 ha), Small (1.01-2.00 ha), Semi-Medium (2.00-4.99 ha), Medium (1.00-10.00 ha), Large (>10.00 ha)

The share of marginal and small farmers in owned land was 16.3 per cent in 1953-54, which increased to 43.5 per cent in 2002-03. A similar pattern is observed in the case of operational holdings also. Marginal and small farmers accounted for 80 per cent of operational holdings in 2002-03 as compared to 53 per cent in 1953-54. However, there is considerable inequality in the pattern of distribution of land. Medium and large farmers (6% of farmer households) operate more than 1/3rd of total operated area, while large farmers (0.9% of the total) still operate 13.1 per cent of land.

The small land and limited assets possessed by small and marginal farmers form a vicious circle, and they remain poor with less income. Some basic problems faced by them are imperfect input and output market, inadequate access to credit markets, poor human resource base, inadequate access to suitable extension services and technological knowhow and poor access to public goods. The inadequate access to input or output market leads to lower value realization. Similarly, imperfect credit market lead to suboptimal investment decisions and improper input applications. Inadequate access to technology create serious bottleneck for modern cultivation practices. Poor access to public irrigation, command area development, electricity grids are aggravated by other negative factors like poor quality land and inappropriate water management. Due to small plots of land it is also not possible for them to adopt mechanization or other forms of technological innovations and techniques.

According to the 61st round of NSS, considering formal and informal skills together, 8.2 per cent of marginal farmer and 8.6 per cent of small farmer households hardly had any skills compared to 11.8 per cent medium and large farmer households. This limits the scope of farmer households to find alternative source of income in non-agricultural occupations.

There is also mismanagement regarding use of fertilizers, pesticides and improved manures among small and marginal farmers. Indiscriminate use of these inputs affects the health of soil and nutrition content of products. The NSS data of 59th Round on Survey of Farmers show that, percentage of small and marginal farmers is low compared to large and medium farmers in terms of the usage of modern inputs such as improved seeds, organic manure etc. (Table-2.5).

Table-2.5: Percentages of Farmer Households Using Modern Farming Resources

Land Size (ha)	Fertilizer		Organic Manure		Improved Seeds		Pesticide		Veterinary Services	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
<0.4	71.0	57.7	48.6	37.5	38.0	34.0	39.8	29.6	26.1	21.4
0.4-1	82.3	58.5	62.4	42.0	48.5	36.9	48.9	33.4	30.3	21.9
1-2	82.4	61.0	64.0	43.3	55.8	40.2	54.1	37.4	35.5	26.7
2-4	80.7	59.0	65.9	43.5	57.8	41.6	57.8	36.5	38.8	31.1
>4	75.7	56.6	67.0	42.5	63.6	42.0	56.4	38.8	44.3	31.7
Total	77.8	58.6	58.5	40.8	48.0	37.2	48.0	33.4	31.4	24.1

Source: Computed using NSS unit level data from 59th Round on Statistics Assessment Survey of Farmers, 2003

The XI Plan and The National Commission on Enterprises on Unorganized Sector (NCEUS) observed that the capacity of the agricultural sector to absorb the increasing labour force is limited. Hence, there is a need to diversify to other non-farm and off-farm employment in rural areas. It has been felt that the strategy for development of small and marginal farmers cannot remain confined to agriculture and must recognize the need to generate more employment opportunities through skill development, rural diversification and development of off-farm and non-farm activities. To implement the strategy focusing on small and marginal farmers, the key ingredients are group approach, capacity building and extension services. Hence, skilled human resource is required in the field of training and extension services. Since marginal and small farmers, along with other categories of farmers, can find alternative source of living in non-farm sectors like dairying, fishing, livestock rearing, agro-processing, weaving etc., these allied activities need to be modernized and farmers are to be trained to meet their changing requirements in terms of quality and quantity. These efforts require trained people and extension personnel.

2.2.7 Aspirations of Youth

Youth these days are aware of the importance of education. Thus, the educated youth would play a leading role in agricultural development, but rural youth with a modicum of education do not find agriculture attractive. They hardly choose farming as a profession. Most of them try to get a white-collar job and migrate to cities from rural areas. The youth especially in educated agriculture related fields could be a resource in changing the shape of agriculture. But the situation is totally different. There are a number of reasons which distract youth to shy away from farming. They feel that earnings are low while substantial amount of efforts has to be placed in agriculture. Secondly, they feel that working on farmlands is below the dignity. Thirdly, the highly educated professionals feel that work on farms is not intellectually satisfying, as it does not involve creativity and expression. About 37 per cent of

the total population is of youth which is expected to be 40 per cent up to 2016. About 2/3rd of these will be rural youth and there is a need to develop rural areas in such a way that rural as well as agriculture educated youth are attracted towards it. The country is also facing problem of unemployment among educated youth. Besides, the employment growth rate in the rural areas is dropping from 2.12 per cent during the period 1973-1983 to 0.68 per cent during the period 1993-94 to 1999-2000 (Sheila Bhalla, 2005). It has also been observed that this drop is much more in the agricultural sector as compared to that in non-farm sector. The status of aspirations of youth has to be ascertained and serious thought is needed to make agriculture attractive in farm and non-farm sectors.

2.2.8 Post-harvest Management

A substantial part of the agricultural produce gets wasted due to lack of adequate post harvest management. For instance, in horticulture it is estimated that about 30 per cent produce goes waste between production and consumption due to lack of cold storages facilities, proper packaging loss in transportation etc. Even in cereals and pulses the losses are substantial even though to a lesser extent than in horticulture. An important aspect of post harvest management is value addition through processing of produce and its delivery. The present level of modern processing, even with the stimulus given to food processing industry is very low.

2.2.9 Education and Skill Development

Education in agriculture has to meet the twin needs. One, it has to meet the requirements of industries that employ agriculture educated personnel and secondly, it has to take into account the needs of the farmers and other grass root level workers in the sector. Agricultural education and training have to play critical role in view of large number of stakeholders. A re-assessment of the present system would be necessary in view of new challenges before us.

Apart from higher education in agriculture required for research, teaching, extension, etc. there is considerable need for skill development at the intermediary and lower level for which facilities are far from being adequate. Some of the new technologies being developed like drip irrigation, green house farming, tissue culture and other high- tech require sophisticated but repetitive skills.

2.2.10 Investments

Investments in agriculture are made both in public and private sectors. Plan outlays for successive Five Year Plans indicate a decline in the proportion of outlay on agriculture out of total Plan outlay. This proportion was 5.2 per cent in 8th Plan, 4.9 per cent in 9th Plan and 3.9 per cent in 10th Plan. In the XI Plan, which laid special emphasis on agriculture growth, this proportion is likely to be less than 3 per cent.

2.3 Agriculture Education

2.3.1. Higher Agricultural Education

In the public system, agricultural research and education activities are coordinated by ICAR at national level and State Agricultural Universities (SAUs**)** at state level. Though the central

government supports agriculture development activities, the share of state governments outweighs that of the center as agriculture being a state subject. The SAUs receive funds from respective state governments, ICAR, central government and other agencies in that order.

The establishment of SAUs on the pattern similar to that of the Land Grant Colleges of the United States made a landmark in reorganizing and strengthening agricultural education system. The contributions made by these universities and other institutions accorded the status of deemed-to-be universities, as partners of the National Agricultural Research System (NARS), are well recognized. The green revolution, with its impressive social and economic impact, would not have been possible without the significant contributions made by these centers of learning in the form of development of trained scientific human resource, the generation and assessment of new technologies and their dissemination to the farming community.

The number of agricultural universities in a state varies, depending on the size of the state in agriculture and its regional requirements. The growth of agriculture and general universities over the years is shown in Table-2.6. Briefly, during the past three decades there was a three fold growth in the infrastructure for education in agricultural universities. There was a very heavy reliance on funding from the public sector, and few linkages established with organizations in the private sector.

During 2011, there are 61 agricultural universities, which includes 52 State Agricultural Universities (SAUs), one Central Agricultural University, four ICAR research institutes with the status of deemed to be universities and four central universities having agriculture faculty (Annexure-2.1). In 2010, 436 colleges (383 in SAU's/DUs, and 53 colleges in general universities) were imparting education in eight major disciplines of agriculture and allied sciences such as crops, horticulture, forestry, veterinary, fishery, dairy, agri-engineering and agri-biotechnology. These institutions put together have annual intake capacity of about 35,000 and produce about 24,000 graduates and post-graduates in the eight disciplines of agriculture and allied sciences in the country.

Table-2.6: Growth of SAUs/ DU's and General Universities

Year	SAU/DU	General Universities
1950	-	9
1960	2	11
1970	13	14
1980	22	17
1990	31	20
2001	39	-
2005	43	-
2010	52	25
2011	57	34

Sources: Report on Accreditation for Quality Assurance in Agricultural Education, ICAR, 1999; ICAR and DARE Annual Reports for various years; Rama Rao & Muralidhar, Agriunis, 1994; Project data.

India has a largest network of education in agriculture by having facilities for education in 13 disciplines at undergraduate level and more than 95 subjects at postgraduate level through constituent and affiliated colleges/faculties. List of courses offered in these universities in India is given in Annexure-2.2. In addition to the eight major disciplines, SAUs offer courses

in food science & technology, agri-business management, home science, bioinformatics/ information technology and basic sciences. In 2011, the country has about 626 colleges, 360 in SAU's/DUs, 163 affiliated to SAUs, and 103 colleges in general universities and others imparting education in agriculture and allied sciences. In 2011, tll these institutions put together were admitting about 39,300 and producing about 27,600 graduates and post-graduates in various disciplines of agriculture and allied sciences. Number of colleges in different systems, students intake and outturn is given in Annexure-2.3.

Considering rapid changes in the Indian and global agricultural scenario, periodic curricular revisions are being under taken to take into account a number of factors - the decline in public sector employment, the deterioration of the natural environment, innovation led multi-disciplinary approach and the gender dimensions. To effectively address agricultural and rural development problems, higher agricultural education planners are giving equal emphasis to theoretical as well as inductive reasoning skills so that students can interpret problems and devise solutions. A key feature of the changed curricula is the importance accorded to practical and experiential learning

2.3.2. Diploma and Certificate Courses

Agricultural education, as outlined above, has generally been designed in the past to create trained research and extension professionals at higher levels. The practitioners of agriculture (and allied fields) have not had adequate opportunities for acquisition and development of their knowledge and skills in a formal way in the various newly emerging areas that are expected to add significant value to agricultural production. This position is now being corrected. Some of the State Agricultural Universities offer 2 year courses in agriculture leading to Diplomas and some have certificate courses of short duration. At the school level, under the scheme of Vocationalization of Secondary Education, subjects are taught, inter alia, in agricultural vocations. For example, the courses approved by Central Board of Secondary Education (CBSE) include those in inland fisheries, Basic programme in fruits and vegetables, agriculture and Farm mechanics and engineering. Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal under National Council of Educational Research and Training (NCERT) is involved in research training and development of Syllabi for vocational education in various branches including agriculture related sectors. Indira Gandhi National Open University (IGNOU) provides training in a number of certificate and higher level courses in agricultural subjects through distance learning mode. These include (a) Awareness Programmes on Dairy Farming for Rural Farmers and on Value Added Products from Fruits and Vegetables; b) certificate programmes in Organic Farming, Sericulture, Water Harvesting and Management, Poultry Farming, and Bee-keeping, c) diploma programmes in Value Added Products from Fruits and Vegetables, Meat Technology, Dairy Technology, Fish Products Technology and Value Added Products from Cereals, Pulses and Oilseeds, in addition to doctoral programmes in Agriculture Extension and post graduate diploma programmes in Food Safety and Quality Management Plantation Management. Institutions like the Gandhigram Rural University offer courses in Diploma in Agriculture, Commercial Horticulture and Certificate Course in Maintenance and Servicing of Farm Power Equipment. The National Institute of Open Schooling (NIOS) has Diploma courses in Agriculture, and one-year courses in Jute Production Technology, Oyster and Mushroom Production Technology and Poultry Farming. A number of NGOs have programmes of training youth in the field of agriculture and related subjects. For example, The Morarka Foundation in Jaipur, Rajasthan, have launched a

certificate course of 6 months duration in organic agriculture in collaboration with JRNR Vidyapeeth, Udaipur.

In the field of poultry science, there are several institutes offering diploma/certificate and skill development training programmes. These include Central Poultry Development Organization (CPDO), (Mumbai, Bangalore, Bhubaneswar, Chandigarh), Indira Gandhi National Open University (IGNOU), Central Avian Research Institute (CARI) and Indian Veterinary Research Institute (IVRI), Izatnagar, Poultry Diagnostic Research Centre (PDRC), Pune, National Institute of Open Schooling and Dr B. V. Rao Institute of Poultry Management & Technology (IPMT), Pune. For example, Dr B. V. Rao Institute of Poultry Management & Technology offers regular courses in Basic Commercial Poultry Management, Advanced Course for Large scale poultry farming, Feed Formulation & Feed Analyses course for Feed manufacturers, Hatchery Management course for persons engaged in hatcheries. In the field of fisheries science too, there are a number of diploma and certificate programmes offered. For instance, the Central Institute for Fisheries Technology, Cochin, offers a two-year course in collaboration with Ministry of Labour's Craftsmen Training Programme. There are also several short term training programmmes.

2.3.3. Agriculture Education in Schools

With the exception of Rajasthan and Uttar Pradesh states, agricultural education as a separate stream is not imparted at the school level. Even the Committee on Agricultural Education set up by ICAR in 1997 did not recommend its introduction as a separate subject. At 10+2 level the Committee recommended that agriculture could be introduced as an additional optional subject. In absence of academic and financial support from any national or state agency, education at school level is almost a non-starter in other states. Some changes are taking place in this scenario. For example, MP government has initiated steps to introduce aspects of agriculture in the school curriculum from primary level education onwards. It is a welcome change.

2.3.4. Vocational Agricultural Education

In the existing few vocational schools offering agricultural courses, there are no special efforts to recruit agri graduates to teach such courses or to train the general science graduates teaching these courses. In order to revitalize the vocational stream of education, Government of India is now initiating National Vocational Qualification Framework so that students pursuing the vocational educational programme will receive CBSE Vocational Degree on the lines of current CBSE academic degree. This may attract more students to the vocational stream.

Introduction of need based vocational courses in agriculture is seen to offer a vast potential to create productive, profitable and stable employment in agriculture. In order to reach the vocationalisation of agricultural education, appropriate programmes would have to be developed in collaboration with the involvement of relevant SAUs/ICAR/State institutions in the public sector and agribusiness in private sector for reaching the vast human capital through education and training for creating rural livelihoods and incomes.

Vocational education faces many problems, including lack of social recognition, inflexible curriculum and duration, lack of need-based courses and trained teachers, poor vertical mobility and linkage with industry, and absence of a national competency and accreditation system. The

scheme is being restructured on the recommendations of the Task Force on Skill Development (2006), and is now aiming at preparing educated, employable, and competitive human resources for various sectors of the economy and the global market, enhancing the employability of youth through competency-based modular vocational courses, providing multi-entry and exit learning opportunities, and vertical mobility and interchangeability in qualifications.

2.3.5 Problems in Agricultural Education System

Although agricultural education has generally kept pace with scientific progress in the past, the pace of change is much faster today. The extent of scientific advances in the fields of biotechnology, computers and communications allows shorter assimilation periods. In a global economy, food processing, storage and marketing have become increasingly important to agriculture producers, and thus to agricultural education. The specific reasons for the agricultural education system crisis have been that the agricultural education has been isolated from the market place and from the rest of the education system. This isolation has been leading to curricula irrelevance, falling teaching and learning standards, unattractive employment opportunities and, thus, decreasing investment support. Responses to such crisis were mostly fragmented and inward looking. According to the situation, agricultural education has taken responsibility only for a limited clientele, and has not addressed the needs of all stakeholders. By disregarding the educational needs of all sectors, governments have built an agriculture human resource pyramid where the absence of a diffuse general or specialized knowledge, limit national efforts to implement sustainable policies for agriculture.

There is a need for institutions to develop ways of keeping in touch with the employment market and adapting agricultural education curricula accordingly. It was felt that, ideally, institutions should set up permanent mechanisms for observation of the job-market and adaptation of courses, but it was acknowledged that institutional inflexibility and lack of resources would often make this difficult to achieve.

The above discussion highlights the issues that are critical for agriculture and allied sector in case the targeted growth has to be achieved. The issues need to be addressed immediately with multi pronged approach. Needless to mention that these factors have an impact upon human capital planning, development and utilisation. Matching the job market with that of skills imparted is extremely essential. Keeping the future course of action and developmental policies as well as vision in focus, human capital assessment and forecasts are needed. The present project is a step forward in this direction.

Chapter 3

The Present Study

3.1 Objectives

The present study has been conceived to address the developmental needs of the economy with special reference to education in agriculture and its allied sectors which have an important place in the economy due to their role and potential in providing employment to skilled, semi skilled as well as unskilled persons. Skill needs are changing and hence a need for analyzing the skill gaps, the institutional mechanism in imparting education and assess the future requirements of the sector in the context of human capital.

The objectives of the present study are:

- To assess the supply-demand and employment of trained human resources in agriculture and allied sectors
- To evaluate institutional set up, interface between agricultural graduates with various stakeholders and the impact of diversification of agriculture on skill requirements
- To develop a system dynamics model for forecasting and scenario generation of human power requirement and evolve prospective human resource development strategies

One of the principal components of the objectives is to make an assessment of the future human capital needs in agriculture. This chapter

- provides a conceptual framework for human capital assessment,
- reviews available approaches and methods of human resources forecasting,
- reviews past studies and gaps therein, and
- outlines the approach and methodology adopted for the present study

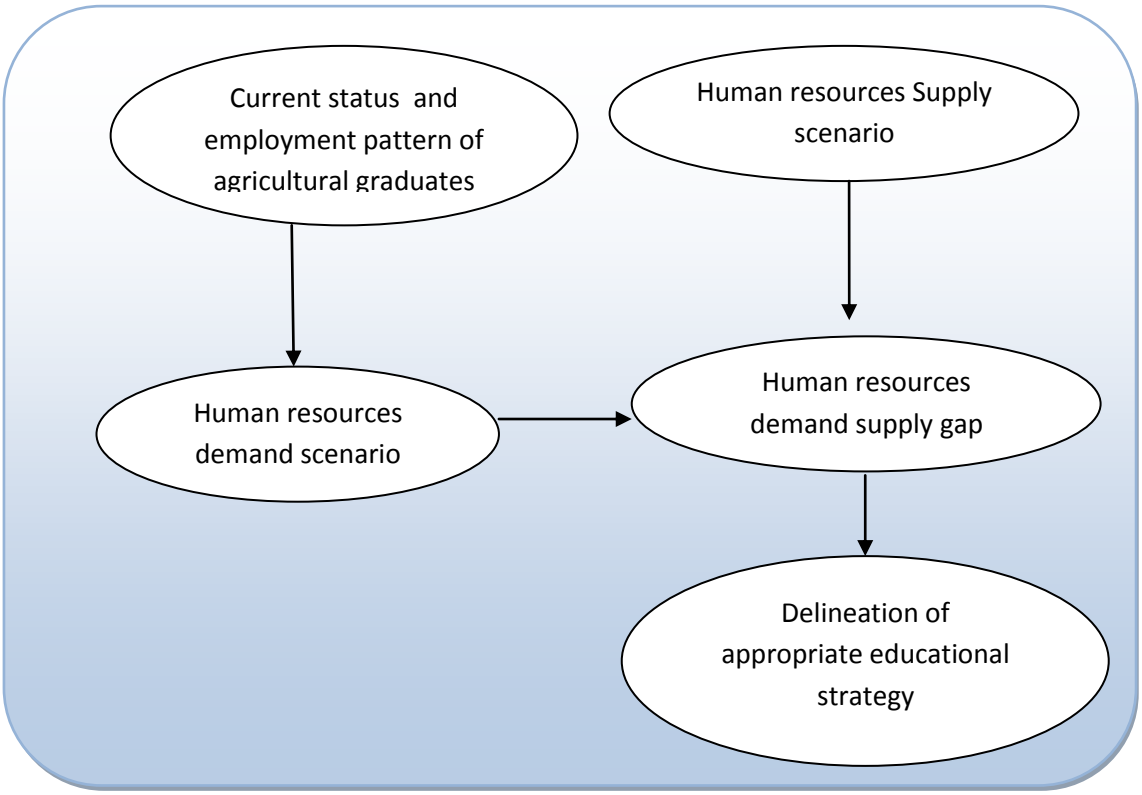
3.2 Conceptual Framework

The broad conceptual framework of the study, comprising five distinct phases, is schematically presented in Fig-3.1.

3.2.1 Human Resources Supply-Demand Process

Both human resources demand and supply can be viewed in terms of both flows as well as stocks. When considered in terms of flows, these terms imply net additional demand and supply during a time period, say a year. In terms of stocks, they imply the total quantum of human resources deployed and the total stock of economically active human resources available at a particular point in time. A graphical representation incorporating the essentials of the human resources demand and supply processes is given in the Fig-3.2, which presents the manner in which all the data collected would lead to integrated framework for analysis of human resources demand and supply gaps.

Fig-3.1: Schematic Diagram of the Study



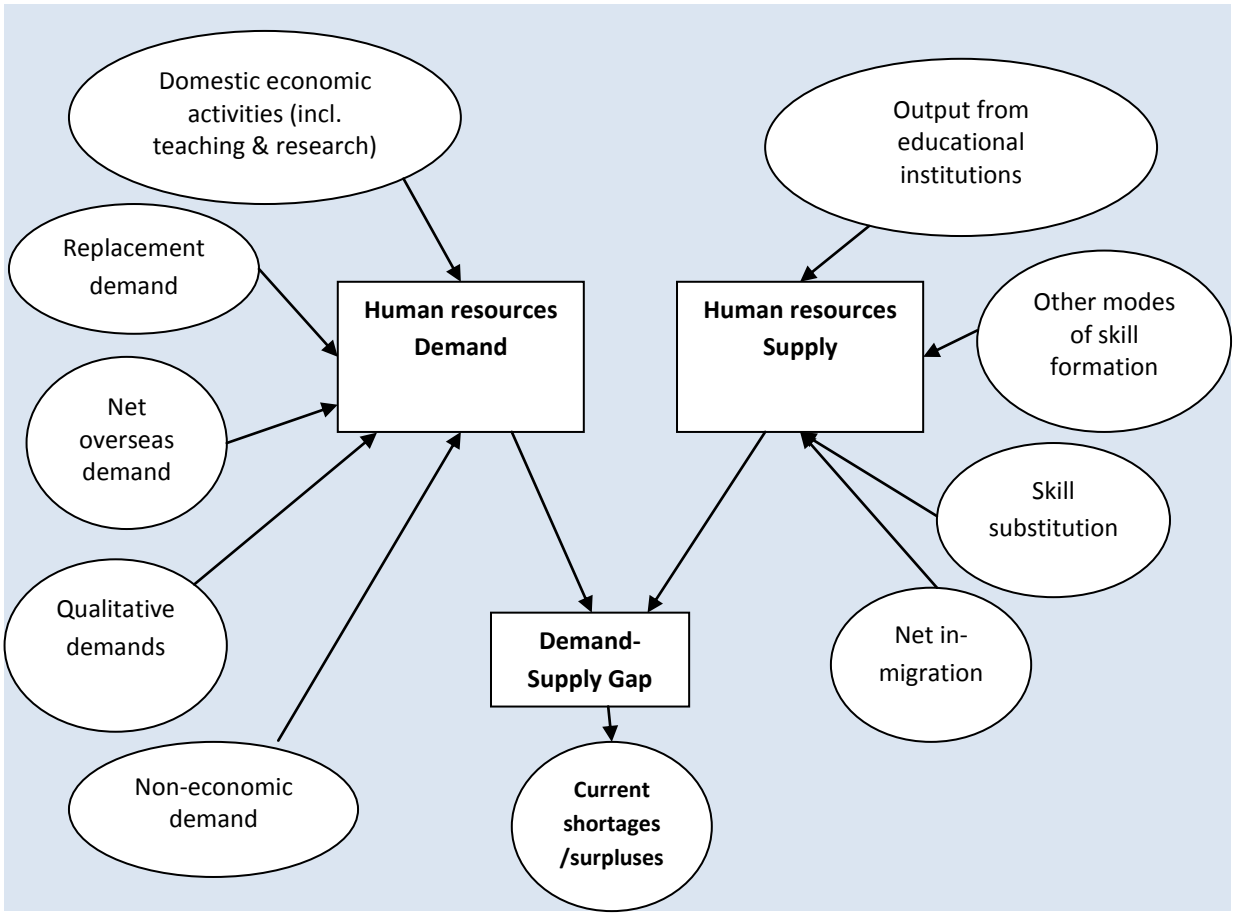


Fig-3.2: Supply-Demand Process

3.3 Forecasting Approaches

3.3.1 Qualitative Forecasts

Qualitative changes likely to take place in future in the human resources demand and supply are captured primarily through qualitative data. The qualitative methods do not aim at exact quantification of future human resources demand in terms of numbers, but ascertain aspects such as gaps between demand and supply in skill content, newly emerging skill needs, structural factors affecting the demand-supply balance, direction of future changes, etc. Such methods include collection of desired qualitative information through structured or unstructured questionnaires in an employers' survey, or eliciting the opinions of experts in the field through key informants approach, focus group discussions covering various quality (as well as, in broad terms, certain quantity) aspects, Delphi technique, etc.

3.3.2 Quantitative Forecasts

Over the past half century, a variety of human resources forecasting techniques have been employed in different countries and in different situations of data availability. These include:

- Employer survey methods
- Norm-based methods
- Time-series and regression (linear/non-linear, simple/multiple) models
- Other econometric models
- Mathematical models
- Rate of returns approach
- Parnes's manpower requirements approach

3.3.2.1 Employers' Surveys of Requirements

A straight-forward method of ascertaining future human resources requirements is to approach the employing agencies directly, either on census or sample basis, and asking for information on their present human resources deployment, skill shortages and the anticipated needs over the forecast period. The method has the advantage of getting information based on the experience and intimate knowledge of the employers about the future labour markets and anticipated technological changes in the industry. However, this approach is handicapped by the fact that few employers would be in a position to foresee their human resources requirements beyond a short period, and even if they are able to, would not always be willing to part with the information.

3.3.2.2 Norm-based Forecasts

In the case of development programmes with standard manning patterns established in relation to the tasks to be performed, future human resources needs can be worked out by applying the staffing norms to the anticipated or planned expansion of the programmes. This approach is applicable mainly in the government sponsored programmes like Community Development, Intensive Child Development Scheme, etc., but has limited or no use in the case of private sector activities. Norm-based forecasts are also useful in arriving at requirements of categories such as teachers (based on projected number of students and

anticipated pupil-teacher ratios) or doctors (based on projected population and desirable density of doctors per thousand of population).

3.3.2.3 Time-series and Regression Models

Time-series models enable making human resources (or for that matter of any economic variable) forecasts on the basis of a study of the historical pattern of changes (usually trends) in the past. Unlike these models, which make use of past data on human resources only, regression models establish relationships between human resources and other safely predictable variables which are associated with human resources variables. Both these types of models, however, require long (spatial or temporal) series of data, not usually available in the field of human resources planning in developing countries. For example, for applying a regression model to forecast requirements of agricultural human resources, one would require a sufficiently long time series on the size of agricultural human resources on the one hand and on the levels of variables that influence the requirement of such human resources like technology, extension network, etc.

3.3.2.4 Other Econometric Models

More complicated econometric models postulating the interplay of a number of variables through a set of structural equations have been developed for forecasting human resources. For example, the Timbergen-Jos[2] model comprises six linear equations relating volume of production, number of students at two levels of education, and the members of the labour force and those entering the labour force during the past six years. The BACHUE models developed by ILO during the 1970s include three sub-models, the demographic, the economic and the income distribution sub-models. The first sub-model tacks the population by age, sex, location and education, the second generates final demand and value added by sector using input-output table, and the third predicts employment and distribution of income[3]. Applicability of these models is again restricted by data availability.

3.3.2.5 Mathematical Models

These models include Markov models, Simulation models , and System Dynamic Models . Markov chain models are extensively used, and are used on the concept of transition probability matrix and usually formulated to estimate long term study state equilibrium conditions. In general these exercises pertain to two distinguished dimensions: human resources supply and human resources demand. Various methods and tools are developed over the time for forecasting. Simulation models imitate and assess the impact of various management scenarios, and answer questions regarding human resource management that determine actual requirements primarily at unit level. System Dynamics (SD) modeling methods developed by Jay W. Forrester is a powerful methodology to understand the systems, their variables and parameters, inter linkages; and to develop a model using both qualitative and quantitative variables (Mohapatra *et al*. 1994). Vizayakumar (1990) has explicitly stated the important features of system dynamics as the ability to (i) dynamically

[2] Timbergen J and Correa, I.H (1962).: *Quantitative Adaptation of Education to Acceleration of Growth, Kyklos, Vol.XV (1962)*

[3] The BACHUE models were developed under ILO's World Employment Programme for the Philippines, Kenya, Brazil and Yugoslavia

model complex relationships of a large number of variables, (ii) consider many related aspects of a problem resulting in a holistic approach, (iii) explicitly model qualitative factors, (iv) experiment with policy alternatives, (v) generate future scenarios, (vi) incorporate features of both the explanatory and normative approaches, (vii) model a wide variety of real world situations. This method was effectively used for human resources assessment in CSIR (Mandal *et al*. 1992, and Shivanagaraju, 1998 & Mohapatra *et al.*1990), for food production (Mandal, 1993), and for oilseed system (Rama Rao et al, 2000) and for soybean system (Bisht *et al*., 1996**)**.

3.3.2.6 Rate of Returns Approach

In this approach the rates of return to investments in different streams of education are computed by assessing the life time earnings foregone. Investment decisions are made on the basis of the relative rates of return from different streams. This approach helps in identifying as to which stream of education results in a better rate of return on investments. It does not help, however, in arriving at a quantitative assessment of human resources requirements.

3.3.2.7 Manpower Requirements Approach (Parnes' Model)

A general approach for forecasting human resources requirements for the purpose of educational planning was originally propounded by Parnes[4] in the context of Mediterranean Regional Project during the early 1960's. The essential steps of this approach is shown in Fig-3.3.

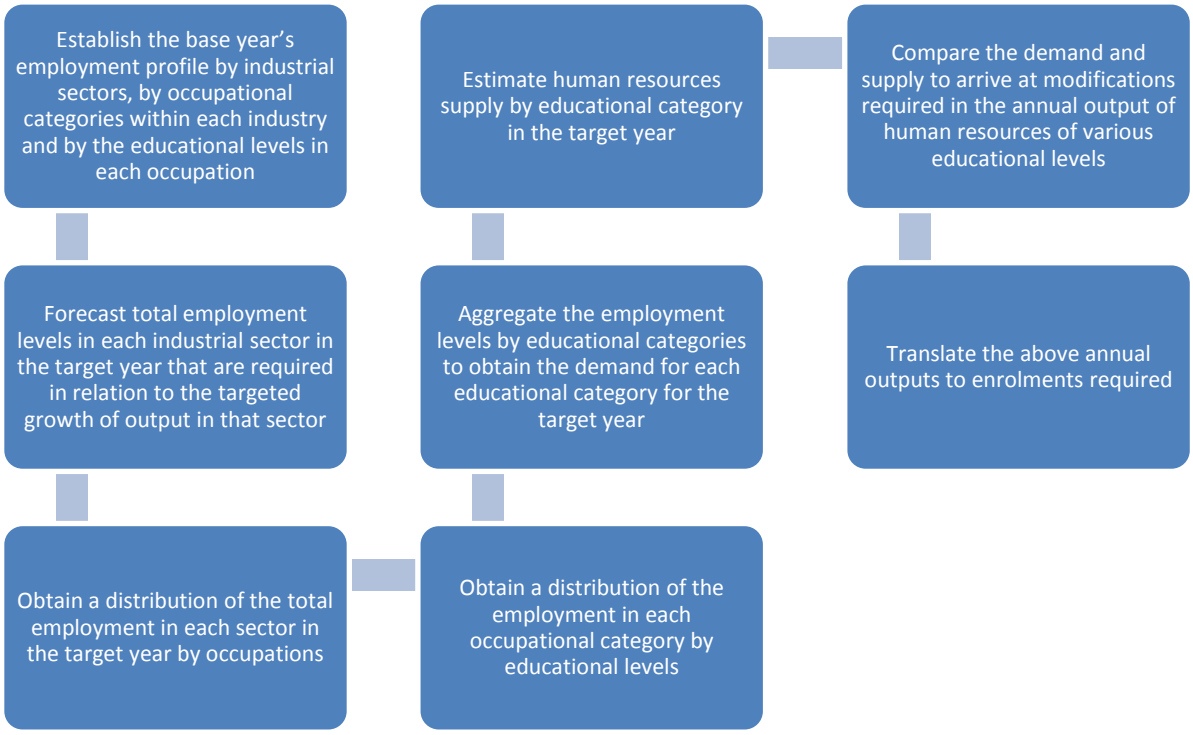


Fig. 3.3: Steps in Parnes Model

[4] Parnes, H.S., (1962): *Forecasting Educational Needs for Economic and Social Development*, OECD, Paris

Mathematical Formulation of Parnes Model:

i) Let the economy be divided into 'k' sectors with outputs of $P^{(1)}(0)$, $P^{(2)}(0)$, ... $P^{(k)}(0)$ in the base period '0', and the corresponding projected outputs of $P^{(1)}(t)$, $P^{(2)}(t)$, ... $P^{(k)}(t)$ in the forecast year 't'. The outputs are generally projected using input-output or other econometric models in the first step.

ii) Let the total employment in the sectors in the base period be $E^{(1)}(0)$, $E^{(2)}(0)$, ... $E^{(k)}$, and the corresponding projected total employment $E^{(1)}(t)$, $E^{(2)}(t)$, ... $E^{(k)}(t)$ in the forecast year 't'. Total employment is projected taking into account likely employment elasticities for different sectors.

iii) Suppose there are 'm' occupational categories and 'n' educational categories and the proportion of occupation 'j' in the employment of sector 'i' is $a_{ij}(0)$ in the base period and $a_{ij}(t)$ in the forecast year. Then, the total employment in occupation 'j' in sector 'i' would be $a_{ij}(0)xE^{(2)}(0)$ in the base period and $a_{ij}(t)xE^{(2)}(t)$ in the forecast period.

iv) If, further, the proportion of educational level 'r' in the employment in occupation 'j' in sector 'i' at time 't' is $b_{ijr,}(t)$ then the total employment of educational level 'r' in occupation 'j' in sector 'i' would be $b_{ijr}(0)x\ a_{ij}(0)xE^{(2)}(0)$ in the base period and $b_{ijr}(t)x\ a_{ij}(t)xE^{(2)}(t)$ in the forecast period.

v) The total employment of educational level 'r' over all occupations and sectors in the base period would then be the sum of all $b_{ijr}(0)x\ a_{ij}(0)xE^{(2)}(0)$ across all 'j' and 'i'. The corresponding sum for the forecast period 't' would give the employment in educational level 'r' in the forecast year. This is the projection for demand for educational level 'r' in the forecast year due to expansion of the economy.

While the mathematical formulation of the approach is easy, the main task is to obtain the various proportions appearing in the equations.

The base year's industry-occupation-education profile of employment (step 1) is to be derived from labour force surveys or censuses. Forecasts of total employment in each sector (step 2) are usually obtained by establishing targets of output for each economic sector (through econometric models, usually Lientief's Input-Output models) and applying projected (on the basis of past trends or anticipated changes) levels of labour productivity or output-employment elasticities for different sectors. Estimated employment by occupations in the targeted year (step 3) are derived by applying to the total employment forecast obtained in step 2 an expected occupational distribution in the target year. There are various ways of anticipating the future occupational distribution – a) assume no changes in the current occupational distributions, b) study, where data are available, past trends in the occupational structure and extrapolate, c) make international comparisons assuming the occupational structures in the less developed countries would gradually move towards those in the more developed countries, d) make inter-firm comparisons assuming that the structures would gradually move towards those in the advanced firms, or d) use appropriate norms in cases where applicable. Translation of these occupational forecasts into educational forecasts (step 4) would again be on the basis of either applying the current profiles assuming that the

existing pattern is the optimal pattern or making appropriate changes in it. Step 5 then is a straightforward one. Step 6 is one of estimating the human resources supply in the target year which equals existing number of workers of the educational category, plus the number of fresh entrants into labour market during the forecast horizon, less the number going out of the labour market for various reasons such as deaths, retirements, and occupational or spatial migration. As a tool for educational planning, Parnes' approach has attracted considerable criticism, but nevertheless is being used extensively with suitable modifications for forecasting occupational employment in disseminating labour market information.

3.3 International Practices

Notwithstanding the objections to Parnes' approach as a tool for educational planning, most developing countries use it, with appropriate refinements, to develop occupational forecasts on a fairly regular basis.

3.3.3.1 Labour Forecasts in United States of America

In the United States of America, the Bureau of Labour Statistics in the Department of Labour develops and publishes ten year forecasts of employment by industries and occupations at highly disaggregated levels (over 300 industries and 700 occupations), revised every two years[5]. The methods used range from econometric and time-series models to explicitly subjective analyses. Labour force projections are made through time-series analysis and smoothing of historical labour force participation rates and applying them to the projected population levels. Industry-wise outputs are projected using econometric models. Occupational distribution of employment is projected by extrapolating the historical data on occupational distribution within each industry to the projection year tempered by appropriate value judgments. Official projections stop with occupational projections, but a study by Bullock and Litzenberg[6] using the official projections for 1998-2008, translated them into educational forecasts and estimated that the job opportunities for agricultural and allied graduates would be about 79,000 in 2008 against the availability of about 57,000 graduates.

3.3.3.2 Occupational Forecasting in Canada

Canada also has been making occupational forecasts since early 1960s. As in the general Parnes's scheme, the starting point for these forecasts is the set of output and total employment forecasts for 67 economic sectors. The industrial scenario was developed in cooperation with the Conference Board of Canada (CBOC)[7]. First, GDP by industry is forecasted based on the outlook for final demand categories of spending in the CBOC's macroeconomic model (Medium-Term Forecasting Model). Secondly, labour productivity by

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[5] Franklin, J.C.,(2007), *Employment Outlook: 2006-16, An Overview of BLS Projections to 2016,* Monthly labour review – November 2007, United States of America, Department of Labour, Bureau of Labour Statistics:

[6] Bullock, K.W, and Litzenberg, K.K (2002): *Forecasting Future employment Opportunities for food, Agriculture, and Natural Resources Higher Education Graduates Using Adjusted Bureau of Labour Forecasts,* Department of Agricultural Economics, Texas A&M University

[7] Government of Canada, Department of Human Resources and Skills Development (2006): *Looking Ahead: A 10-year Outlook for the Canadian Labour Market (2006-15),* Human resources and Skills development Publications Centre, Quebec

industry is estimated based on its historical trend derived from a Hodrick-Prescott filter. The employment forecast by industry is then derived based on the projected GDP and labour productivity by industry. The Canadian Occupational Projection System (COPS) is used to forecast the future occupational patterns in each sector on the basis of past trends revealed by the censuses and the regular monthly labour force surveys. Since 1997, COPS has been using smoothing techniques to project all occupational share series by industry. Over 4,500 equations (140 occupations by 33 industries) are estimated.

3.3.3.3 Occupational Forecasting in Ireland

The most recent occupational projections (XI in the series of Human resources Forecasting Studies) for Ireland relate to 2010-2020[8]. The occupational forecasts were based on sectoral employment projections for 2010 to 2020 derived from the recent projections of the Irish economy made by the Economic and Social Research Institute (ESRI).[9] The macro-economic model used for this purpose provided employment forecasts for eleven major groups, which for the purpose of compiling occupational projections, were further disaggregated on an estimated basis. Occupation –wise employment forecasts were then obtained by projecting the occupational profiles in each sector based on past trends and expectations as to the likely development of occupations over the forecast period. The basic data used to analyse both industries and occupational shares within industries were taken from the 1991 and 1996 Censuses of Population and from the Quarterly National Household Surveys (QNHS) carried out between 1998 and 2005. To convert the occupational; forecasts into educational forecasts, past educational profiles for the period from 1999 to 2005 for occupational groups were analyzed and projected to the forecast years, mainly on the basis of linear or logarithmic forecasting methods. For this purpose, the occupational groups were subdivided into five educational categories - primary; lower secondary (including transition year); higher secondary, PLCs and other non third level; third level diplomas and certificates; third level degree and higher. The projected shares were then applied to the forecast numbers employed in each occupational group for 2010 and 2020, thus providing an educational profile for each occupation in the forecast years.

3.3.3.4 Forecasting in Other Countries

Coming to developing countries and with special reference to agricultural human resources, a study by Hinchliffe (1993)[10] conducted through interviews with potential employers and with secondary school graduates found that the supply of graduates from agricultural schools was far greater than the likely demand.

To summarize, the developed countries generally adapted the Parnes's approach to derive occupational employment forecasts. Only a few countries attempted to translate these forecasts into educational forecasts. The sophisticated methods adopted by the advanced countries to project occupational patterns of employment in different sectors would require a fairly long time series for studying the occupational and educational trends.

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[8] Doyle, N, Lunn, P, and Sexton, J (2006); *Current Trends in Occupational Employment and forecasts for 2010 and 2020,* Final report to The Expert Group on Future Skill Needs, The Economic And Social Research Institute

[9] J. Fitz Gerald, *et al* (2005). *Medium-Term Review 2005-2012.* Dublin: The Economic and Social Research Institute. Dublin

[10] Hinchliffe, K (1993): *Human resources\Forecasting and Rapid Labour Market Analysis: The demand for technical school graduates in Egypt, Journal of Vocational Education & Training, Volume 45, Issue 3, 1993*

3.4 Review of Past Studies in India

Ever since the planning era began in the country, India too has been attempting forecasts of requirements of various human resources categories as a part of its developmental planning. Some important efforts in this direction specifically in relation to agricultural human resources are summarised below[11].

3.4.1 Forecasts in 1970s

The earliest estimates of the requirements of agricultural personnel were those attempted by the Agricultural Personnel Committee set up by the Planning Commission. The Committee[12] estimated the requirements on the basis of certain assumed staffing norms for organizations at block and district levels (e.g. one village level worker for every 10 villages, 3 to 4 agricultural graduates for every block, and 4 to 5 subject matter specialists in agriculture in every district). Replacement needs were calculated at 3 per cent of the employees in position on the assumption of an average working life of 30 to 35 years and even distribution of the stock of personnel across all age groups. Demand estimates were similarly arrived at for various allied sectors like animal husbandry, dairying, fisheries, etc. By and large, the estimation of requirements was limited to the government and government sponsored programmes in agriculture and allied sectors. This is understandably so, as the employment of agricultural and allied sciences professionals was limited primarily to public sector in those years. The Working Group on Agricultural Administration and Personnel, Education and Training set up in connection with the formulation of Fourth Five Year Plan followed same approach in estimating the requirements of agricultural personnel for the Fourth Plan (1966-71) and Fifth Plan (1971-76)[13]. The Working group, however, allowed some provision for the needs of private sector on an ad hoc basis.

3.4.2 Forecasts in 1980s

The Institute of Applied Manpower Research (IAMR) carried out in 1984 two studies, inter alia, to assess the requirements of trained agricultural human resources in Uttar Pradesh and Maharashtra for the ten year period 1983-93. These studies were limited in scope as a) they covered only the requirements of human resources directly involved in agricultural planning and projects, b) only four government departments, viz., Agriculture, Animal Husbandry, Horticulture and Sugarcane were covered and c) private sector was excluded. The estimation was based on data collected from the relevant government departments and agricultural personnel through a set of questionnaires.

Another study[14] by the Ministry of Food and Agriculture, Government of India, while generally following the normative approach followed by the earlier committees as outlined above, made two refinements - one in methodology and the other in coverage. In working out the replacement needs, the earlier assumption of uniform distribution of the stock of employed agricultural personnel across age-groups was given up and the actual age

[11] Institute of Applied Human resources Research: *Assessment of National Human resources Needs in Agriculture and Allied Sectors, Volume III*, 2001, pp 9-13.
[12] Government of India, Planning Commission (1955) *Report of the Agricultural Personnel Committee*
[13] The periods of the Fourth and Fifth Five Year Plan were later revised as 1969-74 and 1974-79
[14] Government of India, Ministry of Food and Agriculture: *Technical Human resources for Indian Agriculture*

distribution derived from the IAMR's studies was made use of. The requirements of the private sector were explicitly covered through a survey of agro-industries.

On a request by the Indian Council of Agricultural Research (ICAR), The Institute of Applied Human resources Research carried out, during the 1980s an in-depth study[15] on the assessment of agricultural human resources, the main objective of which was to estimate the requirement of graduates and postgraduates in Agriculture and Allied sciences over a period of ten years. The assessment was made on the basis of data available from the Annual Reports of Agricultural Universities (1986-87) wherever available and data gathered through a survey of Agricultural Universities for which annual reports were not available and agricultural colleges affiliated to universities other than Agricultural Universities. In view of the low level of response in the all-India survey conducted for the purpose, estimation of human resources needed at graduate level could not be attempted, and only estimates for the post-graduate and higher levels were made.

3.4.3 Forecasts in 1990s

3.4.3.1 Forecast Studies in Andhra Pradesh and Tamil Nadu

As a part of ICAR's Agricultural Human Resource Development Project, three human resources assessment studies were carried out in Andhra Pradesh, Tamilnadu and Haryana during the late 1990s. The **Andhra Pradesh study**[16], conducted by the **Tata Consultancy Services**, Hyderabad, was, ***inter alia***, a) to study the employment trends of the output of the State Agricultural University, b) forecast agricultural human resources requirements in Andhra Pradesh up to the year 2010 in both technical and general categories, c) to study the technical competence of the University alumni to meet the demand in relation to curriculum and education system, and d) to provide a human resources model to present the database on human resources supply and demand projections. Data on the current employment patterns were collected through surveys of various stake holders - a) the government departments and other employers, b) alumni of the State Agricultural University, c) teaching staff of the University and c) farmers. The field surveys provided data ('skill coefficients') on the pattern of the absorption of agricultural graduates into various sectors (such as pesticides, dairy, fertilizers, etc.). Estimates of the Compound Annual Growth Rates (CAGR) for these industrial sectors were independently gathered from the industry circles. These growth rates and the skill coefficients assumed constant over the forecast period, provided the forecasts of future employment of agricultural graduates in these industries. The requirements of extension staff were estimated on the basis of norms (number of villages to be reached by an agricultural graduate, varying from 2 to 5). Skill gap analysis was also attempted through data collected from the surveys of employers and the alumni. Supply side estimates were obtained on the basis of the intake and outturn data from the State agricultural University. The consultants also suggested that a regular human resources information system could be built with the help of the survey instruments used in this study. **Tata Consultancy Services** also did a similar survey for **Tamilnadu** covering the alumni of the State Agricultural University at Coimbatore.

[15] Institute of Applied Human Resources Research;

[16] Tata Consultancy Services, Hyderabad (1999): *Final Report on Human resources Needs Assessment Study (AHRD Project)*

3.4.3.2 Forecast Study in Haryana

The Study for **Haryana** was conducted by **M/s A.F. Ferguson & Co**. who gave their final report in the year 2000[17]. The study was intended to identify the present status and emerging human resources requirements of agriculture, horticulture and allied sectors in farming, agro-industrial and services sectors, demand scenario for agri-professionals at state, regional and national levels, self-employment opportunities, required modifications in curricula for better absorption, etc. Apart from an analysis of secondary data from a variety of sources, the study undertook a primary survey covering existing and potential employers (about 100, in government, corporate sector, financial institutions, research/academic institutions and others including NGOs), discussions with experts in the field, key government officials and with select alumni of Haryana Agricultural University, Hissar, located in Delhi and Haryana. Demand estimates for the government/research/teaching sector were made on the basis of anticipated annual retirements only. In the case of corporate sector, employment was projected using a regression models linking incremental employment with sales/investments. The demand from the self-employment and NGO sectors was estimated from the data collected in the primary surveys. The study led to the following broad conclusions:

- About half of the agricultural graduates are currently employed in government and one-fifth in corporate sector. The share of government sector is declining as future opportunities are limited to retirements only. However, the prospects of employment in the corporate sector are bright
- About 90 per cent of the agricultural graduates are employed in agriculture related activities and only 10 per cent are in un-related activities or have gone abroad
- Employment of agricultural graduates in financial institutions has reached a stagnation point. Majority of fresh employment opportunities in rural credit disbursal process go to plain graduates or MBAs with specialization in finance.
- Less than 2 per cent of the agricultural graduates are presently self-employed and this sector's potential needs to be evaluated

3.4.3.3 Forecast Study by IAMR

While the above studies of TCS and Ferguson & Co were state-specific, IAMR conducted a ICAR-sponsored national level study titled "National Human resources Needs Assessment in Agriculture and Allied Sectors" in 2001.[18] The objectives of this study were to a) to prepare a status report on the current trend in employment pattern and to project the demand and supply of trained human resources in agriculture and allied sectors for one decade, b) to develop a human resources information system, and c) to suggest a workable model for human resources planning. The study collected data from 149 employers and 3,661 individual employees, 75 universities and colleges, 1,747 agricultural graduates passed out, and 93 experts in the field. Estimates of human resources demand were obtained through three approaches. In the first approach, total stocks of agricultural graduates (and veterinary graduates) were first estimated(starting from the base for 1990) up to 2010 by cumulating the outturn data and allowing for attritions at the rate of 1.3 per cent per annum (0.4% for

[17] A.F.Ferguson & Co., (2000): *Final Report on Study on assessment of Human resources Needs and Development*

[18] Institute of Applied Human resources Research (2001): *Assessment of National Human resources Needs in Agriculture and Allied Sectors* (in three volumes)

mortality, 0.3% per retirement and 0.6% for net migration). The stocks less the extent of unemployment among the respective category (as per 1991 census) were taken as the demand estimates. The second method used a norm of 400 agricultural scientists per million of population (suggested by Dr M.S. Swaminathan in the report "Bridge to a Century of Hope on the Farm Front". The third set of estimates is obtained by estimating the CAGR for the period 1981 to 1991 from the respective censuses and holding these rates constant up to 2010. The study recommended, inter alia, a) demand projections based on input-output framework b) a computerised information system on agricultural human resources at state and national levels, c) annual tracer studies covering graduates three years after graduation, and d) a directory of agricultural and allied scientists.

3.4.3.4 Forecast Studies by Others

Apart from the above studies which cover the entire spectrum of agricultural human capital some sector specific assessments have also been made from time to time. For instance, some studies on human resources requirements in fishery sector were conducted by various researchers primarily using normative methods (CIFE, 2000). Similarly in poultry sub sector some attempts were made to forecast human resources demand, mainly on the basis of institutional outturns and the resultant stocks (Sasidhar, 2009).

At the skilled worker level, Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal evolved certain norms to assess the requirements of skilled human resources, particularly at lower levels, in different sub-sectors of agriculture (Sacheti and Salooja, 2000).

The above brief review of some of the major studies on the agricultural human resources bring out the fact that forecasting of human resources demand and supply has been an ad hoc exercise, and each time the researcher has to grope for data. Non-availability of good data and in good time hinders application of sophisticated techniques employed in the US, Canadian or Irish occupational forecasting systems.

3.4.3.5 Recent Studies- A Critique

There have been two studies in recent years that have attempted national level forecasts of requirements of agricultural human resources. The first one is the IAMR's national study and the other the study by M/s A.F.Ferguson. The latter study, even though primarily focused on Haryana, nevertheless attempted national forecasts as well. Both were conducted roughly about the same time, around the year 2000, and the forecast horizon was 2010 in the case of IAMR's study and 2009 in the second study. There is, however, one important difference. While the IAMR's projections were 'stock' projections, those in the other study were 'flow' projections. Thus, while IAMR projected the total number of agricultural graduates and post graduates required by the market by the year 2010, the Haryana study estimated the annual additional number required in the year 2009. The two sets of projections are given in Table-3.1 for 2005 and 2010 in the case of IAMR and 2004 and 2009 in the case of the Haryana study.

As mentioned above, the two sets of projections are not directly comparable as one represents the stocks required and the other the annual additions required. For purposes of comparison, therefore, the IAMR forecasts for 2010 have been converted first to relate to 2009 by linear interpolation between 2005 and 2010 and then as flow variable by adding the annual

expansion demand and replacement demand (estimated at 1.3% of the stock). These are shown in the last row of the table. It will be seen that the trend based forecast of IAMR for 2009 (suggesting an annual outturn of about 10,000 graduates and post-graduates) is fairly comparable with the forecast from the Haryana study. This, however, appears to be much lower than the current annual output from the agricultural educational institutions. It may be mentioned that the trend-based forecast of IAMR is obtained by extrapolating the growth of employed stock between 1981 and 1991, a period very much in the past.

Table-3.1: Forecasts of Agricultural Human Capital Requirements Two Recent Studies by IAMR and AFF

IAMR Study (2000) "Stock" Forecasts (in '000)				Ferguson Study (1999) "Flow" Forecasts (in '000)			
Year	**Stock based**	**Norm based**	**Trend based**	**Year**	**Conservative**	**Likely**	**Optimistic**
2005	284	523	131	2004	7 to 8	7 to 9	8 to 9
2010	344	567	172	2009	8 to 10	9 to 11	10 to 13
2009 (interpolated)	332	558	164	-	-	-	-
2009 Flow forecasts	16	16	10	-	-	-	-

There is, unfortunately, no ready way in which either of the above forecasts for 2009 can be verified or validated. Data from 2001 Census relating to detailed educational categories are not yet published. The National Sample Survey's five-yearly labour force surveys do not give separate data for agricultural graduates. The data from the occupational-educational pattern studies conducted by the Directorate General of Employment and Training (DGE&T) do not give data for the unorganized sector, are based on partial response even for the organized sector, and the latest data relate to 2002-03. Thus, there is no way of estimating the employment size and pattern of agricultural graduates and their unemployment rates for the current year.

3.5 Proposed Approach for Demand Forecast

In the light of the Project objectives, the two basic issues to be addressed through this project are a) to make a forecast of the number of graduates, postgraduates and doctorates (collectively called high level human resources) as well as assess the needs of human capital at sub-graduate level, the number likely to be available over the next ten years, and the quantitative and qualitative skill gaps, and b) to develop a System Dynamic model.

3.5.1 Forecast Period

The base year for the projections has been taken as 2009-10, the year of the commencement of the project. The forecast horizon is taken as 2009-10 to 2019-20.

3.5.2 Demand Forecast

Constraints of data availability dictate the choice of methodology that can be adopted for demand forecasting. Keeping in view the massive and diverse nature of the system of human capital utilization in agricultural and allied sectors and the data availability constraints, the **Parnes' approach** (with certain adaptations) has generally been adopted in the present Project for obtaining quantitative forecasts which covers the needs of the entire economy. This is supplemented by use of **normative approach** where necessary.

The projections have been derived through the following steps:

a) Important sub-sectors have been identified in each sector of the agriculture and allied sectors (such as crops, horticulture, etc.). Such sub-sectors, for instance, include government services, finance, processing industry, research and education, etc.
b) The targeted developments (such as growth rates) in each of these sub-sectors are considered as specified in Plan and other official documents or, where such targets are not available, have been derived on the basis of growth in the recent past and projected using linear regression.
c) Total employment in each subsector in the base year (2009-10) has been estimated, if not available from the existing sources, using either normative approach or trend analysis. Details have been given in Annexure-3.1.
d) The total employment has been broken down into educational requirements of stock on the basis of primary data specially collected in the Project, as outlined later in this chapter. It is generally assumed that the current pattern of employment holds good for future years also. However, wherever deemed necessary on the basis of expert views expressed in Focus Group Discussions, a judgmental approach has been followed to slightly modify the proportions.
e) The stock projections have been converted to flow projections. The flow projections consist of Annual increment in the stock.
f) The replacement needs (due to factors such as retirements, deaths, migration, etc.) taken as 3 per cent of the previous year's stock (Considerations that helped in arriving at this rate of replacement are explained in Annexure-3.2).
g) The requirements of higher education takes into account the fact that the alumni at any level do not all enter the labour market straightaway and a significant proportion of them pursue higher education and become available to economic activity only after certain number of years. (Method of calculation explained in Annexure-3.3)

In addition, qualitative aspects of human capital needs have been captured through **Focus Group Discussions** with various stakeholders, experts and opinion surveys of employed and unemployed agricultural human resources.

3.5.3 Forecast of Supply

The basis for assessing supply of agricultural human resources is the annual institutional output over the years. In the absence of a comprehensive data base on output from agricultural institutions, special efforts became necessary to collect the relevant data from all the academic institutions to assess the levels of output for various years besides taking data from the National Information System on Agricultural Education Network in India (NISAGENET) maintained by Indian Agricultural Statistics Research Institute (IASRI), New Delhi.

3.6 Activities Organised in the Study

As mentioned earlier, data on the current level and pattern of employment and the current shortages and surpluses are not available for the base year 2009-10 or even for a year reasonably close to it. As such, an extensive and detailed **employment survey** became inescapable for establishing the base-line data. No data on the trends in the utilization pattern of the output of agricultural universities are available either. **Tracer studies** covering the recent years' output have, therefore, been contemplated. Apart from the quantitative data that has been collected through the employment survey, tracer surveys provide qualitative information on the adequacy of the education received in agricultural institutions. Qualitative data needs also required Focus Group discussions with various stakeholders in each sector of agriculture and allied sciences.

In the light of set of objectives and the data needs indicated above, the following activities were organized as a part of the Project:

i. Surveys of a sample of establishments
ii. Survey of all SAUs
iii. Tracer Surveys
iv. Individual Experts Survey
v. Focus Group Discussions
vi. Developing a System Dynamics Model

3.6.1 Expert Consultations on Methodological Issues

Various methodological issues including coverage of various surveys proposed, sample size and selection and the data collection instruments were discussed in detail in a series of Workshops of experts from the fields of agriculture and allied sectors, industry, statistics and economics during 2009, followed by detailed discussions with experts from Institute of Economic Growth, CSO, IASRI etc. Based on these deliberations, the sampling scheme and the survey instruments were revised and finalized after a field pre-test. Details of various activities, thus, finalised and executed, are given in the following paragraphs.

3.6.2 Establishment Survey

The primary purpose of the establishment surveys was to obtain a profile of the current deployment of agricultural personnel, an assessment of the employers on the current shortages and skill gaps, emerging skill needs and the quality of the alumni of the agricultural education institutions employed by them. The sample of establishments was selected through a two –stage sampling with stratification at each stage – the Districts in each State/Union Territory being the first stage units and the establishments in the district being the second stage units. The sample size at the first stage was 103 districts and the number of establishments covered the second stage was 4500. Details of allocation of sample to different States and strata are given in Annexure-3.4. Questionnaire used to collect the information from various establishments in the country is given in Annexure-3.5.

3.6.3 Survey of Educational Institutions

Educational institutions in the field of agriculture, besides being generators of agricultural human resources, are also employing units. Therefore, these institutions were also covered by the Establishment Survey as mentioned above. However, as educational institutions, the following additional data had been collected from them.

- Data on the intake and outturn from all agricultural human resources producing institutions by branch and specialty for each year (for estimation of supply)
- Emerging courses and modifications made in curricula and syllabi in recent years
- Relative demand for various courses based on applications
- Anticipated changes in quantity and quality
- Institution-industry linkages
- Transfer of knowledge to farms

In the case of agricultural universities and research institutions, the coverage was on a census basis. The details of items on which information was collected from academic sector is given in Annexure-3.6. In the case of colleges, offering agricultural and allied programmes that are affiliated to SAUs or other universities, students and faculty data was obtained for all such colleges. However, information on the qualitative aspects on education and quality issues was obtained through focus group meetings and personal discussions with faculty and staff of these colleges.

3.6.4 Individual Experts Survey

In addition to the alumni of recent years, expert opinions on the adequacy of the education received in the SAUs in securing jobs and in handling the jobs were also obtained from a number of individual agricultural experts working in various establishments and institutions using the questionnaire given in Annexure-3.7. About 4881 experts were consulted for this.

3.6.5 Tracer Studies

The tracer studies are follow up studies of alumni from the agricultural universities and other teaching institutions, and are expected to provide data on

- Current flows of human resources into different categories – employment by type, self-employment by nature, unemployment, higher education, staying out of labour force, migration (geographical and occupational)
- Migration of agricultural graduates to other occupations
- Perceptions of the alumni about the skill gaps with reference to labour market

The annual out-turn of agricultural graduates and post-graduates is of the order of 40,000 from all universities and colleges. The coverage through tracer studies of alumni was limited to a random sample of alumni covering graduates, post-graduates and doctorates. In all, information was sought from a sample of about 6,000 alumni belonging to various disciplines passed out in 2005 to 2010 through a Questionnaire (Annexure-3.8). The response was from 2,105 alumni.

3.6.6 Focus Group Discussions (FGDs)

Apart from the field surveys to gather the above quantitative data, substantial amount of qualitative data needed was collected about the current skill gaps, anticipated trends and requirements, new disciplines emerging, modifications in curricula, etc. through discussions held with various groups of stakeholders. About 50 Focus Group Discussions (FGDs) were organized as per the target covering different regions of the country and different groups of stakeholders and experts. These stakeholders included university faculty research institutions faculty and scientists, industry personnel, industry associations, students, farmers and farmers associations, NGOs etc.

3.6.7 Data Requirement and Availability

The data requirement and availability from various sources including the activities indicated above are indicated in Table-3.2.

Table-3.2: Methodologies Used for Data Collection

Data items	Data requirement	Data source	Collection method / tool
Current level and employment pattern	Present stock, Employment pattern (Sector-wise, Discipline- wise)	Reports of IAMR, DST and DGET Alumni survey Industry Survey Reports of various departments, Establishment survey	Review of publications Questionnaire
Analysis of human resources supply scenario	Output from the Universities (Discipline-wise, Level-wise)	Education Division of ICAR SAUs	Review of publications Questionnaire
Analysis of human resources demand scenario	Current employment (Sector-wise) Sectoral growth rate Output /human resources ratio	Sector survey Secondary sources Establishment survey	Questionnaire Discussions
Analysis of human resources demand-supply gap	Human resources supply Human resources demand	Establishment survey, Secondary sources	Questionnaire Discussions
Delineation of appropriate agricultural education strategy.	Demand-supply gap (Discipline-wise)	Feedback from SAUs Feedback from alumni and employers	Questionnaire Discussions

3.7 System Dynamics Model

System dynamics modeling was used for forecasting and scenario generation of human capital requirement in agriculture and allied sectors and to evolve prospective human resource development strategies.

3.7.1 Causal-Loop Diagram

Basic causal-loop diagram of the system dynamics model is shown in Fig-3.3. The template shows two negative feedback loops – one related to demand fulfillment and the other related to supply enhancement. The ultimate goal is to create a situation of equilibrium where the demand equals the supply. However, dynamicity of the loops creates imbalances all the time.

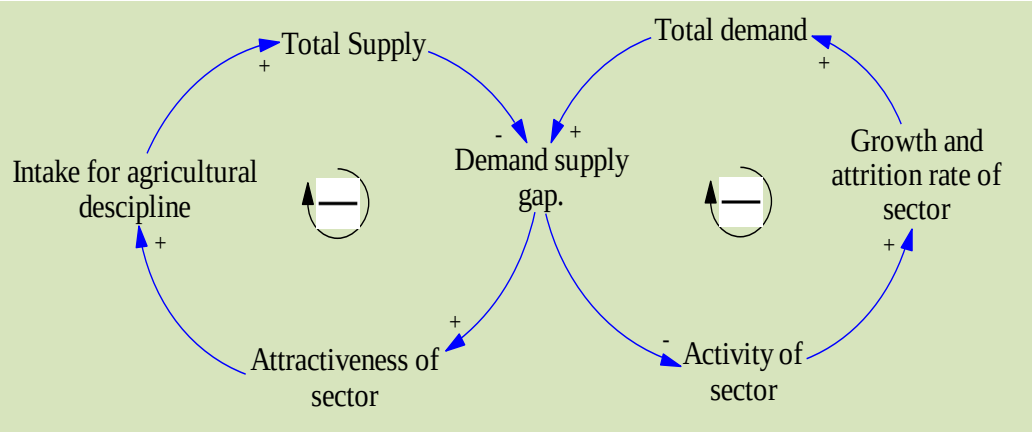


Fig-3.3: Basic Template of the System Dynamics Model

3.7.2 Analysis of Demand-Supply Gap

The Fig-3.3 outlines the overall view of the supply-demand gap process. The demand comes from the attrition of currently employed accumulation and additional requirements due to growth of economic sectors employing the graduates. The supply constitutes the graduating students from the colleges and universities in four categories – diploma graduates, degree graduates, post-graduates, and doctorates. The employment sectors seek agricultural pass-outs with diverse goals and demand-specific skills. The employment depends on the extent to which the acquired skills of the aspiring graduates match with that expected by the employers. Supply-demand gap affects the attractiveness of the sector which subsequently affects the intake in the agricultural colleges and universities and also positively affects the central activity of a sector.

When seen in detail, the causal loops are identified for the demand side as well as for the supply side. The demand side causal loops are shown in the Fig-3.4. As may be seen, demand arises because of inherent growth of the sector as well as for the need of fulfilling the attrition. However, Actual New Jobs are different from the Perceived New Jobs because of demand-supply gaps that may be present in the system.

The supply side causal loops are shown in Fig-3.5. The supply of human resources in agriculture and allied sector arises from the pass-out rates of undergraduate (UG), postgraduate (PG), Ph.D., and Diploma students. The intake capacity and Out-turn Ratios are

important considerations in this regard. When Supply-Demand gap becomes negative, the attractiveness of the sector increases, and the out-turn ratio improves and so are the intake capacities.

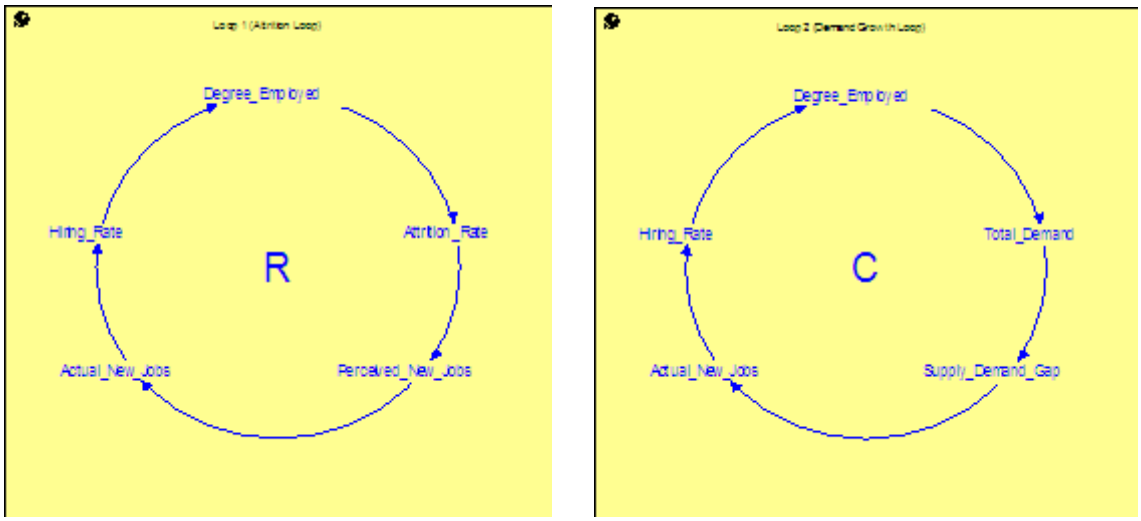


Fig-3.4: Demand-side Causal Loop Diagrams

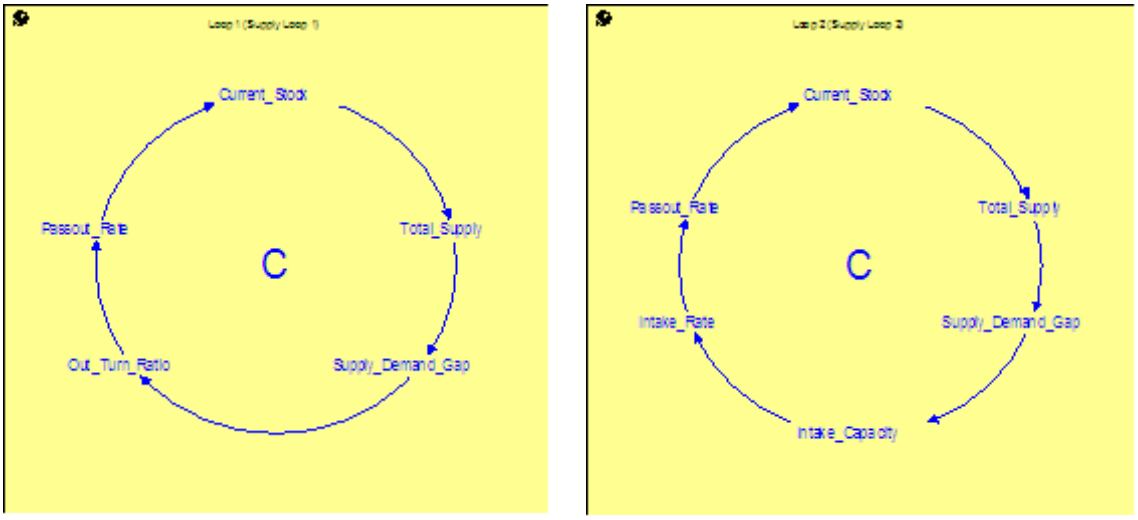


Fig-3.5: Supply-side Causal Loop Diagrams

3.7.3 Development of the Simulation Model

For each sub-sector, the system dynamics model is developed using Stella 5 software. The model dynamically integrates demand and supply sub-models. The simulation model is developed for the following four major divisions. These are as follows:

1) Demand of Degree Holders
2) Supply of Degree Holders
3) Demand for the Diploma Holders
4) Supply of Diploma Holders

The details of these are given below in Figs.-3.6, 3.7, 3.8, and 3.9. 'Total Demand' of the degree holders depends on the 'Degree Employed' as a function of the Growth Rate' of the sub-sector considered. If the 'Total Demand' is less than the 'Total Supply' for this sector, then there exist a 'Supply Demand Gap'.

As is evident from the Fig-3.6, the 'Hiring Rate' of the degree holders depends on 'Actual New Jobs' that are available. The 'Attrition Rate' is assumed to be 3 per cent per year. The 'Degree Employed' is the level variable showing the accumulations at a point of time.

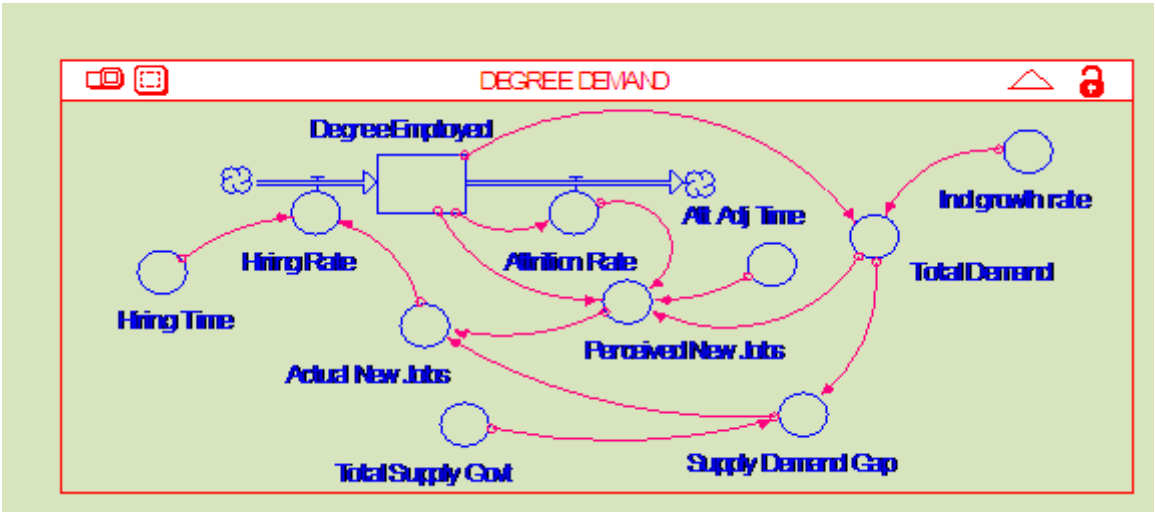


Fig-3.6: Demand of Degree Holders

'Total Demand' of the degree holders depend on the 'Degree Employed' multiplied by the (1 + 'Growth Rate') of the sub-sector considered. If the 'Total Demand' is less than the 'Total Supply' for this sector, then there exist a 'Supply Demand Gap'.

'Perceived New Jobs' are computed as per the following equation:

Perceived New Jobs = (Total Demand – Degree Employed)
+ (Attrition Rate * Attrition Adjustment Time)

Now 'Actual New Jobs' can be defined as:
If Supply Demand Gap is +ve
Actual New Jobs = Perceived New Jobs
Else Actual New Jobs = Perceived New Jobs + Supply Demand Gap

The model in the Fig-3.7 shows that there are Intake Capacities specified for UG, PG, and PhD students. Out of these capacities, only a percentage of students actually pass out. The Pass Rates are determined by the following equation:

Pass Rate = Delay (Intake Rate, Years of Study, Initial Value)

Intake Rate = Intake Capacity * Outturn Ratio

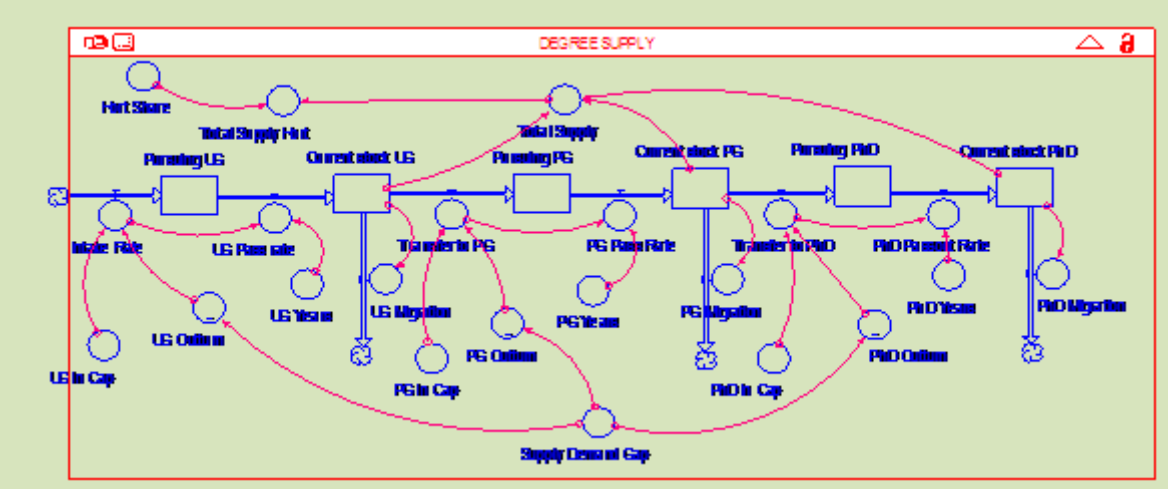


Fig-3.7: Supply of Degree Holders

The years of study is considered to be 4 years for UG, 2 years for PG, and 3 years for PhD. The migration rates are all assumed to be 3 per cent per year.

In case of PG and PhD, the pass-out rate depends on Transfer rate of students from other related disciplines as well. For simplicity, it is assumed that 50 per cent seats are filled by such transfers.

The students who pass out join the accumulations of 'Current Stock UG', 'Current Stock PG', and 'Current Stock PhD' respectively. When these are added together, we get the 'Total Supply' for a sector. Since 'Total Supply' for a sector will be same for all the sub-sectors, the "Total Supply' for a sub-sector may be calculated by the following equation:

Total Supply Govt Sub-Sector = Total Supply * Share of Govt in the Sector

In the case of demand for diploma holders also (Fig-3.8), 'Hiring Rate' depends on 'Actual New Jobs' that are available. The 'Attrition Rate' is assumed to be 3 per cent per year. The 'Diploma Employed' is the level variable showing the accumulations at a point of time.

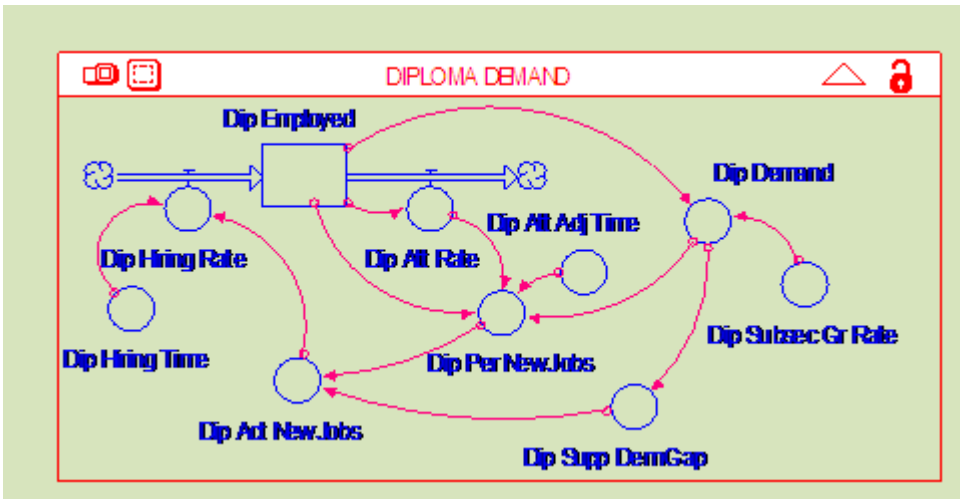


Fig-3.8: Demand of Diploma Holders

'Diploma Demand' depends on the 'Diploma Employed' multiplied by the (1 + 'Growth Rate') of the sub-sector considered. If the 'Total Demand' is less than the 'Total Supply' for this sector, then there exist a 'Supply Demand Gap'.

'Perceived New Jobs' are again computed as per the following equation:

Perceived New Jobs = (Total Demand – Degree Employed)
+ (Attrition Rate * Attrition Adjustment Time)

Now 'Actual New Jobs' can be defined as:

If Supply Demand Gap is +ve
Actual New Jobs = Perceived New Jobs
Else Actual New Jobs = Perceived New Jobs + Supply Demand Gap

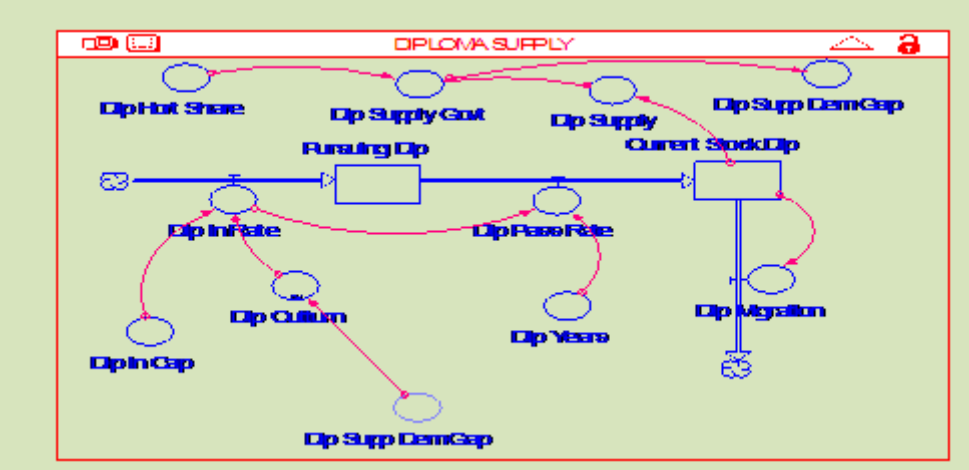


Fig-3.9: Supply of Diploma Holders

The model in the Fig-3.9 shows that an Intake Capacity. Out of these, only a percentage of students actually pass out. The Pass Rates are determined by the following equation:

Pass Rate = Delay (Intake Rate, Years of Study, Initial Value)

Intake Rate = Intake Capacity * Outturn Ratio

The years-of-study is 3 years for Diploma. The migration rate is 3 per cent per year.

The students who pass out join the accumulations of 'Current Stock Diploma', This stock is also equal to the 'Total Supply' for a sector.

Since 'Total Supply' for a sector will be same for all the sub-sectors, the "Total Supply' for a sub-sector may be calculated by the following equation:

Total Supply Govt Sub-Sector = Total Supply * Share of Govt in the Sector

3.7.4 Policy Analysis

The present study has considered an endogenous model in which the growth of the agricultural sector as a whole or one of its subsectors is determined by the dynamics of supply-demand gap as explained through the causal-loop diagram. An overall target growth of 4 per cent is assumed for the entire agricultural sector – although such target growths are different for different sectors and subsectors.

The system also enables testing policy option, i.e. expansion of education and its effect on supply–demand scenario. Two policies are considered. The first one is a base run in which the intake capacities to the agricultural institutes are frozen at 2009-10 levels. The second policy considers increase in the present intake capacities.

3.8 Educational Strategies

One of the main purposes of human resources forecasting is to assist the government in planning future education to meet the societal demands. The projections comprise several components, i.e. stock, future need by sector and occupation. Experts' views are taken into consideration while finalizing the final projections.

For each occupation there is an estimate of current employment and future development trend. From discussions with senior executives in various occupations, desired skills in respective occupations are obtained. Educational strategies are then developed from these outcomes.

Educational strategies were tested as various policy options in the simulation model. The model developed with an emphasis on determining the required outputs of the various technical skills and estimating the enrolments that would be required to achieve these outputs. Thus, the model could be used to determine the labour supply required to achieve targets expressed in terms of economic growth.

Assumptions

- Due to development interventions of the Government of India in terms of various flagship programms like horticulture mission, watershed development, etc., as well as other schemes, there would be a need for professionally qualified personnel.
- Currently at many agriculture related positions, personnel from general stream are working. Gradually professionally qualified persons will be hired in all such occupations.
- To meet the target of agriculture growth, government will adopt pro-active policies and their implementation.
- The booming allied sectors of agriculture such as horticulture, dairy, etc., will continue the pace of development which would have positive impact upon human capital needs.
- The vacant positions will be filled up at a faster rate to meet the needs of agriculture sector.
- With rural enterprise development, technological innovations, etc., qualified persons would be required to cater to the needs of farmers.
- At present, there is a network of higher education institutions across the country while the same is lacking at lower education. Government and other state level organisations will take pro-active measures to establish a network of institutions that would cater to the requirement of technically trained human capital needs.

In all the sectors of agriculture, forecasts have been made keeping two scenarios - one considering the current growth of the sector and sub-sectors and another relatively higher growth envisaged by planning commission, their schemes and flagship programmes, vision of various sectors, etc. After providing the forecasts on the basis of these two scenarios, the study recommends average of the two.

Chapter 4

Profile of Agriculture and Allied Sectors

4.1 Scope

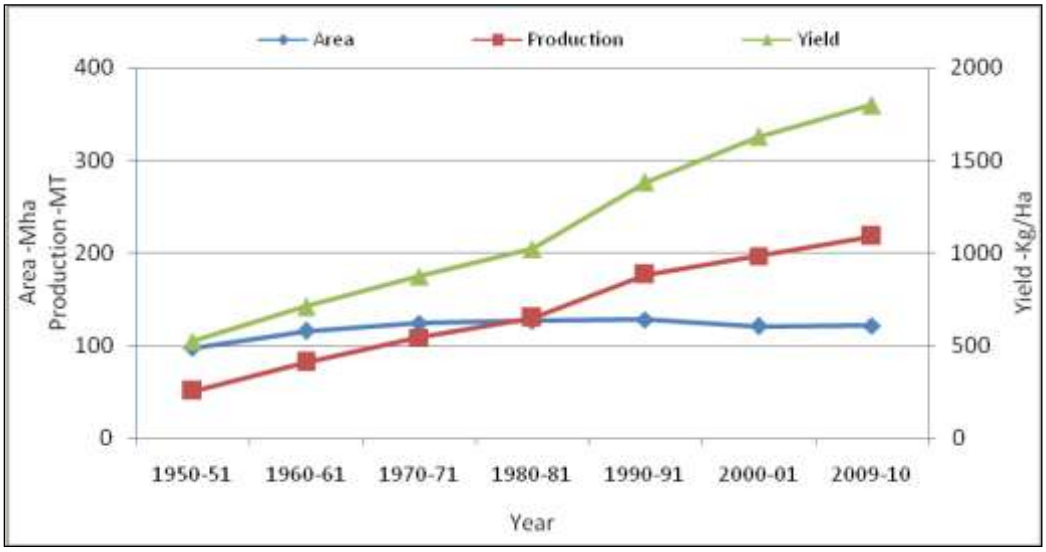
This chapter discusses the main features of different sectors of agriculture namely crops, horticulture, forestry, agriculture engineering, veterinary and animal husbandry, dairy, fisheries and agricultural biotechnology.

4.2 Crop sector

The crop sector includes production of food grains (cereal and pulses), oil seeds, sugarcane, cotton, jute and mesta.

Fig-4.1 demonstrates the marginal increase in land availability for crops over the past half a century and the growth in production mainly through improvement of yield, which in recent years has tended to flatten.

Fig 4.1: Trend in Area, Production and Yield of food grains



Source :Ministry of agriculture, GOI, 2011

4.2.1. Production of Major Crops

Production of important crops during 1950-2010, and their growth rates are given in Table 4.1. The food grain production has increased from 51 million tonnes in 1950-51 to about 234.47 million tonnes in 2009-10. The productivity of food grains increased from about 0.5 t/ha to about 1.7 t/ha since independence. Growth rate declined from 3.72 per cent in 1980s to 2.35 per cent in 1990s (Planning commission, 2004b). About 60 per cent of agriculture potential is unrealized and the productivity is only two-thirds of the world average.

Table-4.1: Production of Major Crops and Agriculture Produce (in million tonnes)

Crop	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2009-10
Rice	20.58	34.60	42.22	53.63	74.29	85.5	87.56
Wheat	6.46	11.00	23.8	36.31	55.14	68.55	80.28
Other cereals	15.38	17.20	30.55	29.02	32.7	30.36	34.27
Pulses	8.41	8.40	11.82	10.63	14.26	11.72	14.27
Sugarcane	57.05	110.0	126.37	154.25	241.05	301.44	251.27
Cotton (million bales)	3.04	5.60	4.76	7.01	9.84	11.48	22.31
Oilseeds	5.16	7.0	9.63	9.37	18.61	18.7	26.32

Source: Directorate of economics and statistics, Ministry of agriculture, GOI, 2011.

India produces around 88 million tonnes of rice against world's production of 700 million tones, thus, accounting for 13 per cent of world rice production and it is second largest producer after China.

4.2.2 Leading States Producing Food Crops

During 2008-09, India recorded maximum food grain production of 234 million tones. Five leading states contributed nearly 54.3 per cent of the total production (Table-4.2).

Table-4.2: Top Five Food Grains Producing States During 2008-09

S.No	State	Food grain Production (Million Tonnes)	per cent Total production
1	Uttar Pradesh	46.73	19.93
2	Punjab	27.33	11.65
3	Andhra Pradesh	20.42	8.70
4	Rajasthan	16.68	7.11
5	West Bengal	16.30	6.95
	All – India	**234.47**	**100**

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2010.

4.2.3 Growth Targets for Various Crops

The XI Plan has targeted an overall growth rate of 4 per cent per annum for the GDP from agricultural sector as a whole (Table-4.3). Within this overall target, the crop sector GDP contribution is targeted to grow at 2.7 per cent. The Working Group on Crop Husbandry[19] constituted in connection with the formulation of XI Plan made the following observations while recommending the above growth scenario for the crop sector.

[19] Planning Commission, Report of the Working Group for the XI Fiver-Year Plan (2007-12) on Crop Husbandry, Agricultural Inputs, Demand and Supply Projections and Agricultural Statistics, Dec. 2006, pp 53-54

- There cannot be exceptionally high expectation of growth from crop husbandry on account of various factors associated with production system and factors of production. However, the growth momentum can be energized and sustained at modest to moderate levels in different crop segments.
- In the case of food grains a modest growth of 2.3 per cent is envisaged, more on the consideration of desirability than feasibility as this much of growth is must for maintaining food security of the country.
- The growth rates proposed for oilseeds (4%) and other crops (3.3%) are desirable and feasible.

Table 4.3: Proposed Growth Rates of GDP in Various Sub-sectors of Agriculture in XI Plan (2007-12)

Sub-sector	GDP share in 2005-06 (%)	Proposed annual growth rate (%)
Food grains	*26*	2.3
Oilseeds	*6*	4.0
Other crops	*14*	3.3
All crops	46	2.7

Source: Planning Commission, Report of the Working Group for the XI Five Year Plan (2007-12) on Crop Husbandry, Agricultural Inputs, Demand and Supply Projections and Agricultural Statistics, Dec. 2006

The demand projected above has to be met through appropriate sectoral development activities like adequately increasing facilities for producing high quality planting material, production and post-harvest management, The demand and supply forecasts of food grains and other crops that led to the above growth targets are given in the Annexure-4.1. It would be seen that the production levels in 2009-10 are in fact lower than in 2006-07 except for oilseeds, and lower than the demand projected in all cases (except jute and mesta). In fact, the Mid-Term Appraisal of XI Plan indicates that the rates of growth of gross value of output of crops have been 6.1 per cent in 2007-08, (-) 2.5 per cent in 2008-09, and (-) 5.5 per cent in 2009-10, averaging a growth rate of about (-) one per cent during the first three years of the XI Plan[20]. This has implications for ensuring food security and calls for a much greater effort to attain the growth rates postulated for these sectors in years to come.

4.3 Horticulture Sector

Horticulture sector includes production of fruits, vegetables, medicinal plants, plantation crops, flowers, and spices.

4.3.1 Production and Productivity

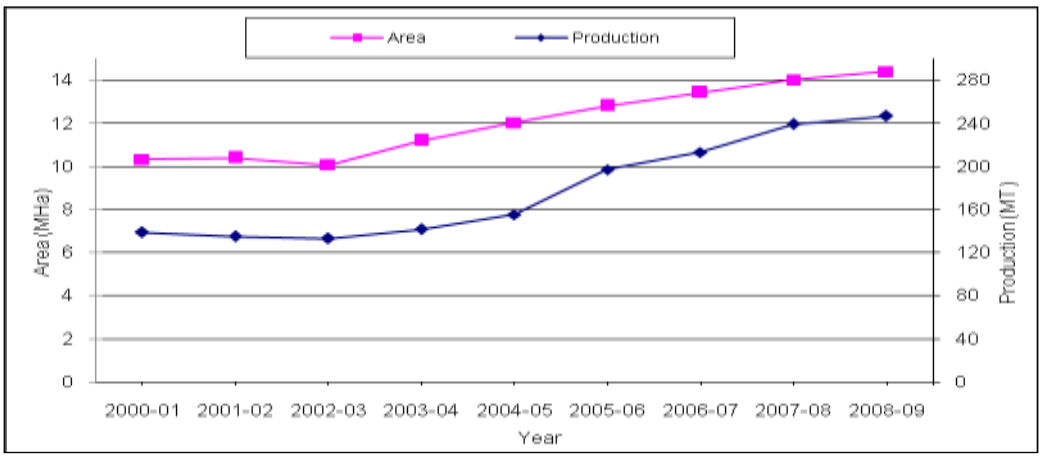
The production of horticulture crops has been expanding steadily after independence. Driven by factors such as the changing consumption pattern among the population in favour of fruits and vegetables and overseas requirements from the demand side, and the shrinking per farmer availability of cultivable land leading to a shift from extensive cultivation of crops such as

[20] Planning Commission, Mid-Term Appraisal of XI Five Year Plan, 2010

cereals and pulses towards to more rewarding intensive fruit and vegetable cultivation on the supply side, and the stimulus received through growing public and investment in horticultural research, development and post-harvest management, the sector witnessed significantly rapid growth since 8th Five Years Plan in the cultivated area, production levels as well as productivity.

Area and production under various horticultural crops during 2000-01 to 2008-09 are given in Fig-4.2. The area and production under horticulture crops rose from 10.32 million hectares and 138.47 million tonnes (MT) respectively during 2000-01 to 14.38 million hectares and 246.64 million tonnes by 2008-09. Area increased at an average annual growth rate of 4.5 per cent during the period 2000-01 to 2008-09, while production rose at a rate of 5.6 per cent, the productivity having gone up from 9.57 MT per hectare in 2000-01 to 10.39 MT per hectare in 2008-09. Production, however, increased at a faster rate of 7.4 per cent per annum during the Tenth Plan period (2002-2007), on account of launching of National Horticultural Mission.

Fig.4.2 Trends in Horticulture Area and Production



Source: Ministery of Agriculture, GOI, 2010

The performance of major horticultural crops is given in Table-4.4. India ranks second in the world fruit production with an annual output of 48 million tonnes accounting for about 8 per cent of the world's fruit production.

Table-4.4: Production of Horticultural Crops

S.No	Crop	Production during 1999-2000 (Million tonnes)	Production during 2009-10 (Million tonnes)
1.	Fruits	46.5	68.5
2.	Vegetables	95.0	129.1
3.	Spices	3.1	4.14
4.	Cashew	0.5	0.6
5.	Arecanut	0.4	0.4
6.	Coconut (billion nuts)	16.9	11.96
	All	**162.4**	**214.7**

Source: Directorate of Economics and Statistics, Ministry of Agriculture, GOI and *Indian Horticulture Database*, National Horticulture Board, Ministry of Agriculture, GOI, 2010.

The diverse agro-climatic zones in the country make it possible to grow almost all varieties of fruits and vegetables in India. The country holds the first place in global production of bananas, mangoes, coconuts and cashew. Horticultural production - fruits, vegetables, flowers, cashew, spices, etc., account for 25 per cent of total agriculture exports. Mango and mango-based products constitute 50 per cent of exports.

The per capita fruits consumption is only about 100 gms/day which is almost half the requirement of a balanced diet. It is estimated that more than 20 per cent of the total production of fruits is lost due to spoilage at various post harvest stages.

The fruit production in India has recorded a growth rate of 3.9 per cent, whereas the fruit processing sector has grown at about 20 per cent per annum. However, the growth rates have been extensively higher for frozen fruits & vegetables (121%) and dehydrated fruits and vegetables (24%). There exist over 4000 fruit processing units in India with an aggregate capacity of more than 1.2 million tonnes (less than 4 per cent of total fruits produced).

India is the second largest producer of vegetables in the world (ranks next to China) and accounts for 15 per cent of the world's production of vegetables. The current production level is over 129 million tonnes and the total area under vegetable cultivation is around 8 million hectares, which is about 4 per cent of the total area under cultivation in the country. The average yield of various vegetables are low compared to those experienced in other countries of the world.

4.3.2 Processing

Bulk of the perishable horticultural produce (fruits and vegetables) is consumed in domestic market directly or exported. At present processing is done only to the extent of about 10 per cent of the production, up from about 6 per cent in 2004-05.

It is estimated that around 20-25 per cent of the total vegetables is lost due to poor post harvesting practices. Less than 2 per cent of the total vegetables produced in the country is commercially processed. Around 150,000 tonnes of vegetables is sold as processed products.

The 2015 Vision Document of the Ministry of food Processing Industries envisages an increase in processing content of fruits and vegetables to the extent of 15 per cent by 2015.

4.3.3 Exports

The scenario of exports of horticulture produce is also encouraging. The exports of fresh as well as processed foods, vegetables and their seeds increased from 581.93 thousand MT in 1991-92 to 3393.60 thousand MT in 2008-09. The quantity of exports nearly doubled since 2003-04 from 1726.27 thousand MT.

Export of processed vegetables has registered a compounded annual growth rate of 16 per cent in volume and 25 per cent in value in recent times. Onions account for about 93 per cent (in volume) of the total export of fresh vegetables from India.

4.3.4 National Horticulture Mission

A major initiative taken for horticulture development was the launching of National Horticulture Mission in 2005-06 as a Centrally Sponsored Scheme to promote holistic growth of the horticulture sector through an area based regionally differentiated strategies. The mission envisages an end-to-end approach covering production, post-harvest management and marketing of horticultural produce. The scheme is fully funded by the Government and different projects in the areas of infrastructure for plantation (such as, production of planting material, establishment of new gardens, rejuvenation of existing plantations, creation of water sources, protected cultivation like greenhouses, etc.), integrated post-harvest management (cold storage units, mobile cooling units, storage units, cooling chambers and preservation units) and marketing infrastructure (like terminal markets, wholesale and environmentally controlled retail markets, infrastructure for colleting, grading and packing, etc.) are supported on the scales laid down. All the states, and three UTs of Andaman and Nicobar Islands, Pondicherry, and Lakshadweep are covered under the Mission, except for the eight North Eastern states including Sikkim, Jammu and Kashmir, Himachal Pradesh, and Uttarakhand, which have been covered under the Technology Mission for Integrated Development of Horticulture in the North Eastern States.

Progress under National Horticultural Mission is given in Annexure-4.2 About 2,830 new nurseries are to be established by the end of XI Plan. There is also a provision to strengthen the existing nurseries and establish tissue culture units.

4.3.5 Other Institutional Mechanisms

Other institutional mechanisms established for promotion and development of horticulture in the country include the national Horticulture Board, Coconut Development Board, National Bamboo Mission, Central Institute of Horticulture (CIH), Medziphema, Nagaland, apart from the Coffee Board, Tea Board, Rubber Board and Spices Board under the Ministry of Commerce and various institutes under ICAR in the Department of Agricultural Research and Education, such as the Institute of Horticultural Research, Bengaluru.

4.4 Forestry

Forests are an important natural resource of the country, being the source of livelihood for millions of people and protectors of the country's ecosystems and climate. Forests "support a rich collection of biological diversity, supply a range of products and ecosystem services, and provide the basis of livelihood for millions of forest communities in the country"[21].

The contribution of 'forestry and logging' to GDP has steadily declined and is currently 0.7 per cent in 2008-09[22]. The decline, however, has to be viewed in the context of the overall decline in the share GDP of agriculture sector as a whole as a result of high rates of growth in other sectors, primarily the service sector. More than 100 million rural people depend on the sale of non-timber forest products for their livelihoods. It is estimated that small-scale enterprises based on non-timber forest products provide up to 50 per cent income for 20-30

[21] Ministry of Environment and Forests: Report to the People on environment and forests, 2009-10

[22] Central Statistical Organization; Brochure on New Series of National Accounts (2004-05)

per cent of the rural labour force. Despite excellent forestry tradition, forest quality and forest products have also declined with time.

4.4.1 Forest Area

The forest and tree cover of the country is 78.37 million hectare (m ha), accounting for 23.84 per cent of the geographic area of the country. Out of this, the forest cover is about 69.09 mha, which constitutes 21.02 per cent of the geographic area of the country. Of this 8.35 mha (2.54%) is very dense forest, 31.9 mha (9.71%) is moderately dense forest, and the rest 28.84 mha (8.77%) is open forest, including 0.46 mha of mangroves. In spite of the rising pressures for supply of goods and services from a rapidly growing population resulting in the over-utilization of the country's forests, the forest cover of India increased from 65.96 mha in the 1997 assessment to 69.09 mha in the 2007 assessment, i.e., an increase of 3.13 mha (4.75%). However, despite a relatively stabilized forest cover and marginal improvement since the 1990s, the quality of the resource remains a concern

Many forests in India are found in high-rainfall, high-altitude regions, areas to which access is difficult. About 20 per cent of total forestland is in Madhya Pradesh; other States with significant forests being Orissa, Maharashtra, and Andhra Pradesh (each with about 9 per cent of the national total), Arunachal Pradesh (7%); and Uttar Pradesh (6%). The variety of forest vegetation is large - there are 600 species of hardwoods, sal and teak being the principal economic species.

4.4.2 Strategy to Increase Forest Cover

India's long-term strategy for forestry development reflects three major objectives: to reduce soil erosion and flooding; to supply the growing needs of the domestic wood products industries; and to supply the needs of the rural population for fuel wood, fodder, small timber, and miscellaneous forest produce. To achieve these objectives, the National Commission on Agriculture (1976) recommended the reorganization of State forestry departments and advocated the concept of social forestry. The Commission itself worked on the first two objectives, emphasizing traditional forestry and wildlife activities; in pursuit of the third objective, the commission recommended the establishment of a new kind of unit to develop community forests. Following the leads of Gujarat and Uttar Pradesh, a number of other States also established community-based forestry agencies that emphasized programs on farm forestry, timber management, extension forestry, reforestation of degraded forests, and use of forests for recreational purposes. Such socially responsible forestry was encouraged by State community forestry agencies. They emphasized such projects as planting wood lots on denuded communal cattle-grazing grounds to make villages self-sufficient in fuel wood, to supply timber needed for the construction of village houses, and to provide the wood needed for the repair of farm implements. Both individual farmers and tribal communities were also encouraged to grow trees for profit. The fast-growing eucalyptus is the main species being planted nationwide, followed by pine and poplar.

4.4.3 National Forest Policy

National Forest Policy (1988) emphasized the role of forests in the national economy and in ecology. The Policy23 focused attention on ensuring environmental stability, restoring the

[23] XI Five Year Plan Vol. III. Chapter on Forests

ecological balance, and preserving the remaining forests. National Forest Policy 1988 acknowledged the importance and primacy of local communities and provided for a sustainable management approach with maintenance of environmental stability as the prime objective. Commitment to conservation of nature is highlighted by the targets of maintaining one-third of land under the forest/tree cover. The social concerns are targeted through increasing productivity to meet local and national needs and creating a people's movement for aforestation. Industries have been advised to network with farmers for industrial raw material. Other objectives of the Policy were meeting the need for fuel wood, fodder, and small timber for rural and tribal people, while recognizing the need to actively involve local people in the management of forest resources.

4.4.4 Conservation of Forests

Conservation has been an avowed goal of government policy since Independence. However, despite large-scale tree planting programmes, forestry is one arena in which India had actually regressed since independence. Annual felling at about four times the growth rate is a major cause. Widespread pilfering by villagers for firewood and fodder also represents a major decrement. In addition, the forested area has been shrinking as a result of land cleared for farming, inundations for irrigation and hydroelectric power projects, and construction of new urban areas, industrial plants, roads, power lines, and schools. Since the early 1970s, it was realized that deforestation threatened not only the ecology but their livelihood in a variety of ways and people became more interested and involved in conservation. In 1988, the Forest Conservation Act of 1980 was amended to facilitate stricter forest conservation measures. In June 1990, the central government adopted resolutions that combined forest science with social forestry, which takes the socio-cultural traditions of the local people into consideration. A Joint Forest Management (JFM) was envisaged as an effective tool for halting further degradation of forests. By the end of 2006, there was an estimated 22 mha covered by JFM and out of 173,000 villages, about 40 per cent villages have been associated with the programme. The decade 1997-2007 has witnessed a small increase of about three mha in the forest cover of the country.

4.4.5 The XI Plan and Forestry

The XI Plan's core strategy for forestry sector development consists of the following elements:

- Strengthening the Joint Forest Management programme by incorporating the concepts of harvesting, value addition, and facilitated marketing of forest produce.
- Achieving optimally productive forests capable of providing timber and non-timber products, apart from the ecological services without unnatural change in the composition of the forests.
- Management of the forests in the vicinity of habitations for livelihood needs of the populations in the neighbouring areas.
- The harvest of forest products will be governed by the availability. However, strategy for widening the production base beyond forests will be pursued to ensure sustainable use of the land resources of the country.
- Integration of protected areas with the sensitivities of local populations and protected area management planning will be based on the optimization of local community resources and the use of noninvasive benefits from the PAs directed towards the neighbouring population, on village eco-development principles.

- Evolving support systems for attaining these results will be evolved in terms of R&D, capacity building, and strong information system for long as well as short term objective monitoring.

4.4.6 Forestry Products

The forest based industries utilize forest produce as raw material. The major forest based products include pulp and paper, fuel wood, sawn wood, match wood, newsprint. Besides these products, industrial round wood and poles also constitute forest-based products. Wooden furniture is an important export item.

4.5 Agriculture Engineering

Although agricultural engineering is a fairly new subject, its effect is being felt in India increasingly. In recent years it has contributed to agricultural production in the country both directly and indirectly. The number of modern machines used in agriculture is a fairly good index of the progress made during recent years. The development has made two things clear. First, the Indian farmers are quick in adopting new methods and techniques and second, the Indian industries can manage as good machines as those abroad.

Agricultural engineering comprises of four main branches, (i) farm implements, (ii) soil and water conservation, (iii) drainage and irrigation and (iv) rural electricity.

4.5.1 Farm Implements

A variety of agricultural implements, equipment and machineries are being used in the agriculture sector primarily with a view to increasing the productivity. Mechanization of agriculture has profound positive impacts on Indian agriculture, in particular, after Green revolution in 1960s. About 250 improved agricultural equipment and technologies have been designed and developed in India for various pre and post-harvest operations operated by human, animal, mechanical and electrical power for timely field operation (Pandey, 2006).

Overall distribution of farm mechanization (traditional to modern) can be broadly classified in to three categories, namely village craftsmen, small industries and organized big industries (Italia, 2010).

Village Craftsmen: About 10-15 million villages craftsmen, present throughout India, are main source of supply and repair and maintenance of hand tools and traditional implements. Implements made include tools like spade, sickle, local ploughs, sowing devices, yokes, patelas, levellers, grinding wheels, hand mills, hand operated milk churning tools, winnowing devices, sieves, wooden storage structures, bullock carts, manual water lifting devices etc. Products are not very sophisticated as the level of technology is low and these enterprises need low level of capital.

Small Scale Industries: The bulk of the farm machinery is made by these units located throughout India is certain clusters. The level of technology offered is higher than that offered by village craftsmen. These units fabricate bulk of the improved agricultural machinery such as ploughs, cultivators, disc ploughs and harrows, seed drills, planters, plant protection equipment, reaper harvesters, combine harvesters, threshers, cleaners, graders, mills, crushers, oil expellers, diesel engines, irrigation pumps, dairy machinery etc.

Organized Large Industries: Higher end machinery like sprayers and dusters, land development machinery, tractors, power tillers, rotavetors, combine harvesters, threshers, post harvest and processing machinery and dairy equipment are manufactured by them. The marketing of agricultural machinery by these is through their network of dealers; therefore, these manufacturers are able to provide effective after-sales service and repairs.

Farm machinery industries have grown rapidly in order to meet the bulk of the requirement of mechanization inputs and also for export. The entire machinery industries are heterogeneous meeting requirements of traditional farming practices to modern farming to export needs. There are array of technologies available such as plough, harrow, seed driller, horse hoe, threshing machines, tractor, power tillers, implements for clearing, breaking ground, implements for depositing seed, seed-sowing machines-drills, cane crusher, combine harvesters, post harvest and processing machinery and dairy equipment, implements for the cultivation of the plant – cultivators, implements for gathering crops, implements for clearing, breaking ground, irrigation technology etc. Annexure-4.3 provides status and growth of farm machinery industries including spread of about 18,000 units with major concentration in select regions of the country.

Tiny and small scale units have been manufacturing substantial proportion of agricultural machineries. It is estimated that there are over 1,51,655 units with a turn over of 25,005 million rupees in 2007. The gross output of **a**gricultural equipment manufacturing units in top six states is given in Table-4.5. Punjab is highest among all the states of India and is about four times higher than that of the next highest state Uttar Pradesh. Haryana, Rajasthan, Madhya Pradesh and Gujarat respectively are following next to Uttar Pradesh in regard to gross output of **a**gricultural equipment manufacturing units.

Table-4.5: Output of Agricultural Equipment Manufacturing Units in Major States

State	Total number of units	Gross Output (in Million Rs.)
Punjab	5873	9034
Uttar Pradesh	18936	2483
Haryana	1992	1739
Rajasthan	5466	1736
Madhya Pradesh	39216	1723
Gujarat	3116	1654
All States	151655	25005

Source : Lok Sabha Unstarred Question No. 5277, dated 14.05.2007, www.indiastat.com

It has been clearly established by the national and international experiences that the benefits of engineering inputs in terms of enhanced productivity by about 15 per cent and reduction in cost of production by 20 per cent. Also, it has enormous spill over beneficial effects to increase in cropping intensity, speed in farm operations and reduction in drudgery as well as wastage. However, engineering inputs in Indian agriculture have been inadequate and that too only in the case of a few crops, farm operations and post harvest activities. Its impact has been minimal in the case of mechanization in livestock and fisheries sectors (CIAE, 2007).

4.5.2 Soil and Water Conservation

A substantively large part of holdings are small (more than 80% holdings are less than 2 ha) Fast fragmentation has led holdings uneconomical owing to increasing pressure of population. Not only holdings are getting smaller but also accompanied by degraded due to soil erosion, salinity and alkalinity, and chemicalization. Nearly, two third agricultural lands are estimated to be degraded and only one third is fit for agricultural uses. This has resulted in declining of agricultural productivity.

Steering Committee on Agriculture and Allied Sectors has greatly dealt this issue of soil and water conservation and suggested strategic and action points for improvement of soil health through balanced use of fertilizers and application of micro nutrients and improvement in the organic matter for soils and strengthening watershed development through social mobilization and institution-building for the formulation of XI Five Year Plan Strategies for the agricultural sector (Planning Commission, 2007). The imbalance in the use of nitrogen– phosphorus– potassium (NPK) has resulted in distortions in prices ratio in favour of nitrogenous fertilizer that is creating serious problem of soil degradation and adversely affecting productivity.

Soil and water conservation measures are critical for increased agricultural production and productivity. Government of India launched centrally sponsored scheme for the catchments of River Valley Project (RVP) in the Third Five-Year Plan. Later, Flood Prone Rivers (FPR) was started in the Sixth Five-Year and both the programmes were combined on recommendation of Expenditure Finance Committee during the Ninth Five Year Plan. In RVP and FPR, 53 Catchments were covered, spread over in 27 States. The total Catchment area is 141 million ha. with priority area needing urgent treatment in 28 million ha. Out of this 6.08 million ha have been treated till 2004-05 with an expenditure of Rs 1894 crore and an area of 0.17 million ha have been treated with an expenditure of Rs 145 crore during 200-06.

On similar lines, reclamation of Alkali Soil was taken up in Punjab, Haryana and Uttar Pradesh during the Seventh Five Year Plan.The scheme was extended to other states having alkali soil problems during Ninth Plan. The objective of the scheme was at improving physical conditions and productivity status of alkali soils for restoring optimum crop production. Out of 0.5 million ha. an area of 0.66 million ha has been reclaimed till the end of 2004-05. An additional area of area of 0.03 million ha have been reclaimed in 2005-06. The Scheme at present stands subsumed within the Macro Management Scheme.

XI Plan has given high priority to soil health management and stressed the need for dissemination of knowledge and strengthening of soil testing labs. In order to expand the reach and ensure accountability, PPP mode shall be explored.

4.5.3 Irrigation

There has been over-exploitation of groundwater as a result fast depletion of ground water. This has led to limited possibilities of expansion of surface irrigation. The anticipated irrigation potential created is 102.77 MH up to March 2007, which is 73.5 per cent of the Ultimate Irrigation Potential (UIP) of 140 MH. Major and medium irrigation projects have an UIP of 58.47 MH against which irrigation potential created is 42.35 MH. Minor irrigation potential created is 60.42 MH against the UIP of 81.43 MH (XI Five Year Plan, Chapter 2, Water Management and Irrigation). There is a huge difference between potential created and utilized.

Total number of spillover projects into the XI Five Year Plan works out to be 477 including 166 major, 222 medium, and 89 extension, renovation, and modernization projects. The reasons for non-completion of the projects from the projected level include inadequate funds due to thin spread of funds over many projects. At the beginning of XI Five Year Plan, of the 477 projects under implementation, 148 major and 195 medium projects envisaged benefits to drought-prone districts. Among these, 76 major and 102 medium projects benefit tribal areas as well.

A total of 229 major and medium irrigation projects have been included under Accelerated irrigation benefit programme (AIBP), out of which, 91 have been reported completed by July 2007. The performance of MMI projects in terms of completion of the projects as well as the potential creation is not very satisfactory. Steering Committee and XI Five Year Plan has suggested range of action points for speedy delivery of water management and irrigation projects.

4.5.4 Energy in Agriculture

The total power consumed in agriculture sector has shown a increasing trend during 1971-72 to 2005-06 with annual compound growth rate of 52.44 per cent (Table-4.6).

Table-4.6: Total Power in Agriculture Sector of India (kw/Ha)

Year	Share of Total Power (%)						Total power (kw/Ha)
	Agricultural Worker	Draught Animal	Tractor	Power Tiller	Diesel Engine	Electric Motor	
1971-72	15.11	45.26	7.49	0.26	18.11	13.77	0.295
1981-82	10.92	27.23	19.95	0.33	23.79	17.78	0.471
1991-92	8.62	16.55	30.21	0.4	23.32	20.9	0.759
2001-02	6.49	9.89	41.96	0.54	19.86	21.26	1.231
2005-06	5.77	8.02	46.7	0.6	18.17	20.73	1.502

Source: Compiled from the statistics released by: Lok Sabha Unstarred Question No. 2588, dated 14.03.2001, taken from www.indiastat.com on May 10, 2011.

The contribution of different power sources to the total power changed with time. The share of agricultural workers and that of draught animal power continuously declined during past three decades. This is compensated with contribution from mechanized power. For achieving desired intensity of cropping average farm power requirement of 2 kW/ha is considered essential. Shifts in agriculture leading to crop diversification towards horticulture, animal husbandry fishery, forestry and on-farm agro-processing are going to bring in greater use of mechanization (Alam, 2006).

4.6 Veterinary and Animal Husbandry

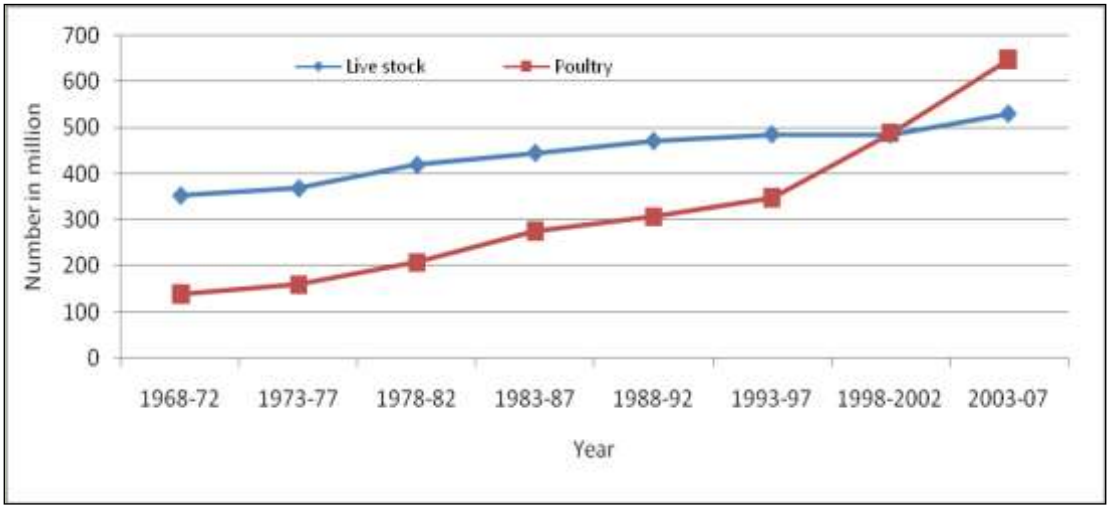
Development of the sector covers programmes for quality enhancement among animals through genetic improvement and maintaining them in good health. The livestock sector covers breeding and rearing of various animals like cattle, horses, pigs, sheep and other small ruminants, poultry, dogs, etc. Livestock production is an important source of income for the

rural poor in developing countries. It enables poor and landless farmers to earn income using common-property resources. The rapid growth in livestock production is critical to designing policies that promote the incorporation of the rural poor into economically and environmentally sustainable growth patterns. Animal breeding and maintaining animal health veterinary services and meat production are the main components of this sector.

4.6.1 Live Stock Census

India has the largest livestock population in the world. Distributed over 100 million households in approximately 600,000 villages, Indian farmers' stock animals as varied as the little known Yak and Mithun to the seemingly insignificant backyard poultry. According to the data from Livestock Census of 2003, the country had 485 million livestock population and 489 million poultry population, being the first in cattle and buffalo population, second in respect of goat and third in respect of sheep population in the world. India has 57 per cent of the world's buffalo and 16 per cent of the world's cattle population. Provisional results from the 18th Livestock Census conducted in 2007 recorded a livestock population of 530 million and a poultry population of 649 million is shown in Fig-4.3.

Fig-4.3: Trends in Live Stock and Poultry Production (1968-72 to 2003-07)



Source: Department of Animal Husbandry, Dairying and Fisheries, 2011

4.6.2 Contribution to GDP

The contribution of animal husbandry and dairying to total Gross Domestic Product (GDP) was 5.26 per cent in 2009-10 at current prices. The value of output of livestock and fisheries sectors was estimated to be Rs 3,10,891 crore during 2008-09, which is 27 per cent of the total value of output of Rs 11,58,400 crore from the agriculture and allied sectors.

The livestock sector recorded a growth rate of 3.6 per cent per annum during the Tenth Five Year Plan (2002-2007). Growth targets for the XI Plan (2007-12) are: (i) to achieve an overall growth between 6 per cent and 7 per cent per annum for the sector as a whole with milk group achieving a growth of 5.0 per cent per annum and meat and poultry group achieving a growth of 10 per cent per annum[24]. The main development programmes in this

[24] XI Five Year Plan (2007-12), Vol. III, Chapter on Agriculture

sector relate to improvement in the quality of animals through appropriate breeding techniques and maintaining an efficient animal health and disease control system. The XI Plan states that "Market ability to capitalize on new market opportunity is constrained by the availability and quality of support services, which are mainly provided by the government. Moreover, these services are not available at the doorsteps of the producers. There is a need to restructure service delivery mechanism to become conducive to the requirement of the rural livestock producers".

A growth rate of 6 to 8 per cent in the livestock sector is needed in order to realize overall agriculture sector growth rate of 4 per cent. Despite the fluctuating growth rate in agriculture, the growth rate in livestock sector is steady (above 4.5%).

4.6.3 Live Stock Dependent Livelihoods

Market opportunities have opened up for the livestock sector following the policy of economic liberalization initiated by the Government of India in 1991. There are expectations of faster growth in demand for livestock products due to expected increase in incomes combined with the high income elasticity of demand for livestock products. But, the sector's ability to capitalize on the new market opportunities is constrained by the non-availability and poor quality of support services for quality genetic material and the animal health system.

The importance of livestock to the rural economy stems from the following facts:

- The ownership of the livestock is more evenly distributed with landless labourers and marginal farmers owning bulk of livestock. The progress in the sector, therefore, results in balanced development of the rural economy particularly in reducing the poverty amongst the weaker sections.
- Livestock provides stability to family income especially in the arid and semi-arid regions of the country, and is the best insurance against the vagaries of nature due to drought, famine and other natural calamities.
- Livestock plays an important and vital role in providing nutritive food in the form of dairy and meat products to families both in rural and urban areas.
- Bullock power continues to be the main source of draught power for agricultural operations and transport of agricultural products to nearby markets, and is likely to remain so for a long time to come.
- Livestock contributes to enhancement of agricultural production through valuable organic manure.

4.6.4 Leading States Producing Meat

During 2008-09, the total meat production in the country 3822 thousand tonnes. The leading five states contributed nearly 64.11 per cent of the total production (Table-4.7).

Table-4.7: Top Five Meat Production States in India During 2008-09

S.No	State	Production (000' tonnes)	Share (%)
1	Andhra Pradesh	604	15.80
2	Maharashtra	536	14.02
3	Uttar Pradesh	517	13.52
4	Tamil Nadu	419	10.96
5	West Bengal	375	9.81
	Total production in India	**3822**	**100**

Source: Department of Animal Husbandry, Dairying and Fisheries, 2010

4.6.5 Veterinary Services

Over the years, an elaborate organization of veterinary health services has been established by the government in the form of veterinary hospitals/polyclinics, veterinary dispensaries and veterinary aid centres, stockman centres and mobile dispensaries which function under the respective State governments. As of 2007, there were 9,578 veterinary hospitals/polyclinics, 20,443 veterinary dispensaries and 26,583 aid centres/stockman centres/mobile dispensaries[25]. Disease control efforts over the years have resulted in eradication of Rinderpest. However, there are other animal diseases, existing and newly emerging, such as Peste des Petitis Ruminants (PPR), Bluetongue, Sheep Pox and Goat Pox, Swine Fever, Contagious Bovine Pleuropneumonia, New Castle-Disease (Ranikhet Disease), which pose a hazard to animal health and productivity. The XI Plan placed high priority on animal health and bio-security. The control of foot and mouth disease would be extended to 200 new districts and control of brucellosis and paste des petits ruminants (PPR) to whole of the country. The disease diagnostic facilities would be upgraded so as to function on internationally acceptable standards. An independent Veterinary Drug Control Authority would be established and National Animal Disease Reporting System would be created.

4.6.6 Animal Breeding

On animal breeding front, successive Live Stock Censuses indicate a steady increase in the proportion of cross-bred animals among the cattle population – from about 5.7 per cent in 1987 to 16.6 per cent by 2007 (Annexure-4.4).

The major on-going scheme is the National Project for Cattle and Buffalo Breeding (NPCBB) which has been under implementation since 2000. The project envisaged genetic up-gradation of indigenous cattle and buffaloes, development and conservation of important indigenous breeds and to evolve sustainable breeding policy.

4.6.7 Artificial Insemination

India has the world's largest AI (Artificial Insemination) infrastructure consisting of 54 functional frozen semen stations producing about 37 million frozen semen straws annually. There are 65,871 AI centres; 50,123 with government, 12,300 with Cooperatives and 3448

[25] Basic Animal Husbandry Statistics 2008, cited in IASRI, Agricultural Research Data Book, 2009

with NGOs and private organizations performing in all about 34 million inseminations per annum covering approximately 14 million out of the total 114 million breedable females. About 37,000 Centres are static, while 29,000 are mobile. The Working Group on Animal Husbandry for the XI Plan recommended that "an action plan to cover the target population under AI should be considered and human resources to deliver the semen should be evaluated and trained. Analysis of AI network and semen delivery indicates that AI done per centre is very low. Minimum AI done per year per technician should be around 1200 (against about 516 now) for it to be a viable and self-supporting earning proposition". Fifty four semen stations (41 under the government and 13 under various government and non-government organizations) have been taken up for strengthening by providing the necessary infrastructure and equipments. There are also seven Central Cattle Breeding Farms and a Central Sheep Breeding Farm, and a Central Frozen Semen Production and Training Institute.

4.6.8 Poultry

Indian poultry industry is booming at the phenomenal rate of 12-15 per cent every year, and has emerged as the world's second largest market. The Indian poultry industry has come a long way from a backyard activity to an organized, scientific and vibrant industry. The growth achieved so far is only a fraction of its immense potential. Poultry, which was considered as a backyard venture in the early 1960's has now been transformed into a strong agro-based farming activity. Poultry occupies an important place in the Indian economy, as it contributes nearly Rs 11,000 crore to the national GDP.

Poultry sector has been making rapid advances. The number of birds has been increasing at an impressive rate of 4 to 5 per cent a year over the past three decades. Today India ranks fifth in egg production in the world. It is estimated that the egg production in the country is about 532 billion during 2009-10 and poultry meat production is about eight million tonnes per annum. Average annual growth rate of egg production during 2009-10 is 5-8 per cent.

Majority of Poultry industry is in organized sector contributing nearly 70 per cent of the total output while rest 30 per cent is coming from unorganized sector[26]. The broiler industry is well dominated in southern states in our country with 60-70 percent total out coming from these states. Presently about 800 hatcheries are operating in the country.

Poultry utilizes substantial quantities of non-edible agriculture and industrial by-products and converts them into high quality, nutritious, protein-rich food. It helps to bridge the gap between the requirement and availability of high quality protein for the human population of the country. Eggs and poultry are the cheapest source of animal proteins. Besides, poultry yields as a byproduct approximately three million tonnes of manure every year, which is a rich organic fertilizer.

4.6.9. Leading Egg Production States

In the year 2008-09, country's total egg production of 5, 56,378 lakhs. Five leading states contributed nearly 68.64 percent of total production (Table-4.8).

[26] The XI plan Working Group on Animal Husbandry

Table-4.8: Top Five Egg Production States in India for the Year 2008-09

S.No	State	Production (Million Nos)	Share (%)
1	Andhra Pradesh	18344	32.97
2	Tamil Nadu	8809	15.83
3	Haryana	3815	6.85
4	Punjab	3679	6.61
5	Maharashtra	3550	6.38
	All India	**55638**	**100**

Source: Department of Animal Husbandry, Dairying & Fisheries, 2010.

4.6.10 Other Livestock

Piggery is mainly concentrated in the North-eastern states. Meat and meat processing activities also contribute significantly to GDP and also to the export market. In India, meat production is largely a byproduct of animals at the end of their productive life. Meat production was estimated at 4.6 million tonnes (1998) and annual growth rate of 4.1 per cent was achieved during the last decade. Indian meat exports started with 2,000 tonnes in the year 1973-74 and increased to about 60,000 tonnes by 1987-88 valued at Rs 88 crores. During last decade (1991-2000) buffalo meat export was 93 per cent of total meat export in quantity terms and 88 per cent in value terms.

Public health and food safety, animal management in relation to environment and climate change, wild life health management and pet animal health care are some of the important emerging areas in animal husbandry.

4.7 Dairy Sector

Activities in this sector include production of milk and its processing and packaging in dairy plants. India is emerging as mega dairy market of the 21st century.

4.7.1 Milk production

The milk group is the highest contributor to the total output of the agriculture sector. Annexure-4.5 shows the milk production trends and per capita availability of milk. India's milk production in 2010 is estimated at 117 million tonnes and is forecast to increase approximately four per cent to a record 121.5 million tonnes in 2011.

India is currently the largest producer of milk in the world. The 'Operation Flood' programme undertaken by the National Dairy Development Board has been instrumental in substantially improving milk production in India from 23 million tonnes in 1972-73 to 117 million tonnes in 2010. The per capita availability of the milk in India has increased from 124 gm per day in 1950-51 to 260 gm per day in 2008-09. However, it is still below the world average of 285 gm per day.

Average annual milk production per animal has increased substantially for both cows and buffaloes during the last three decades. The average milk yield of Indian breeds (about 520

kg/year in cattle) is still far below the world average (2026 kg/year) and just one-third to two-thirds of productivity in many developed countries.

The major concerns facing the dairy sector are large number of unproductive cattle and low milk yield. Limited usage of right quality and quantity of feed to the cattle and inadequate health care infrastructure are other two important issues. Dairy operations have always been secondary to farming in rural India thus inhibiting scientific farm management techniques.

4.7.2 Leading States Producing Milk

During 2008-09, country recorded Milk production of 1, 08,465 thousand tones. Five leading states contributed nearly 51.95 percent of the total production (Table-4.9).

Table-4.9: Top Five Milk Production States in India in 2008-09

S.No	State	Production (000' tonnes)	Share (%)
1	Uttar Pradesh	19537	18.0
2	Andhra Pradesh	9570	8.82
3	Rajasthan	9491	8.75
4	Punjab	9387	8.65
5	Gujarat	8386	7.73
	All India	**108465**	**100**

Source: Directorate of Economics and Statistics, GOI, 2010

4.7.3 Dairy Development in India

Milk production, per capita availability of milk, sources of milk production and accessibility of milk has increased. India has 134 million cows and 125 million buffalos which is largest population of the cattle in the world. Indian dairy sector also contributes to the large share in agriculture Gross Domestic Product. There are more than 70,000 village dairy cooperatives across the country. While world milk production decreased by 2 per cent in the last 3 years according to FAO estimates, Indian milk production has increased by 4 per cent.

The growth of dairy sector can be divided into three phases: first phase had been just after independence and continued during the first two decades of planned development. There had been a leaner trade growth of less than two per cent during this period. The second phase of dairy development had been during the period of 'Operation Flood' in the forth Five Year Plan. It aimed at, especially establishment of milk cooperatives on the lines of 'Amul'. This initiative strengthened the dairy development programme in the country. After mid 70s, the per capita availability of milk increased. The third phase can be attributed to the globalization and liberalization policies. In the dairy sector manufacturing of milk products was delincensed. This phase witnessed the qualitative growth of dairy sector. The increase in dairy cooperatives helped to eliminate the middleman from the dairy sector enabling farmers to exercise control over the value chain for their produce. Despite rapid population growth in the country, the per capita availability of milk in India has now increased to 245 grams per day which is very close to WHO standards. Through innovations in product formulation, packaging technology and distribution system by dairy scientists and technologists, farmers have made it possible to make the milk products available to all the consumers even in remotest areas.

The XI Five Year Plan aims at a growth rate of 5 per cent per annum till 2011-12. The National Dairy Development Board is working on a plan to launch a second White Revolution to double milk production from the existing levels to exceed the projected demand level of 180 MT by 2020-21 through planned programmes for improving livestock quality, bovine productivity, faculties for animal health and veterinary services, better milk procurement and handling systems.

4.7.4 Dairy Processing

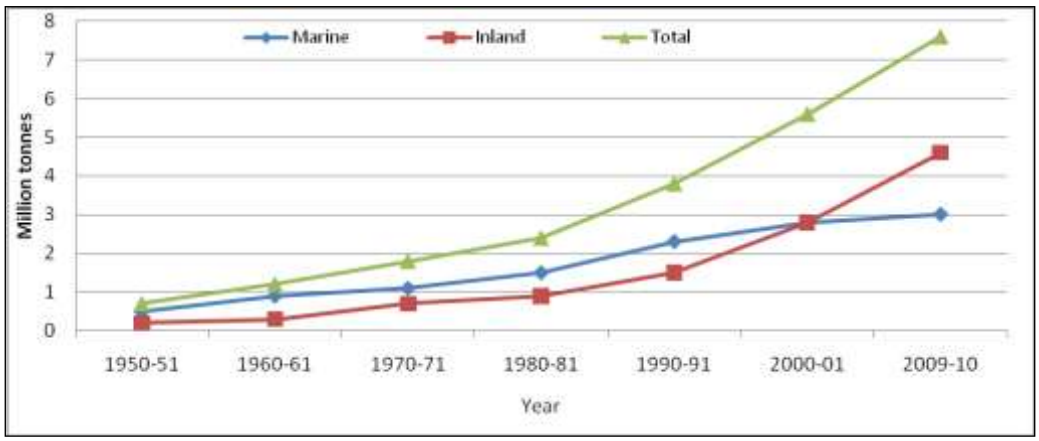
A substantial part of the milk produced is consumed by the consumers or subjected to elementary processing in unorganized sector. Less than one fourth of the milk is processed in modern processing plants in cooperatives, private sector as well in public sector. The total number of dairy plants registered under Milk and Milk Products Order, 1992 was 832 in 2007 which included 254 in cooperative sector, 532 in private sector and 46 in public sector. The total installed capacity in these Plants was about 97 million liters per day. Both the number of plants and the capacity has been increasing over the years.

4.8 Fisheries Sector

This sector covers both marine and inland fisheries and each case capture or culture of fish. Fisheries sector contributes about one per cent of national GDP and 5.4 per cent of agriculture GDP. India's share in global fish production is about 4.4 per cent (about 10% inland and 3 per cent in marine fisheries. This sector provides full time employment to 9 lakh and part time employment to 11 lakh persons in fishing operations alone. Others are engaged in fish marketing, repairs of equipment, processing and allied activities. It is estimated that about 31.5 lakh people are engaged in fishing and related activities directly or indirectly.

4.8.1 Growth in Fish Production

During the last five decades, fish production has increased with an annual growth rate of 4.1 per cent. India is the sixth largest producer of fish and second largest producer of inland fish in the world. More than six million people in the country depend on fisheries and aquaculture for their livelihood. The trends in total fish production are presented in Fig 4.4.



Source: Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, 2010.

Fig: 4.4 Trends in Fish Production (1950-51 to 2009-10)

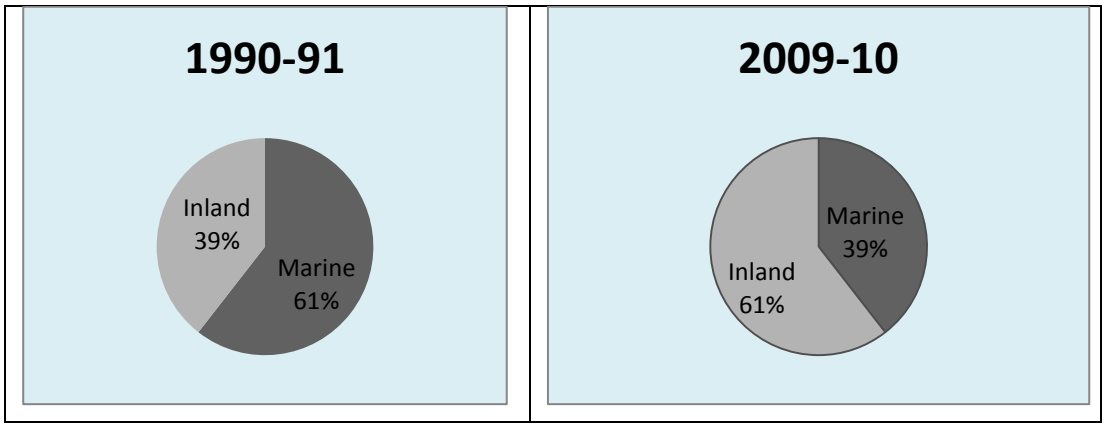
Over the years, India has achieved significant progress in the development of the fisheries sector. Fish production increased tenfold between 1950-51 and 2007-08. Trends in fish production in India, marine as well as inland, show that over the last three decades (1980 to 2008) total fish production increased at an annual growth rate of 4.4 per cent. The rate of growth has been falling from 4.8 per cent during the eighties to 3.9 per cent during the nineties to 3.0 per cent during the next eight years (Table 4.10). While the inland fisheries maintained a fairly high rate of growth over the entire period (5 to 6% per annum), it is the growth in marine fish production which fell steeply over the years.

Table 4.10: Growth Pattern of Fish Production (1980-81 to 2007-08)

Period	Production (lakh tonnes)			Shares in production (%)			Rates of growth		
	Marine	Inland	All	Marine	Inland	All	Marine	Inland	All
1980-91	15.55	8.87	24.42	63.7	36.3	100.0	4.3	5.4	4.8
1990-01	23.00	15.36	38.36	60.0	40.0	100.0	1.9	6.3	3.9
2000-08	28.11	28.45	56.56	49.7	50.3	100.0	0.4	5.2	3.0
1980-08	29.20	42.07	71.27	41.0	59.0	100.0	3.0	6.1	4.4

Source: Rates of growth are the rates during the decades 1980-81 to 1990-91, 1990-91 to 2000-01 and 2000-01 to 2007-08, calculated from the fish production data from Department of Animal Husbandry, Dairying & Fisheries, and Ministry of Agriculture.

Changing structure of fish production in the country is shown in Fig-4.5. As a result of the divergent growth patterns in the two sub-sectors of fisheries, the structure of fish production in the country has undergone drastic changes. The share of inland fisheries has been increasing over the years, while that of marine fisheries correspondingly declined. At present, inland fisheries account for about 60 per cent of the total fish production. These trends were because of deceleration in growth of marine fish production and a policy shift in favour of inland fisheries, especially aquaculture.



Source: Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, 2010.

Fig 4.5: Structure of Fish Production

4.8.2 Leading States Producing Fish

During 2008-09, country recorded total fish production of 7636961 thousand tonnes including marine (39%) and Inland (61%). Five leading states contributed nearly 61.9 per cent of the total production (Table-4.11).

Table-4.11: Top Five Fish Production States During 2008-09

S.No	State	Marine		Inland		Total Production	
		Production (tonnes)	Share (%)	Production (tonnes)	Share (%)	Production (tonnes)	Share (%)
1	West Bengal	186789	6.27	1323123	28.39	1509912	19.77
2	Andhra Pradesh	291159	9.77	961618	20.63	1252777	16.40
3	Gujarat	623055	20.92	142847	3.06	765902	10.02
4	Kerala	583579	19.60	82574	1.77	666153	8.72
5	Tamil Nadu	365280	12.26	168885	3.62	534165	6.99
	All India	2977379	100	4659582	100	7636961	100

Source: Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, 2010.

4.8.3 Production Targets of XI Plan

The Fisheries division, ICAR projected demand for fish by 2011-12 at 9.74 million tonnes which requires a growth of 5.4 per cent per annum in production over the XI Plan. This includes 3.15 million tonnes in the marine sector (3.1 million tonnes capture and 0.05 million tonnes via mariculture) and 6.46 million tonnes in the inland sector (1.12 million tonnes through capture and 5.338 million tonnes through aquaculture). XI Five Year Plan has accordingly targeted a fish production of ten million tonnes by 2012. While the production from the marine sector is reaching a plateau, there is a vast potential for enhanced production in the inland sector. The target growth rate for fisheries sector as a whole is, therefore set at 6 per cent per annum, and the targets for inland and marine sectors have been fixed at 8 per cent and 2.5 per cent respectively. The Plan recognizes that future increases in marine fish production will have to come primarily through deep-sea fishing. The importance of development of high quality fish seed and feed on an adequate scale has also been stressed.

The growth pattern since 2000-01 has not been so encouraging, particularly in the marine sector. The growth rate recorded during 2000-01 to 2007-08 has been just 0.4 per cent per annum in the marine sector and 5.2 per cent in the inland fisheries sector, combining to only three per cent overall (Table 4.10). In view of this past performance, it seems likely that that a growth of 2.5 per cent may not be achieved in the marine sector. Even in the inland sector the growth rate may fall short of 8 per cent per annum as such a high rate has not been achieved so far on a sustained basis.

4.8.4 Fisheries Infrastructure

The infrastructure[27] available for the fishing sector in the country consists of 1,07,448 traditional fishing crafts, 76,748 motorized traditional crafts, and 59,743 mechanized boats.

[27] In 2005, IASRI Data Book 2009, Table 4.25

The country is bestowed with a large coastal line of about 8,118 Kms, with an exclusive economic zone of 2.02 million square kilometers. Six major and 45 minor fishing harbours and 158 landing centres were in operation in 2005 for the marine fisheries. The additional requirement by the end of XI Plan was assessed at 2 major and 13 minor harbours and 46 boat landing centres, in addition to upgrading the existing facilities.

India has vast inland water resources in the form of rivers and canals (0.2 million km), reservoirs (3.1 mha) and tanks and ponds (2.2 mha) offering tremendous scope for fish production. The extensive network of Indian rivers (45,000 km) constitutes one of the major inland fisheries resources of the country. The present day riverine fishery is below subsistence level with an average yield of 0.3 tonne per km, which is only about 15 per cent of actual potential. The estimated fish production from inland sector will be about 4.8 million tonnes by the end of the tenth plan. Of the total inland fish production, about 75-80 per cent was obtained through aquaculture.

4.8.5 Fish Seed

Fish seed production has increased from 9,691 million fry in 1989-90 to 16,589 million fry in 1999-2000 and to 24144 million fry in 2007-08. (Handbook of Fisheries Statistics, 2008). The Working Group on Fisheries of XI Plan estimated the total requirement of fish fry during the Plan as about 52,400 million fry or post larvae.

4.8.6 Fish Feed

For aquaculture, with an average conversion ratio at a moderate efficiency level of 2:1, need at least 6.6 million tonnes of feed. The envisaged fish production target would require about three million tonnes each of oil cake and bran along with organic manure and fertilizers. The feed may have at least 40 per cent of animal protein thus posing a demand of 2.6 million tonnes of fish-meal. The currently produced meal remains totally booked for poultry industry. The way out would be either to increase the fish meal production or to import the commodity. Alternatively, technologies are to be developed to utilize plant protein sources from soyabean etc., which would force a compromise on fish production quantum per unit area. The fish feed requirement during the XI Plan was estimated (XI Plan Working Group report) at 3.15 million tonnes for fresh water aquaculture and 0.23 million tonnes for brackish water aquaculture.

4.8.7 Fish Processing

There is a growing demand for canned and processed fishes from India. In last six years there was substantial investment in fisheries to the tune of Rs 30,000 million of which foreign investments were of the order of Rs 7,000 million. The potential could be gauged by the fact that against fish production potential in the exclusive economic zone of 3.9 million tonnes, actual catch is to the tune of 2.87 million tonnes. Harvesting from inland sources is around 2.7 million tonnes.

The bulk of the fish catch (about 83%[28]) is consumed as fresh fish. The limited extent of existing processing is primarily in the form of freezing, curing, and reduction, each accounting for about 5.9 per cent, 5.1 per cent and 4.6 per cent of the total production

[28] IASRI Data BOOK 2009, Table 4.21

respectively. Canning accounts for only for 0.35 per cent of the total production. Trends over the years show that the proportion of fish marketed fresh has been slowly but steadily going up (from 76% in 2000 to 83% in 2007). The proportion of fish production canned has correspondingly come down. The estimated number of fish processing plants in the country is 399, and the number of cold storages 471 with a freezing capacity of 7,283 tonnes per day[29]. The storage capacity available is 89,273 tonnes.

Pattern of processed fish production in the country is shown in Fig-4.6. Processing of fish into frozen and canned forms is carried out almost entirely for the export market. The XI Plan observed that India's substantial fishery resources are under-utilized and there is tremendous potential to increase the output of this sector. The units in the fish processing sector are largely small scale propriety / partnership firms or fishermen cooperatives. In the past ten years, the corporate sector has increased its operation in preservation process and export of coastal fish. There are now about 350 operating processing units. The XI Plan aims at giving a boost to fish processing.

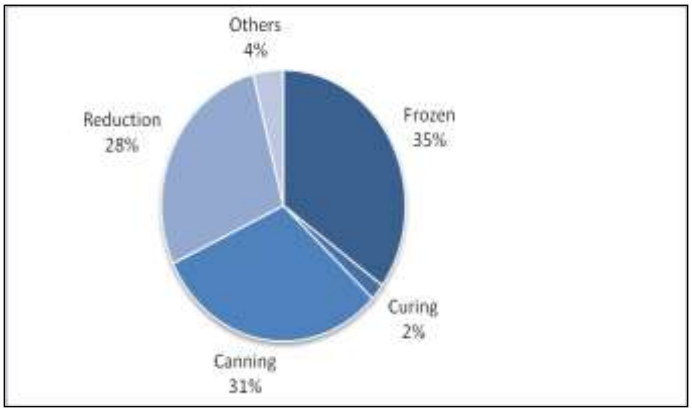


Fig 4.6: Pattern of Processed Fish Production, 2010

4.8.8 Exports

Annual Fish and fish product exports accounted for approximately about 99,000 million rupees during 2009-10 (Table-4.12). This constituted 10 to 15 per cent of the total exports from agricultural sector[30]. There are at present an estimated 1,273 sea food exporters and importers in the country.

Table-4.12 Export of Marine Products in India

Year	Export of marine products	
	Quantity ('000 Tonnes)	Value (million rupees)
1950-51	20	20
1960-61	20	40
1970-71	40	350
1980-81	80	2350
1990-91	140	8730
2000-01	503	62960
2009-10	664	99215

Source: Department of Animal Husbandry and Dairying from http://dahd.nic.in

[29] Provided by NAARM

[30] IASRI, Agricultural Research Data Book 2009

4.8.9 Institutions for Development of Fisheries

There are a number of institutions for the development of fisheries. Apart from ICAR institutes, these include the National Fisheries Development Board, Fish Farmers' Development Agencies, Fisheries Survey of India, and the Marine Products Export Development Authority (MAPEDA).

4.9 Agri-Biotechnology Sector

In terms of number of biotechnology companies, India has been ranked at number three position after Korea and Japan in the entire South- Eastern Asia in 2006 (Ernst & Young, 2009 Global biotechnology report). Biotechnology is being promoted in the country keeping in view its enormous potential to improve agriculture, food, health, environment and energy requirements of the population, and thereby to generate employment. India has 2.0 per cent share of the global biotechnology industry and it has registered 18.0 per cent growth in the year 2008-09. According the Biospectrum- ABLE survey report, in 2006 the bioagri sector has the highest growth and the popularity of BT cotton helped the bio-agri sector to grow to Rs 598 crore from Rs 330 crore. India became the fourth largest adopter of biotech crop in the world, and planting BT cotton on 8 million hectares (above 85 per cent of the total cotton grown in the country).

The post Green Revolution era, particularly after 1990, is almost merging with the gene revolution for improving crop productivity and quality. With increase in population and concern about quality and quantity of food, the bio-agriculture has gained focus in the recent past. The development of new hybrid seeds and planting material with desirable traits and genetic enhancement of all important crops has become the research agenda for the agriculture scientists. Increasing the shelf life of fruit and vegetables is another boom area especially in a country that is the world's largest producer of fruits and second largest vegetable producer, but has only one per cent export market due to post-harvest handling losses of more than two billion USD. With the use of biotechnology in food processing, India can become one of the world's largest exporter of fruits and vegetables by 2020. Advances in bio-technology have implications for animal breeding and health, so vital for the country's 'white revolution' as well as animal-based food products.

4.9.1 Development Initiatives

The Sixth Five Year Plan (1980-85) was the first policy document to stress the importance of biotechnology development in the country. The existing national laboratories under the S& T organization, such as Indian Council of Medical Research (ICMR) and Council for Scientific and Industrial Research (CSIR) initiated several research programmes to fulfill the Sixth plan objectives of the Sixth plan. An apex official agency viz. National Biotechnology Board (NBTB) was set up in 1982, to spearhead development of biotechnology. The Department of Biotechnology implemented the National Biotechnology Development Strategy 2007 to support India's core biotech which seeks to address challenges relating to the sector in terms of R&D, technology transfer, and investment on human resources. During the XI Plan, about 50 Centres of Excellence (COE) in biotechnology discipline are established mostly around universities, which are expected to:

- Improving scientist density and faculty research capabilities,
- Enhancing research infrastructure and innovativeness,
- Putting together new research groups through synergy between related departments or by augmenting the capacity of existing groups to create inter-disciplinary teams,
- Developing high quality human resources by creating adjunct faculty positions,
- Inviting scientists from other countries to work with Indian institutions, and
- Creating loci around which research collaborations and networks could be organized.

4.9.2 State Governments Initiatives

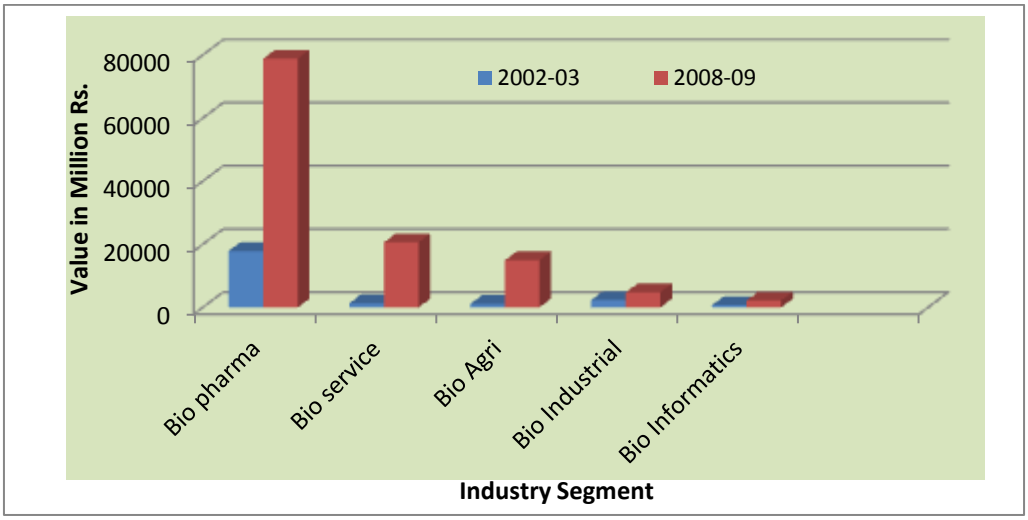
Several State Governments have launched a number of initiatives to attract biotechnology industry to their respective States. Tamil Nadu has announced its biotechnology policy in September 2000, followed by Karnataka in 2001. In the same year Andhra Pradesh was seeking to leverage its strengths in the pharmaceuticals, agriculture and IT services to put itself at the forefront of the biotechnology race among the various State Governments. The Tamil Nadu Industrial Development Corporation (TIDCO) has signed a technical service agreement with Cornell University, USA for setting up a biotechnology park in Chennai. In north, Himachal Pradesh has also prepared a framework for promotion of biotechnology in the state. This include setting up of a biotechnology park at Solan, conservation and exploitation of bio-researches, and promoting biotechnology entrepreneurship through tax concessions and relaxed labour laws. The idea is to tap the huge potential of bio-resources and commercially exploit the state's rare herbal plantation.

The central and state governments have identified biotech as a strategically important knowledge-based industry that could boost the country's economy. A series of initiatives since last decade helped in creating a conducive environment for entrepreneurs. These initiatives had been multi-fold, which includes the following:

- Establishment of Public Sector infrastructure such as research labs and Biotechnology Parks for new ventures,
- Promote Educational Institutes to generate adequately trained man-power,
- Collaboration between industry & research labs,
- Formulation of a policy for legal framework involving issues such as patent, IP rights, ethics, etc.

4.9.3 Growth Pattern

Driven by market potential and the incentives offered by the government, the Biotechnology sector has in recent years witnessed accelerated growth. A large number of companies have taken up activities related to biotechnology in the agriculture sector. With approximately 340 industries/biotech companies, the growth of the biotech sector in India has been estimated at 35-40 per cent per annum. The share of agriculture and veterinary biotech products is about 25 per cent per annum (Bio-Spectrum 2007). The sector is broadly categorized under five distinct segments: (i) Bio-informatics, (ii) Bio-industrial, (iii) Bio-services, (iv) Bio-pharmacy, and (v) Bio-agriculture. The year wise growth of the entire biotechnology sector and for the agriculture biotechnology sub- sector is presented in Fig-4.7.



Source: Exim Bank (Occasional Paper No 137), Jan, 2010

Fig-4.7: Indian Biotechnology Industry – Revenue by Segments

It is seen that the sector as a whole has grown at a phenomenal rate of 32 per cent per annum during the period 2002-03 to 2008-09, while the growth in the agri-biotech sector is even more spectacular at 49 per cent per annum. In the process, the share of agri-biotech industry has increased from a mere 5 per cent of all biotech industry to about 12.5 per cent in 2008-09, and would be around 15 per cent now.

4.9.4 Industry Profile

The agri-biotech companies can be classified into three groups. **The first** comprises the larger integrated seed companies which are expanding their R&D to cover biotechnology like Mahyco, Indo-American Hybrid Seed, etc. to develop their own transgenics. The **Second** group includes the smaller companies which have not been active in research or product development but have started implementing biotechnology techniques such as tissue culture for their breeding programmes. The **third** group covers highly specialized technology companies that undertake services for specified research, like contract research. In the animal-biotechnology sector, the growth has been mainly in the veterinary pharmaceutical industry.

The details of various sectors and sub sectors of agriculture indicate towards the growth and future prospects. It may be noted that some sectors are growing faster (horticulture, dairy etc.) than some others (crop sciences, forestry etc.). The developing sectors have a hope for the future. Processing of agriculture produce is one area that would certainly contribute to agriculture growth. The developing sectors' requirements in human capital would be functional skills and training as well as appropriate and updated knowledge.

Chapter-5

Human Capital Assessment in Agriculture (Crop Sciences) Sector

5.1 Introduction

This chapter deals with the human resource needs for agricultural graduates in general, excluding graduates in horticulture, veterinarians and animal sciences, fisheries and dairy sciences, and will cover the group generally called the crop sciences.

Concerns about achieving food security for the growing population in the face of shrinking availability of land for cultivation, impact of climatic changes and vagaries of monsoons, response fatigue of land to standard agricultural inputs, decelerating productivity increases and other factors have led to adopting a multi-pronged approach to boosting agricultural production during the XI Plan. The overall strategy includes diversification into promising sub-sectors like horticulture, dairying, fisheries, food processing, etc., but at the same time, raising productivities in the crop sector through greater attention to need-based research, emphasis on transfer of technologies through better extension, development of high-yielding seeds and their distribution, efficient water management, agricultural investments and other measures to raise production of crops like cereals, pulses, oilseeds, sugarcane, etc, essential for tackling the food security concerns, particularly for the poor.

5.2 Supply of Graduates

5.2.1 Education

Agricultural education and research have been accorded fairly high priority and elaborate institutional set-up has been established over the years. List of colleges providing education in crop sciences in both agricultural and general universities is given in Annexure-5.1. According to the data collected for the project from the universities and colleges and Education Division of ICAR[31], the annual admitted strength of students in agriculture (including Environmental Science) in various State Agricultural Universities is 4348 in diploma, 10429 at under-graduate level, 4373 at post-graduate level and 1125 at doctoral level, including the intake from colleges affiliated to various agricultural universities and colleges in the general universities. There are 184 colleges (including 83 in SAUs, 68 affiliated to SAUs and 33 others) providing education in agriculture (i.e., crop science or plant science). In addition, another 44 affiliated colleges are being established by private sector during 2011. Details of students admitted during 2009-10 in to various agriculture colleges are given in Annexure-5.2. The Admitted strength of various agriculture colleges in SAUs and general universities is about 4350 in diploma and 21300 in UG and above (Table-5.1). The annual out turn from all the colleges is about 3230 in diploma and 16000 in graduate courses. More than 40 per cent under-graduate students come from the private colleges, whereas PG/PhD is largely confined to public system.

[31] Data provided by DDG (Edn), ICAR and IASRI Agricultural Research Data Year Book, 2009, Table 11.2, p323

Table-5.1: Students Admitted and Passed in Agriculture Courses during 2009-10

System	Diploma		UG		PG		PhD		UG & above	
	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pas	Adm	Pass
SAU's	4348	3235	10429	8136	4373	2809	1125	583	15927	11528
Others	-	-	4476	3716	898	705			5374	4421
Total	4348	3235	14905	1185	5271	3514	1125	583	21301	15949

5.2.2 Areas of Employment

Human resources in agriculture (crop sciences) is required in research and education, extension of technology to farmers, production and distribution/sale of seeds and other inputs like fertilizers, farm equipment and pesticides, production of crops, agricultural credit and crop insurance services, pricing and marketing, post-harvest storage, quality control, and processing and wholesale and retail sales to the consumer. Agri-businesses, agri-clinics, agro-service centres and other modes of self-employment also have a large potential to employ human resources trained in crop sciences. The chain of operations for needed qualified human resources is shown in Fig-5.1.

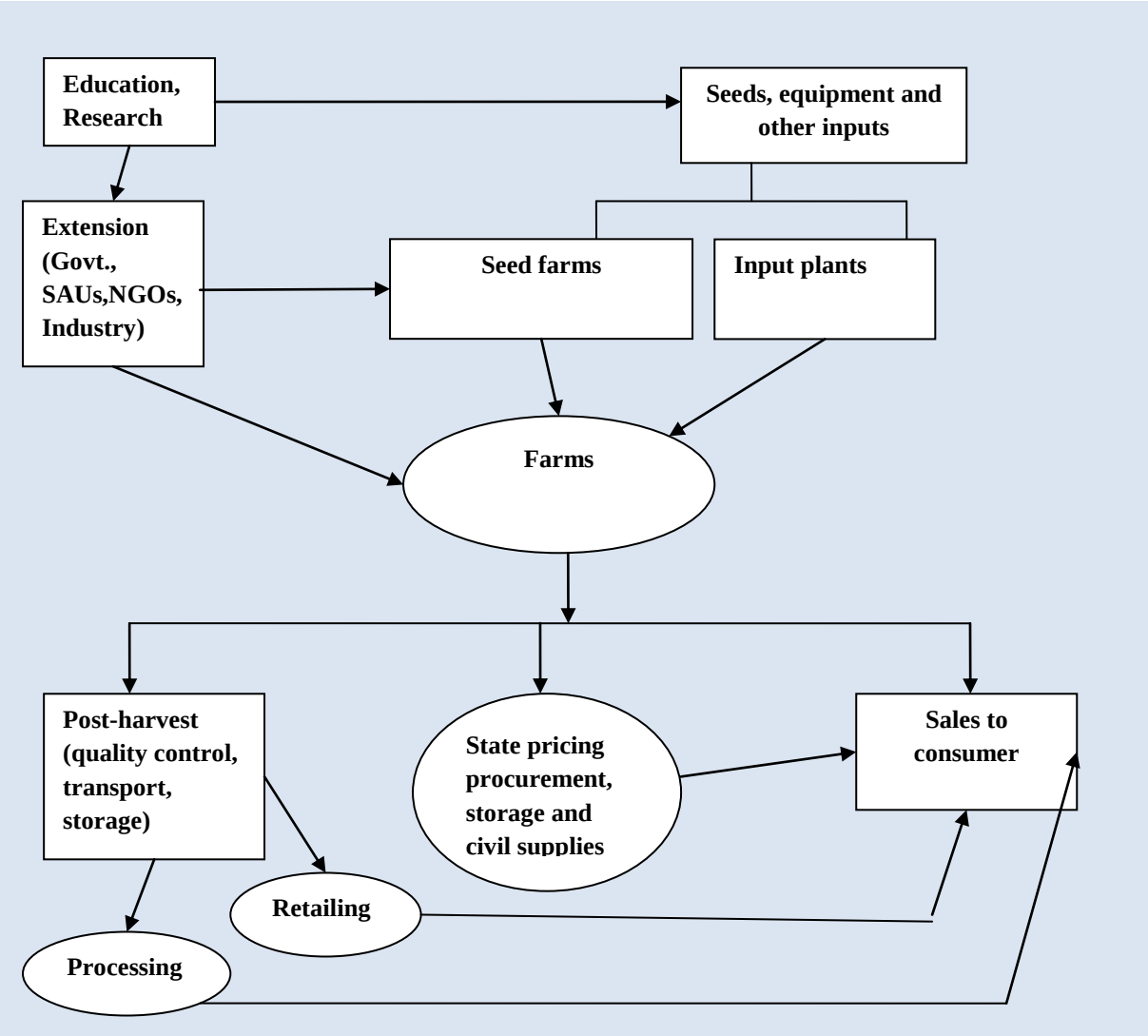


Fig-5.1: Operations Needing Crop Sciences Human Resources

5.2.3 Current Stock of Human Resources in Crop Sciences

There is no direct source of data on the number of active crop science human resources in the country. As such, the current stock can only be estimated, as in the case of other agriculture related disciplines, indirectly by cumulating the outturn of graduates, post-graduates and doctorates in crop sciences over several years (as many as the active working life of a graduate, post-graduate or doctor) and adjust for attrition due to retirement, migration and such causes.

IAMR, in its previous study on agricultural human resources, had estimated the stock of post-graduates (not including doctorates) in agriculture as 33,036 and of doctorates at 2,613 in the year 1990. These stocks were projected to grow to 87,370 and 7,868 by the year 2010 on the basis of projected out-turns of the two categories during the years 1991 to 2009. These projections assumed that the out-turn of human resources at post-graduate level would increase steadily and linearly from 2,633 in 1991 to 5,029 in 2009, and that at doctoral level from 261 to 402 in the same period. No corresponding estimate of graduates was made.

An effort was made to estimate the stock of crop science graduates from annual supply data from different sources. The stock from supply side is estimated from the outturn of graduates in the past 37 years (details given separately in Chapter-15). The total stock of graduates and above in agricultural (crop) sciences, estimated from annual supplies is about 1,88,708 in 2010.

5.3 Demand Projections

5.3.1 Development Departments

Formulation and implementation of policies and programmes for agricultural development is mainly the responsibility of the Ministry of Agriculture and Departments of Agriculture in States. Public offices directly under the government, particularly the State governments, are the biggest employers of formally qualified agricultural human resources. The network of agricultural offices in the States, the primary purpose of which is to provide various agriculture-related services down to the farmers and stimulate development of agriculture in the respective State, extends to divisions, districts, blocks and sub-divisions of blocks in the State. Available details of the posts for agricultural human resources (excluding posts for soil conservation and also horticulture to the extent possible) in some States are given in Annexure-5.3.

The number of agricultural officers in the country has been estimated at 89,000. Besides, the Department of Agriculture and Cooperation in the Central Ministry of Agriculture (Department of Agricultural Research & Education has been considered separately under "Research") and its attached and sub-ordinate offices like Directorate of Marketing & Inspection, Directorates of Rice, Pulses and Sorghum Development, Directorate of Plant Protection, National Institute of Agricultural Extension Management (MANAGE), National Institute of Agriculture Marketing (NIAM), National Rain fed Authority, Agriculture Insurance Co., etc. together employ approximately 500 persons with agricultural qualifications. Similarly, in the States also there are a number of autonomous organizations (Seed corporations have been considered separately) with potential for employment of agricultural human resources. For example, in Andhra Pradesh, the Directorate of Marketing

has an Assistant Director in each District and Deputy Directors at Divisional levels. While it is difficult to identify the number for each organization, one may conservatively place the number at around one thousand for all the States put together. Thus, the total number of posts with graduate qualifications in agriculture may be placed at about 90,000. While these numbers broadly indicate the number of sanctioned posts, the actual incumbents will be less. For instance, in Karnataka over 40 per cent of the officers' posts are vacant. Similarly, in Himachal Pradesh, about 20 per cent of the officers' posts are vacant and Madhya Pradesh reports a 14 per cent vacancy position. One may take it that for the country as a whole, about one-fifth of the sanctioned posts are vacant, leaving a balance of 72,000. Considering that the head-quarters and field organizations in the States are more or less stabilized, there is not much scope for expansion of staff positions in future. Even filling of the current vacancies will be limited, given the governments' policies of downsizing their establishments. In view of this, it is presumed that the stocks will increase only marginally till 2020 perhaps to reduce the gap between positions and incumbency to 10 per cent from the current 20 per cent, apart from the replacement of future vacancies due to attrition.

Establishment survey showed that approximately half of the officers in the State governments (46.8%) were graduates, a tenth were post-graduates (11.0%), a small fraction (7.2%) were Ph.Ds and one-fifth to one-fourth (23.0%) were diploma holders. The rest (12%) were certificate holders. It is assumed that these proportions hold good till 2020.

Detailed Projected stock demand in development sector is shown in Annexure-5.4. These projections estimate that the stock requirement in 2009-10 is about 78,000. This would increase to 88,400 by 2019-20. Thus, government agricultural services would need about 1000 per annum during 2010-20.

5.3.2 Extension

Agriculture extension work is also carried out by a number of organizations. These include state governments, Krishi Vigyan Kendras, and several non- government organizations (NGOs)/ agro- clinics. Various input industries like fertilizers companies also provide some extension services as part their marketing so do some private retail major organisations like ITC, Godrej Agro-vet., etc.

Krishi Vigyan Kendras (KVKs) attached to various SAUs constitute the principal extension organization in the country for transferring farm technology and training farmers. There were 569 KVKs in 2010 and by July 2011 the number increased to 598. On an average, a KVK has 3 to 8 (average of 5) professional agricultural scientists (Project Coordinator and Subject Matter Specialists). Not all the professionals in the KVKs are crop scientists- they include horticulturalists, fisheries animal science professionals as well. The present pattern suggests that about three-fourths of the KVK professional human resources would be crop scientists. The XI Plan aims to establish KVKs in all the 578 rural districts. The expansion, thus, is only marginal. Thus, the total number of crop scientists in KVKs at present may be estimated at about 2,200, which may at best grow to 2,500 by 2020. Agricultural Technology Management Agencies (ATMAs) in different parts of the country are a recent innovation in enhancing the efficiency of agricultural extension work. However, these agencies are bodies created mainly to synergize the activities of the existing agencies and have the workforce from the existing organizations.

According to MANAGE, there are around 8,000 agri-clinics, of which about 6,000 relate to crop activities. As these are mainly self-employment units it may be assumed that there would be on an average one professional graduate in each. In fact, a sample of 28 agri-clinics studied under the Establishment Survey showed that on an average each of them employed a total of 5 persons. The 28 units together employed 21 agri-graduates, 1 post-graduate and 1 diploma holder. For projections, it has been assumed that the number of agri-clinics would grow at 750 per year, the average growth in the past eight years.

As regards NGOs, the total number of NGOs is about one million. Probably half of them are actively functional. A sample assessment of NGOs through web site- *www.ngosindia.com* indicated that about 5 per cent of them work in the area of agriculture or rural development, which comes to about 25,000. Assuming that half of them at least engage agricultural professionals, the number of NGOs relevant for the projections can be placed at 12,500. A sample of 53 NGOs engaged in activities relating to field crops studied as a part of the IAMR's Establishment Survey indicated that on an average each such unit engaged 13 persons, of whom about 3 to 4 are agri- professionals. Projections in this sector have been made using these proportions and on the assumption that the number of NGOs would increase at one per cent per annum.

In recent times, modern retailing, which includes trade in agricultural commodities also, has become a rapidly expanding business. The industry majors engaged in this business like Reliance, ITC, etc. provide extension services to farmers from whom they procure the agricultural commodities direct. As per industry estimates reported in Times of India (29th Oct.,2010) suggest that organized retailing, which accounts for 5 per cent of the total retail market, would grow at a compound growth rate of 40 per cent per year from less than $20 billion to $75 billion by 2015[32]. The extension services provided by the retail industry have not been considered here as they have been included under retail marketing.

The projections under extension activity include only KVKs, agri-clinics and other NGOs which are primarily in extension activities. The human resources requirements of other providers of extension services namely government, input industries and retail etc. have been included in the major activities of these respective sectors. It may not be possible to separate the number of staff specifically engaged in extension activities in these sectors.

As a rough estimate, the total number of crop science professionals engaged in extension work (through KVCs, NGOs and agri-clinics) may be placed at 50,000 at present, and may be assumed to grow to about 60,000 including below graduate level professionals by 2020.

The number of agri-graduates, post-graduates and doctorates required for extension work (through KVCs, NGOs and agri-clinics) is projected to go up from 32,420 in 2009-10 to 40,900 by 2020, i.e., about 850 per year during 2010-20. Detailed projections are shown in Annexure –5.5.

5.3.3 Research

As regards research, ICAR has an extensive network of Central Institutes, National Bureaux, Project Directorates, National Research Centres and All India Coordinated Research Projects.

[32] Times of India 29 October, 2010.

Research activities are undertaken by the SAUs, which is supported by ICAR. Dissemination of farm technologies coming out of the research is transferred to the farmers by the Krishi Vigyan Kendras (KVKs) in the SAUs (598 at present covering with minimum one in each of the 578 rural districts of the country) and through Agriculture Technology Management Agencies (ATMAs).

Research takes place in the SAUs through projects operated by the Directorates of Research and their sub-centres. This activity is not considered separately for projections, but is taken into account while assessing the SAUs requirements under Academic sector. In the private sector, the research is mostly related to seed development and the needs are considered under that sub-sector.

In view of the limits on growth in area cultivated for field crops in future due to factors like diversification into other sub-sectors like horticulture, and the claims of urbanization for housing and other infrastructure development, future growth in the crop sector has to come from enhancement of productivity, which demands need-based research. The critical areas of research identified by the XI Plan have already been indicated earlier.

Research in crop sciences takes place both in the ICAR institutes as well as in SAUs and private institutions. The ICAR set up (including all its institutions) had a combined sanctioned strength of 6,428 scientists, of which 1,958 positions (30%) were vacant as on April 1, 2010 (Annexure-5.6). In particular, the Crop Sciences Division of ICAR has a sanctioned strength of 2,055 positions of scientists, whereas only 1,340 (about 70%) were in position in 2010. In addition, about 10 per cent of the estimated 3,000 technical staff in crop division also may be agricultural personnel, taking the total to about 1,700 in 2010. Considering past experience, the number of sanctioned posts is not likely to increase significantly, and any expansion may only reduce the current gap of vacant posts. It may be assumed that the gap may at best be reduced from the current 30 per cent to 20 per cent by 2020.

Year to year projections for the human resources requirements for research are estimated to grow from 1,700 in 2010 to about 2,200 by 2020 as shown in Annexure-5.7. The qualification wise break up has been worked out in the ratio of 5:25:70 for graduates, post graduates and PhDs respectively. This ratio has been worked out on the basis of institutional survey.

The stock of 1700 in 2010 would grow to 2200 in 2020, i.e. about 50 per annum during 2010-20.

5.3.4 Academic Sector

Data on scientists and faculty in crop sciences research and education in SAUs and other colleges is shown in Table-5.2. The total staff sanctioned for teaching in agricultural disciplines in SAUs in 2009-10 has been about 10919, of which a third were vacant (Annexure-5.8). Thus, the existing staff strength was around 6518. In addition, affiliated and private colleges offering agriculture courses employ about 1626 faculty against the sanctioned strength of 1996. Projections for the future years have been worked out assuming that the current vacancies will be filled, and the requirements would grow at the same rate as the outturn in graduate/post-graduate and PhD.

Table-5.2: Scientists and Faculty in Crop Sciences Education as on March 2010

System	Sanctioned	In position	Vacant
SAU's	10919	6518	4401
Affiliated colleges	1296	1136	160
Other colleges	700	490	210
Total	12915	8144	4771

Finally, necessary adjustments have been made to take into account the fact that the need for out-turn at various levels is to meet not only the needs at that level of the economy but also the requirements to achieve the projected outturns at a higher level. Thus, for example, the out-turn of post-graduates should meet the needs of the economy for post-graduates but also the need for turning out post-graduates who will eventually meet the needs of doctorates. The manner in which these requirements have been computed is given in methodology chapter.

The projected stock demand for 2020 is 4780, which would increase from 4000 in 2009-10. The annual requirement of teachers in academic sector is about 80 per annum.

5.3.5 Seed Sector

In view of the limitations of land availability, Indian agricultural output can grow only through productivity increases. Improved seeds and post-harvest management are two key elements in this process. High quality seed is the most important input for sustainable agriculture. According to Working Group report on Crop sector estimates, quality seed alone contributes to the total production to the extent of about 15 – 20 per cent depending upon the crop which can be further raised up to 45 per cent with efficient management of other inputs. The responsibility for seed production is shared between ICAR research institutions, SAUs, National Seeds Corporation (NSC), State Farms Corporation of India (SFCI), State Seeds Corporations (in 15 States), KVKs, Departments of Agriculture in State governments, as well as private sector with necessary infrastructure and expertise. Apart from NSC, SFCI, State Seed Corporations and other institutions in the public sector, and about 450 private sector establishments (Annexure-5.9) are in the field of seed production. The distribution of seeds is undertaken through a number of channels i.e. departmental outlets at block and village level, cooperatives, outlets of seed corporations, private dealers etc. There are also about 90 seed testing centres all over the country and a National Seed Research and Training Centre at Varanasi.

During the past decade (2000-01 to 2009-10) production of breeder seed has grown at an annual rate of 11%, foundation seed by 7% and the distribution of certified/quality seed by 12%. In recent years, the Indian seed industry has been growing at an annual rate of 12 to 13%. The trend is likely to continue.

Over the years, the production of Breeder and Foundation seed and availability of certified seed has been increasing. The growth has been particularly fast in the in recent years (Annexure-5.10).

The contribution of private sector in seed production has been steadily increasing, though the private sector concentrates mainly on high value but low volume seeds (vegetables and fruits, maize, sunflower and cotton). The production of high volume cereals (paddy, wheat, oilseeds and pulses) is still primarily in the sphere of public sector players. Private sector today accounts for about 70 per cent of the market in terms of turnover while public sector has greater share in terms of volume sales[33]. Several large multi-national seed firms such as Cargill, Monsanto, Bayer Crop Science, Advanta, Dupont are now operating in India, with a focus on bio-technology-based research. A number of Indian companies like Indo American Seeds also make a significant contribution to the seed industry. Private industry is largely concentrated around Bengaluru (horticultural crops) and Hyderabad (field corps, particularly cotton seeds).

The Establishment survey of IAMR indicated that the average size of a seed production establishment in terms of employment is 46, of whom one-fourth (25.2 per cent) are professional graduates, post-graduates and doctorates. Assuming that there are 500 seed production companies (including public sector) the total employment in the sector in 2009-10 may be estimated at 23,000, employing about 5800 agriculture graduates. An estimate of the current deployment made through discussions with Seed Industry Association coincides with this estimate.

Seed Industry is poised for rapid growth in future years also. The requirements of seed bill, competition in the industry and the fact that the seed industry looking forward to take part in National Agricultural Development Programme through production and marketing of quality seeds requires a high level of professionalization in the industry and hence greater absorption of agricultural graduates. It is also focusing upon investments in technology, human resources, processing and other infrastructure facilities.

The industry is currently growing at 12 to 13 per cent and this trend is likely to continue. Seed Industry Association is of the opinion that the human resources requirements of the industry will double by 2015 in view of the rapid expansion in private sector. This implies almost 18 per cent growth in employment annually. Discussions with seed industries show that the seed industry has vast potential to grow and employ professionals and the employment can grow at 10 per cent per annum. Considering the factors such as mergers and automations which have a dampening effect on employment growth it is not likely that the employment growth in future years would be more than 10 per cent per annum. Even otherwise in spite of the emergence of a growing private sector, the public sector corporations play a major role in the seed sector and employment in them is not likely to grow. Projections of demand for the future years have been obtained assuming a conservative growth of 5 per cent per annum and also a better rate of 10 per cent per annum.

The detailed projections of requirements for the seed sector are shown in Annexure-5.11. The stock requirement of human capital would grow from 5810 in 2009-10 to about 12,670 by 2020, i.e. about 690 per annum during the period 2010-20.

[33] Vinay G, Indian seed Industry – An Overview, www.commodityIndia.com, 16 Nov. 2010

5.3.6 Fertilizers

Fertilizers constitute a very important input to crop production, and have been in fact a major contributor to the attainment of food self-sufficiency in the country over the years. Even though, as pointed out in the Mid-Term Appraisal of XI Plan, in some areas excessive use of chemical fertilizers has led to degradation of natural resources such as land and water, about one-fourth of the districts still use less than 50 kg/ha of fertilizers which is below the recommended level. There is, therefore, considerable scope for expansion of fertilizer production in the country. The XI Plan Working Group on Fertilizer Industry[34] assumed a total consumption of 220.5 lakh nutrients and projected that the consumption would grow at a rate of 4.1 per cent per year to reach a level of 269 lakh tonnes by the terminal year of the current Plan (2011-12) and suggested policy measures to expand production accordingly. While the actual level of consumption in 2006-07 (216.52 lakh tonnes) was only slightly lower than the assumed level of 220.5 lakh tonnes, the rates of growth during the first two years of the Plan (2007-08 and 2008-09) were much higher than the projected rate of 4.1 per cent at 4.2 per cent and 10.4 per cent respectively. However, data on production of chemical fertilizers during the last decade indicate stagnation, and almost the entire increase in consumption of fertilizers is met through imports, which now account for 40 per cent of the total consumption (Annexure-5.12). There has been a fast growth in the production of bio-fertilizers (from 9799 tonnes in 2003-04 to 24455 tonnes in 2008-09) but this sub-sector is still in a nascent stage and its impact on the fertilizer situation will be significant only in the long term.

There are 64 large fertilizer units (including 2 in the cooperative sector) and 72 medium and small units. Nine of the large units are in the public sector, 2 in cooperative sector and the rest in private sector. According to Annual Survey of Industries, employment in registered fertilizer units has shown a gradual decline from 90,000 in 1999-2000 to 54,000 in 2005-06. Some of the decline could be attributed to some loss-making public sector units which have been closed and others which have been declared sick. It is not likely that the falling trend would continue in years to come. Production capacity needs to be, and will be augmented through appropriate investments and policy regime. Employment in fertilizer industry is bound to reverse the current trend and move forward albeit slowly. The employment level has, therefore, been projected to 2010 and beyond on the basis of the following two assumptions.

i) No growth till 2009-10 and an annual rate of one per cent beyond (Low projection)
ii) One per cent growth till 2009-10 and two per cent in the subsequent years (High projection)

The Establishment Survey of IAMR gave an estimate of the proportions of personnel with different agricultural qualifications in the total employment. Human resources requirements of the future years have been worked out on the basis of the above two assumptions and the pattern of employment revealed by the Establishment survey.

Detailed projections are given in Annexure-5.13. The requirement of human capital would grow from 6870 in 2009-10 to about 7980 by 2020. The requirement during 2010-20 is about 110 per annum.

[34] Planning Commission: Report of the Working Group on Fertilizer Industry, 2006

5.3.7 Pesticides

According to the Annual Survey of Industries, employment in manufacture of pesticides and other agro-chemicals increased from about 30,500 in 1998-99 to 37,000 in 2005-06 or by about 1.1 per cent per annum over the entire period. The pattern of growth has, however, been zigzag with upward and downward movements. The 2009-10 level has been estimated at 36,174 using linear regression over time. Subsequent growth has been projected using two growth paths, one with a one per cent annual growth (about the same rate as that observed between 1998-99 and 2005-06) and another with two per cent per annum. Pattern of employment by agricultural qualifications has been estimated as usual applying the proportions given by the Establishment survey.

gives Detailed projections of requirements in the pesticides sector are given in Annexure-5.14. **The requirement of human capital would grow from 1940 in 2009-10 to about 2250 by 2020, i.e., about 30 per annum.**

5.3.8 Financial Services

Financial institutions like scheduled commercial banks (including Regional Rural Banks) and NABARD as well as cooperative credit institutions employ a fair number of agricultural graduates as officers to deal with agricultural credit. Establishment Survey showed that about 4 per cent of the total employment (or, 10 % of the officers in banks, as officer strength is 40% of the total employment) in banks comprised graduates and post-graduates in agriculture and allied sciences. About 90 per cent of them were graduates; 3 per cent post-graduate; doctorates forming a mere 0.2 per cent, the rest being diploma/certificate holders in agri-related fields. Employment of officers in public sector banks has been growing at an annual rate of 3.7 per cent during the last decade (2000-01 to 2008-09) – the rate being 5 per cent in urban and metropolitan branches and 1.4 per cent in the semi-urban and rural branches of the banks. Two projections of total employment of officers in banks have been made – a low projection with 1.5 per cent per annum growth and a high projection with 3.7 per cent annual growth leading to estimated 5.1 lakh officers under the low projection and 6.4 lakhs under the high projection. As 10 per cent of the officers are with agri-related qualifications of graduates and above, the number of such personnel has been estimated as 44,000 and 56,000 in 2020 under the two projections respectively.

Detailed stock projections for financial institutions are given in Annexure-5.15. The stock requirement of human capital would grow from 37,930 in 2009-10 to about 49,870 by 2020. Thus, the requirement is about 190 per annum.

5.3.9 Insurance Sector

Insurance sector is also important for employment of agri-graduates because of crop insurance schemes. The total employment of this sector (both public and private sectors) has been estimated at 85,000 in 2009-10 and is projected to grow at a modest pace to 90,000 by 2020. Agriculture related human resources forms 2.5 per cent of this, according to IAMR's survey of establishments. The projected requirement for this sector is 2,200 graduates and post-graduates by 2020.

Projections for insurance sector are given in Annexure-5.16. The stock of human capital would grow from 2120 in 2009-10 to about 2250 by 2020, i.e. about 12 per annum.

5.3.10 Agro-processing Sector

Processing of agricultural crop produce takes place both in informal as well as in the organized sectors. Apart from the traditional processes of milling of cereals and pulses, extraction of oils from oilseeds, extraction and refining of sugar and various tobacco- related activities, manufacture of various value-added food products of quality has been growing rapidly.

Various agro-processing industries employ a large number of agricultural human resources. According to the data published in a recent report concerning TNAU graduates[35], about 85 per cent of the graduates and 40 per cent of the post-graduates and doctorates in the years 2006, 2007 and 2008 found employment in agro-industries. Data made available by Directorate of Students Welfare at TNAU for the years 2004-05 to 2010-11 (up to Sep'2010) also indicated the agro industries absorb 44 per cent of the alumni.

Annual Survey of Industries (ASI) data for agro-industries (other than horticultural, fishery, dairy and animal husbandry-related industries) cover manufacturing of sugar and sugar products, tobacco products and various other food products like grain mill products etc. of these sugar (including cooperative sugar mills) and tobacco industries are the very large employers with the sugar industry employing about 3 lakhs and tobacco products employing near about five lakhs. Altogether these processing industries as a whole employ about 16 lakh persons. The ASI data indicate that total employment in the registered sector had grown very little during the period 1998-99 to 2005-06. However, in the three most recent years for which data are available, i.e., 2003-04, 2004-05 and 2005-06 the growth has been of the order of 3.7 per cent per annum. Accordingly a low projection with 1 per cent and a high projection with 3.7 per cent growth have been made. Under these two projections total employment in the processing industries is expected to grow from 15.6 lakhs in 2009-10 to 17.2 lakhs in 2020 under the low projection and to 19.2 lakh under the high projections. As per the Establishment Survey 11.8 per cent of the total employment are those with agri-skills, about 39 percent of whom are graduates and one-eighth are post-graduates and doctorates. On this basis, the requirement of the processing sector by 2020 has been projected at a total of 2.02 lakh agri-skilled personnel under the low projection and 2.26 lakhs under the high projection. Graduates in agriculture (including post-graduates and doctorates) included in these two estimates are 1.02 lakhs and 1.14 lakhs respectively.

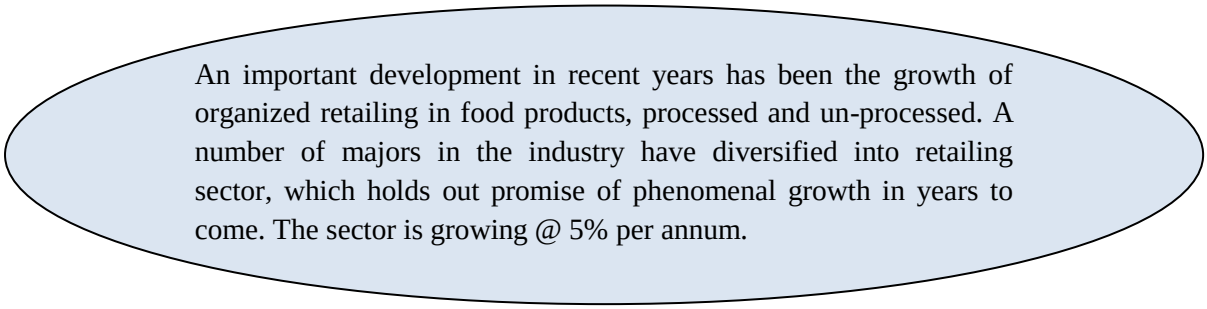
Detailed stock projections based on these calculations for agro-processing sector are given in Annexure-5.17. The stock requirement of human capital would grow from 92,500 in 2009-10 to about 1,07,490 by 2020. The requirement during 2010-20 would be about 500 per annum.

5.3.11 Agri-marketing

The term 'Agri-marketing' refers to the entire range of business initiatives relating to food production, and includes contract farming, seed supply, fertilizers and pesticides, farm machinery, and post-harvest activities like storage and transport, wholesale and retail trade of agricultural commodities, processing and retail sales. Apart from activities relating to agricultural inputs like seeds, fertilizers and pesticides already covered in the above

[35] Dr P. Murugesa Boopathi, Vice Chancellor, TNAU, Agriculture and Industry Survey, Special Feature: Inst5itutes, Vol. No. 19, Issue No.12, 2009, p34-35.

paragraphs, modern retail trade in agricultural commodities is an emerging area which has potential to employ agricultural human resources.



Over the last decade, the Indian retail sector has expanded dramatically, with the retail food sector growing at an annual rate of 5 per cent. Even though small independent shops dominate most of retail food sales, supermarkets and modern retail stores, which have until recently occupied less than 2 per cent of the market (compared to 75-80% in developed countries), have been rapidly expanding their share of retailing business. It has been assessed that if current trends continue, the share could go up to 15–20 per cent by 2020. Consumer preference for purchases at supermarkets is led by growing demand (due to lower prices and better quality of product in modern retail stores, apart from psychological and other factors). Chains operating in India in retailing agricultural commodities include Reliance Fresh, ITC's Chaupal fresh, Adani Agrifresh, Godrej, Food World, Food Bazaar, Big Bazaar, Mother Dairy Fruits and Vegetables (Safal), Haryali Fresh, Spencers, etc. Some of these major players buy their requirements of agricultural produce direct from the farmers (either through contract farming or otherwise) and have a well-maintained supply chain such as collection centres refrigerated transport and pack houses, while others obtain their supplies from wholesale markets or other retail majors which have such direct collection arrangements. Apart from maintaining their supply chains, the retail majors also provide extension services to farmers through demos, advice, cold store support, etc., through their technical teams.

Agricultural human resources requirements of the retailing sector have been perceived on the basis of focus group discussions and taking into account the present status of the sector. It has been pointed out that the sector has tremendous potential for growth and employing agri-professionals. For example Godrej Agrovet Adhar has about 65 outlets in 2006 and had a plan to expand to about 1,000 stores by 2011. Each outlet services around 20 villages in its neighborhood. Similarly Reliance outlets are coming in a big way. ITC has 6,500 chaupals and have a plan to expand the network to 20,000. All these employ professionals. For instance Godrej outlet has a team of qualified agronomists.

While exact picture of the unfolding organized retail sector is difficult to visualize it seems likely that at least 5,000 of the blocks in the country would be covered by the services delivered by one or the other organization and will have a core team of at least five professionals including diploma/certificate holders. The human resources requirement is on this basis estimated to go up from 5,000 to 25,000 over the next ten years, an increase of 10,000 diploma holders, and 5,000 each of graduates and post-graduates.

Apart from the Directorates of Marketing in the Central and State governments, the cooperative sector plays an important part in agricultural marketing. There are apex national

federations like National Agricultural Cooperative Marketing Fedration of India Limited (NAFED) and Tribal Cooperative Marketing Development Federation of India Limited (TRIFED), there are 28 State level Cooperative Marketing Federations, 381 District Level Federations and 7871 Primary Marketing Cooperatives (of which 2,679 are general purpose and 5,192 are specialized agricultural commodities)[36]. The number of these institutions has been more or less stagnant since 2000-01. It is not likely that these institutions would be absorbing qualified agricultural human resources to any significant extent. Thus, requirements of this component are covered under "others".

Stock projections for the organized retail marketing have been shown in Annexure-5.18. The stock requirement of human capital would grow from 3000 in 2009-10 to about 13,000 by 2020, i.e. 1,000 per annum.

5.3.12 Others

Some agri-graduates also work in many unrelated government and private establishments, albeit in small number, like central and state civil services, export houses, farm/campus management of public and private establishments, etc. The agricultural human resources requirements of the sectors covered above have been inflated by 10 per cent to take care of any other sectors not specifically covered.

5.4 Summary of Demand Projections

The projections of stocks of agriculture human resources required to meet the needs of various segments of the economy and the consequential flows required from the educational system are summarized below:

5.4.1 Stock Projections

The overall stocks of crop science human resources required to meet the requirements of various segments of crop sciences have been added up to give projections for various years up to 2019-20. Two sets of projections have been worked out as explained in the segment-level projections – one a high projection, a low projection and an average of the two. These projections are given in Annexure-5.20. The corresponding annual outputs required from the educational system to lead to these stocks are given in Annexure-5.19.

Considering the current supply and experts opinions on graduates aspirations and employee organizations capacity to absorb graduates, the average variant projection is considered desirable. The overall stock as per the average scenario is given in Table-5.3. The stock of diploma holders would grow from 87,000 in 2010 to about 1,11,500 in 2020. On the other hand the requirement for graduates and above would grow from about 2,92,550 in 2010 to about 3,64,060 in 2020, i.e., the average addition to the stock during the period 2010 to 2020 is about 7,000 per annum.

[36] All data relate to 2007-08, Source: National cooperative Union of India: Indian Cooperative Movement –A Statistical Profile 2009

Table-5.3: Overall Projections of Requirements Stocks of Agricultural Human Resources

Year	Diploma	UG	PG	PhD	All UG & above
2009-10	87028	211107	59424	22019	292549
2019-20	111489	261004	77077	25984	364064

5.4.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 1,88,708. Assuming outturn levels will grow at the same growth rate as observed during the last five years (i.e., 5.3 per cent during 2006-10), the estimated demand – supply scenario in 2020 will be:

Supply: 2,64,280
Demand: 3,64,064
Gap: 99,785 (27.4% of the demand)

5.4.3 Flow Projections

The overall annual flow required in all sub-sectors of crop sciences is given in Annexure-5.20 and summary in Fig-5.2.

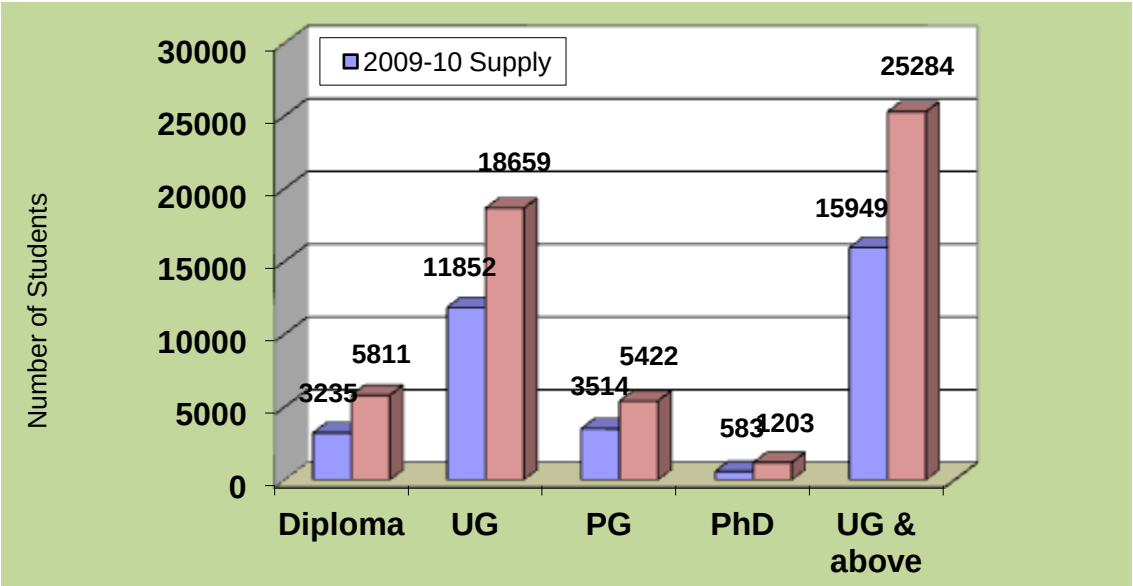


Fig-5.2: Current (2010) and Projected Outturn Required (2020) in Crop Sciences

The projections suggest that by 2020, the annual outturn from the agricultural crop science education system should be about 18,660 under-graduates, 5,420 post-graduates and 1200 doctorates, rising from 11,850 under-graduates, 3,500 post-graduates and 580 doctorates in 2010.

5.5 Institutional Mechanisms and Skill Issues – Expert s' Views

- As large number of the graduates is finding employment in the non-government sectors, good number of private colleges has come up to meet the growing demand. However, the expansion of education is not uniform across the country as the new colleges have come up largely in Maharashtra followed by few in Tamil Nadu and Karnataka. Human resources requirement in Gujarat is met from the rural development graduates being produced in general degree colleges. **There is a great demand for practical-oriented agricultural education from industries as well as from students.** While teachers were of the view that substantial component of practicals was already there in the syllabus, the other two stakeholders i.e. students and industries felt that the emphasis on practicals was not enough to make students employable. Sometimes, the students were attached with the industries for about 10-15 days at the fag end of their education which did not serve the intended purpose. **The students felt that the practicals should be concurrent during the whole course.** Some students also felt that since agricultural practices vary from state to state it would be a better idea to place the students outside the home state to give them a better exposure.
- At present, industry is employing many general degree holders and diploma holders, even for positions requiring agri. graduates, for continuity in business as many of the agriculture graduates frequently leave the job. They prefer to have more diploma holders for routine works in their various field related work and other operations. It has been pointed that these industries would like to employ agri. graduates in preference to general graduates for many of their requirement.
- Data collected during the project showed that a high percentage of students preferred to join higher studies after graduation while in other professional courses the case is different. This issue was raised for discussion to help in identifying the reasons. It came to light that while in other courses like MBBS or engineering, substantial knowledge is gained by the students at the under-graduate level, the agriculture education at that level did not adequately prepare students to be employable as professionals. Therefore, most of them tried to go for post-graduation. The lacunae in agricultural education were many. A large number of courses were taught at the undergraduate level enabling the students to pick up only a little information about everything. No subject was taught in-depth which could give specific skills to the students in at least a few areas. Moreover, at graduation level courses were not practice oriented. Although, they were attached with farms and industries for a few days the training at these places remains limited to observation only and therefore, they hardly got any practice in the farms or industries. It is necessary to provide the students more practical orientation from time to time so that they could have mastery over some subjects as well as skills. It was also pointed out that the syllabus of graduation should be revised involving industries, students and faculty together. The number of courses should be reduced with specialization in certain areas. Courses also needed to include computer related education, engineering mathematics, applied statistics as well as development of soft skills.
- **Teaching strategies should be modified. There is a need to limit lecture method and introduce other methods such as group discussions, case studies, presentations by**

students, quizzes, interaction with experts, conferences, paper presentations and so on. This not only will develop the knowledge of the students, but also would develop their personalities and soft skills. Such teaching strategies would enable students apply the knowledge gained.

- Advance production techniques developed in various universities and research institutes do not get translated into practice. This requires a multi-faceted approach. For example, the new technologies are to be publicized on a continuous basis, the students should get an opportunity to practice the new technology and its implications, the mindset of the farmers has to be changed so that they could apply the new technologies on their farms. Programmes like farm-industry linkages and university-industry-farm linkages are must. Researches that are published in various Journals should be circulated amongst farmers and industries in a simple language so that they could understand and implement.
- **If agriculture has to develop, world class laboratories are needed to be developed in colleges and research institutions to produce quality scientists and graduates.** Public Private Partnership model should be introduced for research and development Universities and research institutions are doing researches on one hand while some big industries also have research units conducting their own researches on the other. There is no networking amongst these.
- With the introduction of agri-business courses, a number of agri-business units have been established under the agri-clinics and agri-business scheme. But the fact is that a substantial percentage of such units have been closed down. A discussion on this has revealed that the agri-business centres established at block or village level do not get enough support from the universities or government in terms of expertise. The students have less operational knowledge and therefore lack in confidence.
- Out of all the students completing +2 stage, only about 12 per cent are opting for higher education. Remaining 88 per cent should be targeted for short-term job-oriented diploma courses which are crop-specific, technology-specific and agro-industries-specific to address local problems. This would not only increase the employability of the people, it would also help the industries as well as farm sector to increase the production and productivity.
- Some of the emerging areas for agriculture education, specialization and research are carbon trading, waste management, bio-fuel, bio-control of pests and diseases, scientific farming, molecular biology, modern production techniques, cold storage management for increasing shelf life of perishable items, organic farming, value addition & processing, etc. These require specific skills as well as continued researches. Special training and courses should be introduced.
- At present approximately 68 mha land is lying as waste land in India. Out of this, about 50 per cent is non-forest land. **There is a need to promote cooperatives of graduates which can be allotted sizeable acreage of these waste lands on a long lease basis for farming purposes. This will increase self-employment as well as the production in agriculture. Such initiatives are being taken in some other countries like Africa, Israel, etc.**
- It was pointed out that although Mahatma Gandhi National Rural Employment Guarantee Act (NREGA) had been beneficial for the villages, it has created substantial shortage for labour in agriculture. It is suggested that agriculture activities may also be included under NREGA and other government schemes to combat the problem of shortage of agriculture labour. Another option is to provide more attractive incentives for promotion of farm mechanization and automation.

- **Another problem is of trained and expert teachers.** Even where courses have been modified and made practice oriented, teachers have not been fully trained. In several universities a substantial number of positions are vacant and there is dearth of teachers.
- It has been observed that in the agriculture related courses students in most of the universities are from urban background and that too not because of their choice but because of the compulsion of not getting selected in other professional courses. In such cases, they do not intend to join agriculture sector after completing their education. They take the course as merely a degree and not a professional course to excel further. Therefore, after obtaining a degree they try for MBA courses and other courses other than agriculture. A suggestion was made that the **students who own land and belong to farmer community should be given a preference at the time of admission so that they could opt for agriculture as their career. Another alternative could be that agriculture is introduced as a subject at school level like other subjects and students with real aptitude for the sector would develop interest and opt for this sector later not by compulsion but by choice.**
- Media can be a important means to develop interest in agriculture. While private channels do not come forward to promote agriculture and allied sectors' education, the programmes on National TV are outdated. The policies towards agriculture sector are to be modified. **The agriculture sector should be treated as an industry and specific concessions should be given to agro-based industries as was done for IT sector.** It is note-worthy that interest charged in case of agriculture loans are as high as 15 per cent.
- There is a need to establish National Technology Development Board for agriculture.

5.6 Conclusions

Current annual out turn of about 16,000 graduates is less than the requirement of 25,300 by 2020. There is need to expand agri-education to produce additionally 9,330 graduates (6810 UG; 1900 PG and 620 PhD) per year by 2020. This needs opening up of number of additional colleges across the country. Taking the experience of private sector colleges in Maharashtra and Tamil Nadu, there is need for more serious dialogue on entry of private sector to maintain quality in agri-education. The issues relating to course syllabus, effective teaching strategies, functional skill development and quality of teachers need appropriate policy interventions while considering expansion of agricultural education.

The annual supply for diploma holders is about 3,230 in 2010 and the requirement would grow to 5,810 by 2020. However, as bulk of private sector is keen to have more diploma level persons, the requirement would be much more if more diploma holders are available. In such case, diploma holders would be preferred in place of general graduates now being employed by many employers, especially for some field based rural jobs. Bulk of the diploma holders are needed for micro-level organizations and this requirement is being reflected separately.

Chapter -6

Human Capital Assessment in Horticulture Sector

6.1 Introduction

The term "horticulture" traditionally included cultivation of fruits and vegetables, ornamental flowers (floriculture) and their post-harvest technology. In recent years, the scope of the subject has been expanded to include growing of crops such as mushroom and bamboo, plantation crops like tea, coffee and rubber, and even beekeeping as it is considered a tool for improving the productivity of horticultural crops. India is the second largest producer of fruits and vegetables in the world. Fruits such as Mango, Banana, Citrus, Guava and Apple account for 75 per cent of the total fruit production in the country. India produces about 70 different varieties of various vegetables. **The horticulture sector constituted nearly 20 per cent of agricultural GDP and contributes four per cent in the national economy. It is one of the fastest growing sectors in agriculture and is a thrust area to stimulate agricultural growth, spurred by the changing domestic food habits towards more nutritious food and increasing overseas demand.** A study by Confederation of Indian Industries (CII) and Yes Bank (2008) noted that a massive surge in production as well as a significant demand shift at global and domestic consumer segments from traditional to high-value crops, led by growth in disposable income and growth of the middle class, have collectively contributed to the demand for fruits and vegetables.

6.2 Supply of Graduates

6.2.1 Education

Dr Y.S.Parmar University of Horticulture and Forestry in Himachal Pradesh had been the sole exclusive university for horticultural education in the country for several years. In 2005, 14 SAUs have facilities for education in this field at graduation level and 32 at post-graduation level with an intake capacity of about 870, i.e. 441 at under-graduate level, 331 at post-graduate level and 87 at doctorate level[37]. Data from Planning Commission indicate that the annual outturn of these institutions is 470 graduates and 540 post-graduates[38]. During the past two or three years, two more horticulture universities have been set up, one in Andhra Pradesh and one in Karnataka, primarily by bringing all horticultural colleges in the respective States under the new institutional set-up. Besides, some colleges came up in the private sector affiliated to both SAUs as well as in general universities. A list of colleges providing horticultural education in the country is given in Annexure-6.1. An important point to remember in regard to higher education in horticulture is that the courses at post-graduate and doctoral levels are open not only to the graduates in horticulture but also to graduates from a number of other disciplines such as general life sciences and plant sciences. Current admitted strength in horticultural education is given in Annexure-6.2 and summary in Table-6.1.

[37] Agricultural Research Data Book, 2009, IASRI

[38] Report of the Working Group on Horticulture, plantation Crops and Organic Farming for the XI Five Year Plan, Chapter 12, Planning commission, 2007.

In 2011, horticulture education is offered at 46 colleges (35 in SAUs, 8 affiliated to SAUs and 3 others). Fourteen SAUs have facilities for education in this field at graduation level and 32 at post-graduation level. The intake capacity has sharply increased from about 1,100 in 2000-01 to about 3,000 in 2009-10 with expansion of intake in SAUs, including entry of private colleges affiliated to SAUs and other general universities. Against actual admitted strength of about 2,383 during 2009-10, 1,465 passed.

Table-6.1: Students Admitted and Passed in Horticulture Courses during 2009-10

	Diploma		UG		PG		PhD		Total	
Number of students	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass
	172	10	1602	1001	653	409	128	55	2383	1465

A number of diploma level courses in horticulture are also being organized. The SAUs in Andhra Pradesh, Karnataka, Uttaranchal, Gujarat and Maharashtra have diploma courses. The VCSG College of Horticulture, Bharsar, under G.B .Pant University of Agriculture and Technology has courses at certificate level and diploma levels in addition to undergraduate courses. In addition, short term training courses are also being organized in such skills as gardeners, garden supervision and horticultural entrepreneurship.

6.2.2 Areas of Employment of Horticulture Graduates

The entire chain of operations where qualified human resources is needed in horticulture sector is shown in the Fig-6.1.

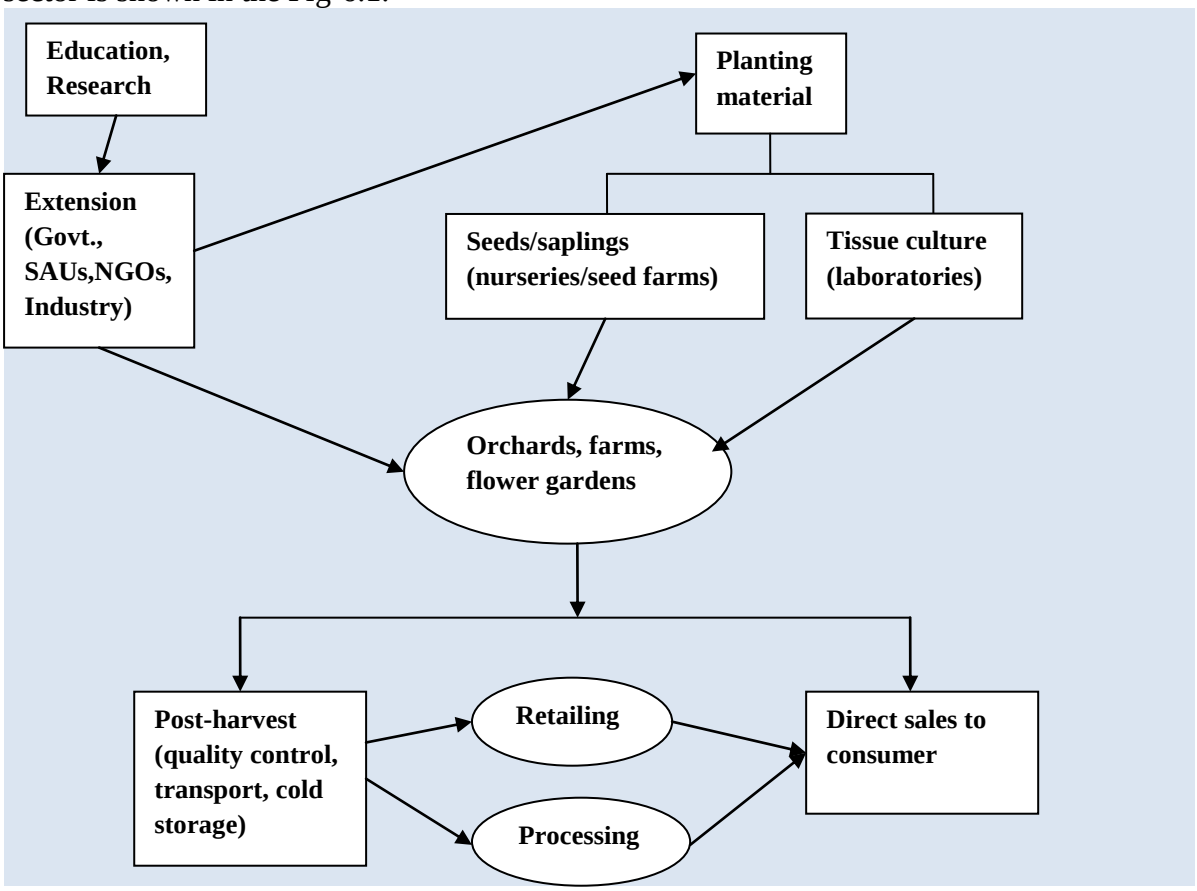


Fig-6.1: Major Sectors Employing Horticulture Graduates

Horticulture human resources is required in production of planting material, establishment of orchards, post-harvest storage, quality control, and processing, besides developmental research and for horticultural education. The type and level of horticultural human resources required at different stages is different.

6.2.3 Current Stock of Horticultural Personnel

There is no direct source of data on the number of active horticulturists in the country. As such, the current stock can only be estimated, as in the case of other agriculture related disciplines, indirectly by cumulating the outturn of horticulture graduates, post-graduates and doctorates over several years (as many as the active working life of a graduate, post-graduate or doctor) and adjust for attrition due to retirement, migration and such causes.

IAMR, in its previous study on agricultural human resources, had estimated the stock of post-graduates in horticulture as 3,652 and of doctorates at 670 in the year 1990. These stocks were projected to grow to 13,004 and 2,242 by the year 2010 on the basis of projected out-turns of the two categories during the years 1991 to 2009. No corresponding estimate of graduates was made. In fact, IAMR made no stock estimates for individual faculties at graduate level, but only at higher levels.

An effort was made to estimate the stock of horticultural graduates from annual supply data from different sources (details given in separately in Chapter-15). The estimated total stock of graduates and above in horticultural sciences from annual supplies is about 14,179 in 2010.

6.2 Demand Projections

6.3.1 Targets of Horticultural Production

The demand for horticultural products is projected by ICAR to grow to 300 million MT in 2011-12 and 360 million MT by 2020-21. The rate of productivity change for different horticultural crops is given in Annexure-6.3. The current level of production (2008-09) is 215 million MT (Table-6.2).

Table-6.2: Current Production and Projected Demand of Horticultural Products

Commodity	Production in million MT			Annual Growth Rate required (%)	
	Production in 2008-09	Demand in 2011-12	Demand in 2020-21	2008-09 to 2011-12	2008-09 to 2020-21
Fruits	68.47	81.00	98.00	5.7	3.0
Vegetables	129.08	185.00	220.00	12.7	4.5
Spices	4.15	5.50	6.50	10.3	3.9
Others	13.02	29.50	35.50	29.9	8.7
All commodities	**214.72**	**300.00**	**360.00**	11.7	4.4

Source; Horticulture Data Base 2009 for production in 2008-09. For projections of demand in 2011-12 and 2020-21, ICAR

This implies that if the projected demand is to be met, the production in the sector is to grow at the rate of about 4.4 per cent per annum from now till 2020-21. However, in the short term

till the end of **XI Plan (2008-09 to 2011-12), the targets are tougher requiring a growth rate of 11.7 per cent per annum in all horticultural products taken together.**

Considering the recent growth rate of 5.6 per cent per annum over the period 2000-01 to 2008-09 and the growth rate of 7.4 per cent per annum achieved during the X Plan period (2002-07), the long term target growth rate of 4.4 per cent up to 2020-21 appears somewhat low. Even if one argues that the likely area available for horticulture may not increase much in future, it is still possible to achieve a higher rate of growth through productivity increases and control of post-harvest wastage. One could, thus, aim for a target of the same growth rate as has been achieved between 2000-01 and 2008-09, i.e. 5.6 per cent. This would take the total availability of horticultural production to nearly 400 million MT by 2020 as against the present target of 360 million MT. These two scenarios, one aiming for a production of 360 million MT (growth rate of 4.4 per cent per annum from now on) by 2020 and the other aiming for 400 million MT (growth rate of 5.4 per cent per annum), thus, present a low and a high projection till 2020. In view of the scarcity of land available, the higher level of production and availability in the high growth scenario would have to be primarily achieved through research for better varieties, enhanced productivity and better post-harvest management. The higher production will also lead to increased horticultural processing. Hence, the effects of the high growth scenario have been considered only in the areas of research, post-harvest management and processing.

The demand projected above has to be met through appropriate sectoral development activities like adequately increasing facilities for producing high quality planting material, production and post-harvest management, each requiring additional horticultural human resources.

6.3.2 Production of Planting Material

The Working Group on Horticulture, Plantation Crops and Organic farming set up in connection with the XI Five Year Plan made projections of planting material required for various horticultural crops up to 2011-12. These projections assumed a modest growth of four per cent per annum in planting material requirement during the XI Plan period. In so far as floriculture is concerned, the XI Plan requirements were determined as an increase of area by 5,000 ha, and planting material of 19,681 lakhs with 2,232 ha of nursery area.

Horticultural planting material is produced largely through vegetative methods in nurseries and to some extent through tissue culture in laboratories. As per the XI Plan Working Group Report, there were a total of 6,330 nurseries in the country in 2005-06. This number included 1,594 in public sector, 138 in SAUs/ICAR Institutes and 4,607 in private sector. The number of nurseries in private sector does not include the nurseries in some States like Madhya Pradesh, Uttar Pradesh, Sikkim, Manipur, Meghayala, Chhattisgarh, Goa and Jharkhand, which did not have a system of registering nurseries In addition, 2,205 nurseries have been established under National Horticulture Mission between 2005-06 and 2009-10 and more under the Technology Mission for North East. A reasonable estimate would place the total number of small and medium nurseries in the country today (2009-10) at around 9,000. The National Horticulture Mission (NHM) aims to establish 2,830 new nurseries by the end of XI Plan. Of these, model nurseries would be of 4 ha and other nurseries would be of one ha in area. Thus, on an average, about 500 new nurseries, of an average area of about 2.5 ha each, are being established each year during the XI plan. It is assumed that the pattern would continue up to 2020. The XI plan estimated that floriculture would require an additional

2,232 ha of nursery area during the XI Plan, or an increase of about 500 ha per year. The same pattern of increase is assumed till 2020.

The establishment survey of IAMR, which covered nearly 100 nurseries, indicated that most private nurseries employed very small number of formally qualified horticultural human resources. In general, an average nursery is found to be employing about 15 workers in all, of whom at best one or two (9.87%) were agriculturally qualified. It is, thus, estimated that the total employment in the 9,000 nurseries in 2009-10 was about 1,35,000 (@ 15 per nursery). This includes nurseries of all sizes. An analysis of the nurseries by size of employment, however, showed that 68% had fewer than 10 employees, 16 per cent had between 10 and 19, 10 per cent between 20 and 49 and six per cent had 50 or more workers. Thus, over 84 per cent of the nurseries employed about six persons on an average. It is assumed that all new nurseries being set up would fall in this category.

With 500 new nurseries coming up annually and with an average employment of 6 in each, the annual incremental nursery employment would be 3,000. Annexure-6.4 shows the pattern of growth in employment till 2020. By 2020, the employment would, thus, grow to a total of 1,65,000 persons. However, only 9.87 per cent of this employment, or 16,286, will be of the persons with agriculture related qualifications.

Level-wise break up of employment in nurseries has been derived by applying the proportions obtained from the establishment survey. These projections are given in Annexure-6.4.

The projected stock demand in horticulture nurseries for 2020 is 12,000, which would increase from 9,800 in 2009-10. The annual requirement of horticulturists in nurseries is about 220 per annum.

It is to be mentioned here that the above requirements are not exclusively for horticulture specialists as general graduates with science subjects or agriculture graduates, such as soil scientists, plant protection specialists, etc., are also employed in nurseries or can themselves set up nurseries.

6.3.3 Horticulture Production

As mentioned earlier, total horticulture production in the country is to grow to 300 million MT by 2011-12 and to 360 million MT by 2020. The production in 2008-09 was 215 million MT from an area of 20.7 million hectares, and has grown at 5.6 per cent per annum over the period 2000-01 to 2008-09. The overall horticultural productivity (production per hectare) has been increasing at 2.1 per cent per annum over the same period. The rates of productivity changes over the period 2000-01 to 2008-09 and in the more recent years 2004-05 to 2008-09 which broadly cover the period since the NHM came into being is shown in Annexure-6.3 for different crops, which also indicates the rates of growth in productivity assumed beyond 2008-09 till 2019-20.

The likely area under fruits and vegetables (the major groups accounting for the bulk of the production in the sector) on the above basis is shown in Annexure-6.5. The skilled human resources requirements in these two sub-sectors have been worked out applying the norms used by the Central Institute of Vocational Education, Bhopal (1996). These norms indicated

that an additional million hectares of fruit crops require additional 25,000 skilled human resources and a million hectares of vegetable crops required 1,00,000 human resources.

In case of other crops, such clear norms were not available. However, fruits and vegetables accounted for 64 per cent of the area under horticultural crops in 2000-01 and 68 per cent in 2008-09. Assuming that they account for about 70 per cent of the total area till 2019-20, the requirements for horticulture as a whole were projected proportionately.

Establishment Survey results indicated that most of the human resources requirements of production are met by informally trained/certificate level persons. It has therefore been assumed that 90 per cent would be such trained persons and the remaining would be diploma graduate, post-graduate and doctorates in the proportion of 1000:100:100:1. On this basis, the requirement of skilled human resources stock for horticultural production has been projected (Annexure-6.6). **The stock requirement of horticulture graduates and above would grow from 13,800 in 2009-10 to about 16,400 by 2020. Thus the requirement is about 260 per annum.**

6.3.4 Post-harvest Management

Post-harvest management is extremely important for improving the quality of produce and products. It reduces the current heavy post harvest losses estimated at about 20 to 30 per cent of the production. In fact, as the land available for horticultural crops becomes scarcer and scarcer, it is the elimination of these post-harvest losses that would significantly contribute to the availability of vegetables and fruits in future**.** For this purpose infrastructure such as, proper collection centres with cold storage facilities, cold chain transport, cooling units for perishable produce, adequate packaging at pack houses, well-equipped markets, etc., are needed.

> The XI Plan Working Group suggested that a composite scheme for improvement in post-harvest infrastructure providing facilities for: i) grading, sorting and packing, ii) pre-cooling facility, specialized storage such as cold stores, and iv) specialized transport such as refrigerated vans/containers is needed. The Working Group suggested that 20% of the horticultural produce may be covered by 2011-12 by setting up 1,400 packing houses and 7,000 collection centres.

Available data indicate that there were 5,101 cold storages in 2006 in the country with a capacity of 2,16,93,986 tonnes [39], i.e., with an average per unit capacity of about 4,250 tonnes. Most of them (4,609) are in the private sector with an average capacity of 4,480 tonnes each, while 358 in cooperative sector and 134 in public sector are much smaller in capacity. As per the XI Plan Working Group, 81.23 per cent of the available cold stores catered to storage of potatoes and 0.21 per cent for fruits and vegetables, while 17.06 per cent were multipurpose and the remaining 1.47 per cent catered to storage of meat products, milk products and other products. The Working Group also indicated that the capacity available (on 31 December 2003) was only 12.5 per cent of the total horticultural production.

[39] IARI, Agricultural Research Data Book, 2009

Progress achieved under the National Horticulture Mission during the period 2005-06 to 2009-10 included setting up of 254 cold stores, 815 pack houses and 217 regulated markets. Thus, the number of cold stores in 2009-10 may be taken as 5,355. The number of pack houses at present is not available, but as stated above, during the period 2005-10, the number of pack houses set up was 815. It may be conservatively assumed that the total number of modern pack houses in 2009-10 is about 2,000 in 2009-10, and is likely to go up to 4,000 by 2020 -@ 200 more per annum, being the average progress achieved during 2005-06 to 2009-10.

With the same average capacity of about 4500 tonnes each as in the past, the cold storage capacity in 2009-10 would cater to just 11 to 12 per cent of the total horticultural production. Assuming that the coverage would reach 15 per cent by 2015 and 20 per cent by 2020, number of cold stores of the current capacity required would increase from the present estimated 5,480 to 9,885 by 2014-15 and 16,091 by 2019-20, under the low growth scenario of horticultural production (with a production of 360 million MT in 2020. In the high growth scenario of 5.6 per cent per annum leading to a production of 400 million MT by 2020, the same 20 per cent coverage would require 18,246 cold stores in 2019-20. The numbers would be less if the capacity is raised from the current 4,500 MT to a higher level.

Data collected from the Establishment Survey showed that each cold store employed, on an average, about 13 persons of whom around 2 would be those with agricultural qualifications – 1 graduates and 1 diploma/certificate holder. The employment projections, made on this basis are shown in Annexure-6.7. **The stock requirement of human capital would grow from 5500 in 2009-10 to about 18,000 by 2020, i.e. 1,100 per annum.**

The XI Plan also envisages setting up 7,000 Collection Centres, each in compact horticultural crop area of 200-250 ha with facilities for sorting, grading and packing and temporary storage facilities that can handle about 10 tonnes of horticultural produce per day (or 2,000 to 25,000 tonnes per annum), and 1,400 packing houses, each with a handling capacity of 50 tonnes per day with facilities for automatic sorting, washing, grading, waxing lines, packing equipment, pre-cooling units and cold storage in urban areas of concentration of production. The requirements of agriculturally qualified human resources of these units have also been included under cold storage.

6.3.5 Processing of Fruits and Vegetables

Vision 2015 document of the Ministry of food Processing Industry mentions that only 1.4% of the fruits and vegetables are processed in 2003-04. The goals are to raise the proportion to 10% by 2009-10 and to 15% by 2014-15.

A reasonable extrapolation to 2019-20 would be 20 per cent of the production. Assuming that these rates of growth apply to the entire horticultural sector, the volumes of to be processed calculated are given in Annexure-6.8. Thus, the volume of horticultural produce processed is projected to grow at an annual rate of 12 to 13 per cent. This is also the order of growth in market potential assessed in the Vision 2015 of food processing industries.

According to the data available from the Ministry of Food Processing Industries, there were a total of 6,736 fruit and vegetable processing units approved in 2007 under the Fruit Product Order 1955. Most of the units would be in small scale and are not likely to engage qualified horticultural professionals. Some data is available for the organized sector units from the Annual survey of Industries of CSO, which are shown in Annexure-6.9.

The establishment survey conducted by IAMR across the country shows that 65 per cent of the establishments covered have less than 20 employees and may be considered unorganised and small scale sector. The remaining 35 per cent covers 20 or more employees and be considered organised sector. This data is in tune with the Ministry of Food Processing Industry's findings which shows that 25 per cent of the food processing industries are in the organised sector.

According to Vision 2015 document of Ministry of Food Processing Industries, the market potential of various segments of food processing is assessed (Table-6.3).

Table-6.3: Market Potential for Processed Foods as per Vision 2015 of FPI

Sector of Food Processing Industry (FPI)	Market potential (Rs. Billion) at 2003-04 prices		Implicit annual growth rate (%)
	2009-10	2014-15	
Fruits and vegetables	290	550	14.7
Spices	450	886	14.5
Alcoholic beverages	553	1153	15.8
Tea/coffee	169	253	8.4

In view of the projected potential growth rates, it is reasonable to assume that the rates of growth of employment (of 9.3% per annum in fruit and vegetable sector and 4.1% in alcoholic beverages) would continue till 2019-20. The resulting projections are shown in Annexure-6.10. An alternative high projection is based on the assumption that the employment in fruits and vegetable processing industry would grow at the same rate as the volume of produce processed, i.e., at about 12 to 13 per cent. These high projections are also given Annexure-6.10.

Establishment survey conducted by IAMR shows educational level-wise distribution of employment in horticulture processing units (Table-6.4).

Table-6.4: Distribution of Employment in Horticulture Processing Units

Level of Agriculture Education	Vegetable and fruit processing units	Alcoholic beverages units
No qualification in agricultural subjects	89.04	59.44
Certificate/training	2.25	33.57
Diploma	1.74	1.40
Graduates	5.82	5.58
Post Graduates	0.78	0.00
Doctorates	0.37	0.00
All levels	**10.96**	**40.56**

Results in Table-6.4 indicate that about 11 per cent of the total employment in fruit and vegetable processing units constitute human resources in horticulture and related fields. About 59.4 per cent in alcoholic beverages units are without agriculture qualifications. About 33 per cent are informally trained or certificate/diploma holders while six per cent are graduates. In both these units, less than one per cent are post graduates and above.

On the basis of the data in Annexures-6.10 and Tables-6.3 & 6.4, projections have been made of the horticultural human resources needed till 2020 in horticultural processing. These projections are given in Annexure-6.11. **It may be observed from these projections that the horticulture processing industries are expected to employ 2.60 lakh persons by 2020, of whom about 61,000 would be those with some qualifications in horticulture. The stock requirement of human capital would grow from 8,400 in 2009-10 to about 17,100 by 2020, i.e., about 600 per annum during the period 2010-20.**

6.3.6 Retailing

Over the last decade, the Indian retail sector has expanded dramatically, with the retail food sector growing at 5 per cent. Even though small independent shops dominate most of retail food sales, supermarkets and modern retail stores, which have until recently occupied less than 2 per cent of the market (compared to 75 -80% in developed countries), have been rapidly expanding their share of retailing business. If current trends continue, the share could go up to 15 – 20 per cent by 2020. Consumer preference for purchases at supermarkets is led by growing demand (due to lower prices and better quality of product in modern retail stores, apart from psychological and other factors). Chains operating in India in retailing of fruits and vegetables include Reliance Fresh, ITC's Chaupal fresh, Adani Agrifresh, Godrej, Food World, Food Bazaar, Big Bazaar, Mother Dairy Fruits and Vegetables (Safal), Haryali Fresh, Spencers, etc. Some of these major players buy the horticultural produce requirements direct from the farmers (either through contract farming or otherwise) and have a well-maintained supply chain such as collection centres refrigerated transport and pack houses, while others obtain their supplies from wholesale markets or other retail majors which have such direct collection arrangements. Adani Agro Fresh, for instance, have direct collection arrangements for apples in Himachal Pradesh. The volume of all retail marketing in the country is estimated to have grown from $ 300 billion in 2006-07 to $ 427 billion by 2010 and is projected to grow to $ 637 billion by 2015. Modern retailing, estimated to be only about $ 9 to 12 billion in 2006, was expected to grow $ 60 billion by 2011, thus, raising the penetration of modern segment from about 3 to 4 per cent in 2006 to 10 per cent in 2011.

Apart from maintaining their supply chains, the retail majors also provide extension services to farmers through demos, advice, cold store support, etc. through their technical teams. For instance, Adani Agri-fresh has set up three farmer service centres in Himachal Pradesh for apple farmers.

As components of post-harvest management have already been considered, no separate estimates have been made for this sub-sector.

6.3.7 Development and Extension

Horticultural development and transfer of technologies to farmers takes place mainly through the activities of the State governments, KVKs and NGOs. Some private sector establishments also play their part in helping the farmers.

While the agricultural departments in some of the State governments look after the horticultural activities also, quite a few States have independent departments/Directorates looking after horticulture. Available details of the horticultural human resources in some States are given in the Annexure-6.12.

IAMR's Establishment Survey indicated that on an average the number of horticultural officer per district would be around seven. Including headquarters staff, the average may be around 10 (Karnataka and Himachal Pradesh seem to be exceptional). As regards staff, the average per district level is about 18 for the States shown in Annexure-6.12. The same is assumed to be valid for the remaining 450 districts. On this basis, the number of horticultural officers in the country may be estimated at roughly 8,000 (3,638 for the 8 States shown in Annexure-12, and about 10 for the remaining 400 districts, and about 300 for the Central horticultural promotional institutions like National Horticultural Board, Coconut, Spices, Coffee, Tea Boards) and horticultural staff at 12,500 (2,824 for the 6 States shown in Annexure-6.12, and about 18 for the remaining 450 districts, and the rest for Central promotional establishments). While these numbers broadly indicate the number of sanctioned posts, the actual incumbents will be less. For instance, in Karnataka over 40 per cent of the officers' posts are vacant. Similarly, in Himachal Pradesh, about 20 per cent of the officers' posts are vacant. Considering that the head quarters and field organizations in the States are more or less stabilized, there is not much scope for expansion of staff positions in future. Even filling of the current vacancies will be limited, given the governments' policies of downsizing their establishments. In view of this, it is presumed that the stocks will not increase anymore and, at best, only replacement needs at about 1 per cent of the existing staff or about 0.75 per cent of the sanctioned strength will be met.

Establishment Survey showed that approximately half of the officers (49.2%) were graduates, a fifth were post-graduates (21.3%), a small fraction (2.7%) were Ph.Ds and one-fifth to one-fourth (22.9%) were diploma holders. It is assumed that these proportions hold good till 2020.

The stock by 2020 will remain stagnated around 15,000.

6.3.8 Financial Institutions

Financial institutions like NABARD and various nationalized banks employ fair number of agricultural graduates including horticultural graduates. Establishment Survey showed that about 3.9 per cent of the total employment (or, 10% of the officers in banks, as officer strength is 40 per cent of the total employment) in banks comprised graduates and post-graduates in agriculture and allied sciences. About 89 per cent of them were graduates and 3 per cent post-graduate, doctorates forming a mere 0.2 per cent, the rest being diploma/certificate holders in agri-related fields. Employment of officers in public sector banks has been projected to grow at a rate of 2.5 per cent per annum from its present level of 3.50 lakhs (2009) to 4.5 lakhs in 2020. **On this basis, the number of all graduates in**

agriculture and allied sciences has been projected to grow from 35,100 in 2009-10 to 45,000 by 2019-20.

Data on how many of the agricultural graduates employed by the banking institutions are horticulture qualified is not known as the banking institutions do not generally prescribe specific qualifications in horticulture at the time of recruitment, it may be assumed that the recruitment would be in proportion of the horticultural graduates, post-graduates to the total annual intake of graduates in all agricultural fields (which is about 5 per cent, now and may go up to 10% by 2020).

6.3.9 Research and Academic

6.3.9.1 Research

Horticultural research is vital for enhancing productivity, quality of produce, reduction in the cost of production and increasing shelf life of produce through better post-harvest management, as future growing demand for horticultural products cannot be met by increasing land area. **According to the XI Plan Working group Report, productivity per unit area can be increased by 20 to 50 per cent with high yielding genetically modified varieties. In addition, post-harvest losses amounting to an estimated 20 to 30 per cent of the produce can be brought down through improved methods of handling.**

There are 10 Central Institutes with 27 regional stations, 9 multi-disciplinary institutes, 12 National Resource Centres, 15 AICRPs with 22 centres engaged in horticultural research. A number of other institutions like Department of Bio-Technology, Bhabha Automatic Research Centre, Indian Space Research Organisation, etc., are also doing research on horticultural crops. Besides, Ministry of Commerce has research institutes for coffee, rubber and spices. A number of State Agricultural Universities are also engaged in horticultural research.

The sanctioned and vacant positions in horticulture research and education institutions (as on March 2010) are given in Annexures-6.13 and 6.14, respectively and summary for research sector is given in Table-6.5.

Table-6.5: Sanctioned and Vacant Position in Horticulture Sector as on March 2010

	Sanctioned	In position	Vacant
ICAR Institutes	871	647	224
SAU's	3204	2094	1110
Affiliated colleges	90	60	30
Total	4165	2801	1364

Horticultural research is mainly carried out in the public sector institutions. Data based on the results of a Census of Agricultural Scientists (2001-02, unpublished), cited by Jha *et al*[40] indicated that 91.5 per cent of the FTE (Full Time Equivalent) Scientists were working in public sector – 25.9 per cent in ICAR institutions, 65.2 per cent in SAUs and 0.4 per cent in

[40] Dayanatha Jha, Sant Kumar and Laxmi Joshi, " Resources for Horticultural Research in India", National Cente for Agricultural Economics and Policy Research, Pusa, New Delhi

others, while **private sector accounted for only 8.5 per cent**. The census data also indicated that 3,575 researchers were engaged in horticultural activities and that 73 per cent of the researchers were PhDs. Only 30.5 per cent of the researchers in horticulture, however, came from the discipline of horticulture (Table-6.6). Thus, only about 1,100 (30.5% of 3,575) horticultural researchers came from horticultural disciplines in 2001-02.

Table-6.6: Broad Disciplinary Profile of Horticultural Scientists

Discipline Group	per cent of horticultural scientists
Crop Sciences	45.0
Horticulture	30.5
Natural Resources	17.8
Social sciences	5.3
Others	1.4
All	100.0

Source: Census of Agricultural Scientists (2001-02) (unpublished) reproduced from Jha *et al, cited earlier.*

Data supplied by ICAR shows that in 2010, total the number of scientists' posts in ICAR institutions in horticulture is 871 of which 650 are filled. Not all these posts and incumbents were from the discipline of horticulture only. Data from PERMISNET II (as on 23/04/2010) show that the cadre-strength of Principal Scientists, Senior Scientists and Scientists sanctioned in all ICAR institutions in horticultural disciplines was 341 (Table-6.7).

Table-6.7: Cadre Strength in Scientific Category in Horticultural Disciplines in ICAR Institutions (as on 23 April 2010)

Discipline	Principal Scientists	Senior Scientists	Scientists	All
Horticulture-floriculture	30	44	99	173
Horticulture- fruit science	6	16	16	38
Horticulture	13	20	68	101
Horticulture-Post Harvest Technology	1	0	6	7
Horticulture – Vegetable Science	3	3	16	22
Total	**53**	**83**	**205**	**341**

Source: ICAR, PERMISNET II, 23/04/2010

The XI Plan identified a number of thrust areas for horticultural research such as development of improved varieties/hybrids, particularly minor fruits and seed species, protected cultivation for export-oriented vegetables and flowers, efficient water management including micro-irrigation, post-harvest technologies, micro-propagation, disease problems, floriculture research for quality cut flowers, integrated management of nutrients, hi-tech horticulture, organic farming, market intelligence, and mechanization of operations in gardens. These areas may well continue as thrust areas till 2020. However, considering past experience[41], it is not likely that the human resources requirements of research activities in

[41] The number of sanctioned scientific posts in ICAR institutes has steadily declined from 6,965 in 2001 to 6,428 in 2010, while the number of filled posts declined from 5045 in 2001 to 4165 in 2009. However, in 2010, the number of posts again increased to 4470.

horticulture (or for that matter any other agricultural science) will add significantly to the workforce in ICAR or in the SAUs. Research activity in the private sector may expand to some extent. **Considering all the factors, the human resources requirements of research in horticulture (by scientists from horticultural disciplines) may be estimated at 1,200 in 2009-10, which may increase to 2,000 by 2020. About three-quarters of them would be PhDs and the rest post-graduates.**

6.4.9.2 Academic

It is estimated that all the agriculture and horticulture universities including affiliated colleges have about 1,884 faculty in 2010, and it is estimated to grow to 3000 faculty by 2020. Projections for the future years have been worked out assuming that the requirements would grow at the same rate as the outturn in graduate/post-graduate and PhD. Training needs of the certificate level have not been considered.

Finally, necessary adjustments have been made to take into account the fact that the need for out-turn at various levels is to meet not only the needs at that level of the economy but also the requirements to achieve the projected outturns at a higher level. Thus, for example, the out-turn of post-graduates should meet the needs of the economy for post-graduates but also the need for turning out post-graduates who will eventually meet the needs of doctorates.

6.4.10 Other Establishments

6.3.10.1 NGOs, Agri-services and Agri-clinics

A number of NGOs are undertaking extension and promotional work in agriculture in general and horticulture in particular. There are also a number of agro-service centres providing professional services and inputs like seeds, fertilizers and equipment to farmers. In recent years the scheme of agri-clinics and agri-businesses to provide self-employment to agricultural graduates has also led to rapid growth of such clinics. All these developments have an impact on horticulture also.

The total number of agriclinics and agribusinesses financed[42] between 2002 and September 2010 was 7,949 of which 768 were exclusively in the area of horticulture (such as mushroom cultivation, apiary, vegetable production and marketing, tissue culture, seed processing and marketing, nursery, landscaping and nursery, floriculture and cultivation of medicinal plants. Thus, on an average 100 units have come up per year, each generally with one agricultural graduate.

6.3.10.2 Landscaping and Parks

Landscaping in large housing and other construction activities and developing and maintaining of parks in metropolitan cities and large towns also requires horticultural human resources. Investments in large scale real estate industry appear to have grown from about $60 billion in 2006 to over $ 100 billion by 2010, all of which have landscaping needs. The size of the requirement may be gauged from the fact that the Central Public Works Department, with a total workforce of 44,325 in the country as a whole, employs 185

[42] Source: www.agriclinics.net

horticultural officers of various levels and 3,756 malis and other skilled workers. The Horticulture Department of the Municipal Corporation of Delhi employs 121 horticultural officers in addition to around 8,000 malis and the New Delhi Municipal Committee similarly employs 37 horticultural officers in addition to many skilled workers.

6.3.10.3 High-tech Horticulture

Recent years have seen a growth in the hi-tech practices in horticulture by progressive farmers, such as high-density plantations, plasticulture (use of plastics in activities such as drip irrigation, plastic film mulches, greenhouse structures, high and low tunnels, post harvest operations, shade nets, etc.), bio-fertilizers and integrated nutrient management, integrated pest management, micro-propagation through tissue culture, molecular diagnostics and molecular breeding.

National Horticulture Mission has been providing assistance for such activities. **In the absence of detailed data on these activities at present and the future development, the human resources requirements for these segments have been assessed as 10 per cent of all other segments.**

6.4 Summary of Demand Projections

The projections of stocks of horticultural human resources required to meet the needs of various segments of the economy and the consequential flows required from the educational system are summarized below.

6.4.1 Stock Projections

The overall stocks of horticultural human resources required to meet the requirements of various segments of horticulture have been added up to give projections for various years up to 2019-20. Three sets of projections have been worked out as explained in the segment-level projections – one a high projection, a low projection and an average of the two. These stock estimates are given in Annexure-6.15. The average variant projections for stock are given in Table-6.8. **The stock requirement of human capital in horticulture sector would grow from 62,583 in 2009-10 to about 95,902 by 2020. The required additional stock during 2010-20 would be about 3,300 per annum.**

Table-6.8: Estimated Requirements Stocks of Horticultural Personnel

Year	Diploma	UG	PG	PhD	UG & above
2009-10	146320	50005	9325	3254	62583
2019-20	175315	79731	11432	4738	95902

6.4.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 14,179. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., about 15 per cent during 2006-10), the estimated demand – supply scenario in 2020 will be

Supply: 26,030
Demand: 95,902
Gap: 69,872 (73% of the demand)

6.4.3 Flow Projections

The corresponding annual outputs required from the educational system to lead to these stocks are given in Annexure-6.16. Considering the current supply and experts opinions on graduates aspirations and employee organizations capacity to absorb graduates, the average variant projections for annual flow are given in Fig-6.2.

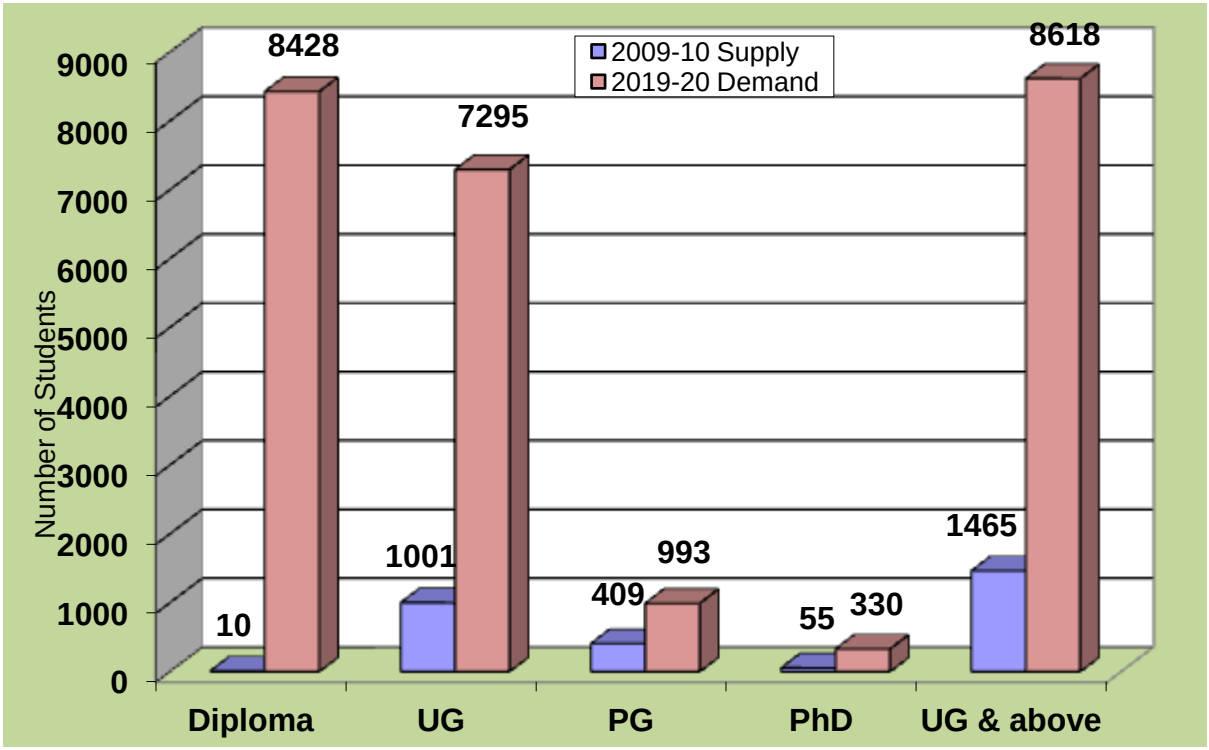


Fig-6.2: Current (2010) and Projected Outturn Required (2020) in Horticulture

The projections suggest that by 2020, the annual outturn from the horticultural education system should be about 8,400 diploma holders, 7300 under-graduates, 990 post-graduates and 330 doctorates. Current supply of about 1,500 per year is far below the requirement of 8,600. However, part of the requirement is met from other graduates – forestry, crop science and general science graduates, especially in the non-government sectors.

6.5 Institutional Mechanisms and Skill Issues – Experts' Views

- Substantial posts are vacant in the universities and government sector which needs to be filled-up to enable horticulture sector grow.

- **Retail industry is growing rapidly, which has tremendous potential for employment generation in horticulture sector**. While on one hand there is a need for technical advisers and business managers, on the other hand the sector needs skilled personnel at field level. Large number of retail companies is employing agri-business graduates. To meet the industry requirements, students need to understand the operations of collection centers, customer interface and pricing in the retail sector. This also entails skills in grading, storage, preservation, display, advertisement and marketing. All these activities require specific skills. **A course on horticulture business management is desired.**

- At present a number of persons are joining this sector with other qualifications i.e., graduates in agriculture and other general science subjects. A policy view is needed on whether the horticulture sector should employ only persons with horticulture qualifications or it should remain open to other subjects.

- **Strengthening the extension services is extremely essential** to cater to the needs of both the farmers and the industry. Seed industry needs more technical persons with breeding specialization.

- **There are number of schemes of Government of India in which loans are provided for setting up own enterprises. The students coming out of the universities/colleges should be helped and linked with these schemes** especially those who are interested and have aptitude to start their own enterprises. These students should be helped in project selection, project preparation, etc.

- Human resources retention is of concern to some employers. The students, who take up employment in horticulture sector, leave the job as soon as they get a better employment even if it is not in their specialized field. This problem could be addressed treating horticulture at par with other professional courses to make the sector attractive to professionals. This needs curriculum focus on mechanization, value addition and management. Further, need **an integrated approach to develop lower level technocrats for working in villages.**

- ITI level training institutes should be established to focus upon horticulture skill needs at micro level. **The courses at lower level are needed in nursery management, seed production, post harvest and processing, hi-tech horticulture and protected cultivation.**

- There is a need to develop a data base on various aspects of horticulture as reliable data is not available at present.

- The issue of climate change, post harvest management and bio-technology are some of the emerging areas which require research, skill development and policy interventions.

6.6 Conclusions

The sector has capacity to augment the stock of human capital from current level of 14,179 in 2009-10 to about 95,902 by 2020. The annual supply would have to increase from the current level of 1,500 to 8,600, i.e., 7,100 additional graduates (6,200 UG; 600 PG and 300 PhD) per annum. The sector promises tremendous opportunity for expansion in education.

An important fact that should be taken into consideration in horticulture sector human resource requirement is that while at the post-graduate and doctoral levels the requirements are generally met by post-graduates and doctorates in horticulture, and it is not in the case of under-graduates. Often, graduates in general life sciences (botany), bio-technology and other streams are employed in jobs seemingly requiring horticultural qualifications. Most officers in the horticultural departments of the State governments seem to possess qualifications in general agriculture. Even the industry and financial institutions do not insist on specific horticultural qualifications. This is so in almost all spheres of horticulture, except in research and education. In fact, a recent advertisement for Sectional Officer (Horticulture) by Delhi development Authority) asks for "B.Sc. (Agriculture) or B.Sc. with Botany/Horticulture as a subject from a recognized university. Two years experience in the field of Horticulture/Landscaping". Unless things change in future and the recruitment rules are amended, the outturn requirements projected above at graduate level have to be suitably down-sized. As mentioned earlier, only 30 per cent of the horticultural researchers come with specific horticulture streams. If it is assumed that the same factor applies at under-graduate level, the requirements of core horticultural graduates would be only about 3,000 in 2010-11 and 4,000 in 2019-20. Even on this conservative estimation, there is a need to double the human resources supply in this sector. In other words, the horticulture education needs to expand to produce an additional 2000 under-graduates in the next ten years, i.e., by 2020. Immediate intervention is also needed in post harvest management and backward forward linkages as horticulture is one of the growing sectors which have hope for Indian agriculture sector.

Chapter-7

Human Capital Assessment in Forestry Sector

7.1 Introduction

Forests contribute to the nation's GDP to the extent of about 2 per cent. More than 100 million rural people depend on the sale of non-timber forest products for their livelihoods. It is estimated that small-scale enterprises based on non-timber forest products provide up to 50 per cent income for 20 per cent-30 per cent of the rural labour force.

7.2. Supply of Graduates

7.2.1 Forestry Education

Realizing the importance of skilled human resources in this sector, programmes have been initiated in various aspects of forestry. The Universities initiated organized forestry education only in 1987, when 14 State agricultural and five general universities established forestry faculties following the recommendations of the National Commission on Agriculture. Thus courses on forestry and its related fields like wood science and technology, wildlife, agro-forestry, biodiversity conservation, participatory forest management are of immense importance from policy and application point of view. The task of forestry education, training and extension is under the supervision of the Ministry of Environment and Forests, Government of India. The Indian Council of Forestry Research and Education, Dehradun, an umbrella organization under the Ministry, is actively engaged in forestry research and knowledge dissemination through its eight research institutes and three advanced centres all over India. Training to frontline foresters is provided by the Indira Gandhi National Forest Academy, Dehradun and the Directorate of Forest Education (DFE) through its four State Forest Service colleges (at Coimbatore (Tamil Nadu), Burnihat (Assam), Dehradun (Uttarakhand) and Kurseong (West Bengal)). The Ministry has several autonomous organizations like Wildlife Institute of India, Dehradun; Indian Plywood Industries Research and Training Institute, Bengaluru and G.B. Pant Institute of Himalayan Environment and Development, Almora affiliated to it. These organizations are working actively in the field of forestry research, training and extension. There are also around 45 Central and one1 State university in India which provide under-graduate courses (some of which are of four-year duration), and 16 universities which provide postgraduate courses in forestry education and extension. Masters degree level specialization includes subjects like Forest Economics, Wood Science and Technology, Computer Applications in Forestry, Biodiversity Conservation, Community Forestry, Wildlife, etc. At present, there are 37 institutions/colleges offering forestry education at various levels – 26 from agricultural universities and 11 from general universities and central institutes. A list of institutions offering forestry education in the country is given at Annexure-7.1.

Some of the State Agricultural Universities also have forestry-related courses at under-graduate, post-graduate and doctoral levels (Table-7.1 and Annexure-7.2). The estimated current (2009-10) intake in these universities/colleges is 1160 (587 at under-graduate level,

406 at post-graduate level and 167 at doctoral level) and outturn is 716 (386 at under-graduate level, 275 at post-graduate level and 55 at doctoral level).

Table-7.1: Intake and Outturn of Students in Forestry Courses

Education system	UG		PG		PhD		Total	
	Intake	Pass	Intake	Pass	Intake	Pass	Intake	Pass
Agricultural Universities	562	386	210	126	57	13	829	525
Others	25	0	196	149	110	42	331	191
Total	587	386	406	275	167	55	1160	716

At below graduate level, the training of foresters and forest guards has always been the responsibility of the State Governments except for a brief period between 1952 to 1960 when a Regional Foresters' School was run by the Government of India at Southern Forest Rangers College (SFRC) Coimbatore which catered to the needs of the States of Madras, Andhra Pradesh, Mysore, Kerala and Andaman & Nicobar Islands. Currently, there are about 48 training schools in the States for imparting training to the Foresters and Forest Guards.

Following the creation of Indian Forest Service (IFS) again in 1966, the training of IFS officers started in 1968 in Indian Forest College (IFC) along with the State Forest Service (SFS) trainees till 1975. After 1975, the IFC was exclusively set aside for training of Indian Forest Service probationers with a separate course of its own and the increased demand for training State Forest Service Officers necessitated establishment of three separate State Forest Service colleges at Burnihat in 1976, at Coimbatore in 1980 and at Dehradun in 1981. The Government of India subsequently upgraded the IFC to the status of a national academy named Indira Gandhi National Forest Academy (IGNFA) in 1987.

7.2.2 Areas of Employment

To estimate the requirements of human resources in Forestry, it is necessary to look at specific fields, where human resources with specialization in forestry subjects. Depending on their field of specialization, forestry-educated can work either in offices, laboratories or outdoors in the wild. They perform an advisory role in government and non-governmental organizations to encourage management and maintenance of the country's forest reserves. This includes jobs in the Ministry of Environment and Forests and in the forestry departments of State governments, and in government-sponsored projects in forestry and environment, and in autonomous organizations in the field of forests and environment.

They also work as industrial and agricultural consultants in various industries that utilize forest resources. On the manufacturing side, they find employment in the manufacture of timber products, paper and other wood based products. They can also find employment in executive positions in timber and plywood companies and in organizations like the Food and Agricultural Organization (FAO). Scientists can find employment in various research labs and educational institutions. The prevention of forest fires, wasteland development, social forestry, eco-tourism etc. are other areas that fall within the ambit of forestry specialists.

Research in the protection and regeneration of forests is also an important area of experts in Forestry.

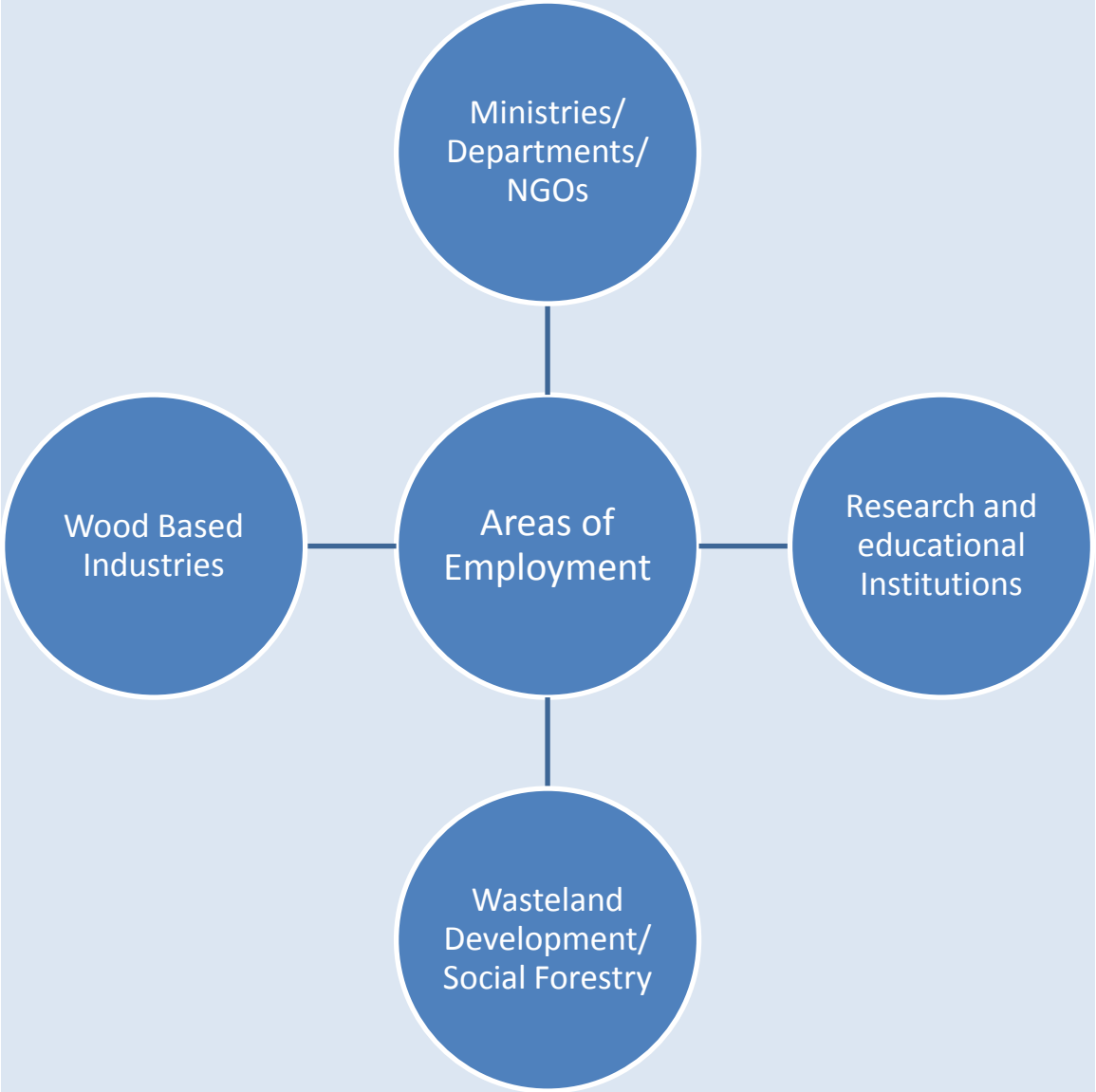


Fig. 7.1: Areas of Employment in Forestry Sector

7.2.3 Current Stock of Forestry-educated Personnel

There are no readily available estimates of the stock of available persons with forestry education at various levels. The IAMR[43], in its earlier exercise on human resources projections for agricultural human resources undertaken around the year 2000, estimated that the number of persons who completed post-graduate courses in forestry-related disciplines from the State Agricultural Universities was 78 in 1991, and (on the basis of projected annual outturns) projected the stock to 207 in 2001 and 369 in 2009. At the doctoral level, the

[43] IAMR: Assessment of National Human resources Needs in Agriculture and Allied Sectors, September 2001, Vol III

corresponding estimates were 7 in 1991, 27 in 2001 and 42 in 2009. These stock projections were made on the basis of projected outturns of 25 at post-graduate level and 2 at doctoral level for the year 2009, which are considerably lower than the estimates (65 at post-graduate level and 9 at the doctoral level) shown in Table-7.1.

An effort was made to estimate the stock of fishery science graduates from annual supply data from different sources (details given in separate chapter). The estimated total stock of graduates and above in forestry sciences, estimated from annual supplies is about 5005 in 2010.

7.3 Demand Projections

For the purpose of projections the forestry sector has been divided into different segments that employ forestry-educated persons on functional basis. The primary areas are for conservation and development of forests by Central and State governments, various industries based on timber and other forest products and NGOs.

The main areas where forestry-educated persons find employment in the government are the Indian Forest Service operated by the Central Government and the State Forest Services operated by the respective State Governments to conserve and develop forests.

7.3.1 Indian Forest Service (IFS)

The IFS is a Central Government Service, for which a selection test is conducted by the Union Public Service Commission, for better and integrated forest management. Two-thirds of the cadre strength of the Service is filled by direct recruitment through the Union Public Service Commission (UPSC) by conducting an all India level competitive examination open to graduates with science background **(**Graduates with at least one of in Botany, Chemistry, Zoology, Physics, Statistics, Geology, Agriculture, Forestry). The remaining (one-third) posts of the cadre strength of IFS are filled by appointing eligible officers of the State Forest Services.

The administrative hierarchy of Indian Forest Service in the Forest Departments in the States and Union Territories is as under:

i) Principal Chief Conservator of Forests
ii) Additional Principal Chief Conservator of Forests
iii) Chief Conservator of Forests
iv) Conservator of Forests
v) Deputy Conservator of Forests

At present, the total strength of forest officers in our country is 3,034. Statement showing cadre wise information in respect of the Indian Forest Service as on 01.01.2010 is at Annexure-7.3.

7.3.2 State Forest Services

State forest officials are recruited by State Public Service Commissions of the respective States. The eligibility for candidates and the examination pattern is almost the same as for

Indian Forest Service examinations. Forest rangers examination is also conducted at State-level by the staff selection commissions. Eligibility for this examination is generally graduation with science subjects. For posts below rangers (Deputy Rangers, Foresters, Forest Guards, etc.) the qualifications required are generally below graduation.

7.3.3 Employment in State Forest Departments

The staff position in the forest departments of various State governments, inclusive of IFS and SFS posts as well as subordinate posts, as obtained from the web-sites of the respective States are given in Annexure-7.4. These posts exclude ministerial posts and technical posts outside forestry.

Data on staff in position *vis a vis* staff sanctioned available in the case of some States indicated that only about 75 per cent of the posts are in fact filled. On this basis, the total number of forestry-related staff in position in 2009-10 has been estimated at 69,242 against the sanctioned posts of 92,321. Further, on the basis of the proportions obtained from the results of the Establishment Survey of IAMR for the government establishments in forestry, it has been estimated that in 2009-10, there were 27,027 certificate/trained persons, 12,508 diploma-holders, 5,964 graduates, 2,262 post-graduate and 687 doctorates in forestry, while 20,795 were graduates and above in other subjects. These numbers have been taken as the base for the projections.

Two projections have been attempted. The first projection, a low projection, assumes that the total forestry-related employment in the forest departments will not change in the next ten years, but the proportion of graduates and above in the subject of forestry out of all graduates and above will improve from the present 30 per cent to 35 per cent by 2019-20 linearly. The second projection, the high projection assumes that in addition, the vacancy position will improve from the present 25 per cent to 15 per cent by 2019-20 linearly at the rate of one per cent per annum.

Detailed projections for government forestry departments are shown in Annexure-7.5. **The projected stock demand for 2020 is 11,900, which would increase from 8,900 in 2009-10. The annual requirement of forestry graduates in this sector is about 300 per annum.**

7.3.4 State Forestry Development Corporations

In pursuance to a recommendation by the National Agricultural Commission, many of the State governments have established Forest Development Corporations to raise manmade forests and restore degraded forests. However, details of staff strength are available only for a few State Corporations (Andhra Pradesh, Tamil Nadu, Kerala, Punjab, Haryana, Orissa and Maharashtra). Data for corporations in the other States have been estimated on the basis of the relationship between the staff in the corporations and forest departments. The overall employment of forest corporation staff in the country in 2009-10 has, thus, been estimated at 12,675 and the filled posts at 9,506 of which 5,308 related to forest professionals. Break-up by educational levels has been worked out assuming that the patterns as in the government forest departments would apply to these corporations as well. Low and high Projections up to 2019-20 have been made on the same assumptions as for forest departments.

Detailed year-wise projections for the corporations are shown in Annexure -7.6. **The stock of forestry human capital would grow from 650 in 2009-10 to about 980 by 2020. The requirement during 2010-20 is about 30 per annum.**

7.3.5 Research

Forest research is carried out in ICAR institutes as well as institutions under the Indian Council of Forestry Research and Education under the Ministry of Forests and Environment. On the basis of available data of NAARM, ICAR and the websites of other Research Institutes, the present scenario related to the number of scientist positions in these institutions is shown in Table-7.2.

Table-7.2: Scientist Staff in Various Forest Research Institutions in 2009-10

Institute	**No. of scientists in position by qualifications**			
	Post-graduates (forestry)	Doctorates (Forestry)	Others	Total
Institutes under ICAR	10	28	-	38
Institutes under ICFRE	65	172	125	362
Total	75	200	125	400

Source: ICAR and web-sites of various institutions under ICFRE

'Others' shown in the above table include doctorates and post-graduates in subjects other than forestry as well as IFS officers with various qualifications. As the primary interest in this exercise is to project the required output from forestry streams, it is assumed that the present strength of 275 forestry scientists (200 doctorates and 75 post-graduates) would increase at one per cent per annum till 2019-20.

Detailed projections are shown in Annexure-7.7. **The stock of human resources in forestry research of 270 in 2010 would grow to 300 in 2020, i.e. less than 5 per annum during 2010-20.**

7.3.6 Academic

As in the case of research and education in forestry is also imparted in the institutions under the Ministry of Forests and Environment as well as in the State Agricultural Institutions. The current staff position in the State Agricultural Universities is shown in Annexure-7.8.

Thus, about 43 per cent of the sanctioned forestry faculty positions in SAUs are vacant. In so far as the academic institutions under Indian Council of Forestry Research and Education (ICFRE) are concerned, the Indira Gandhi National Forest Academy and the four constituent colleges under the Directorate of Forest Education (now redesignated as Central Academies for Forest Services) at Coimbatore.

Dehradun, Burnihat and Kurseong together had staff strength of 49. Most of the incumbents of these positions are IFS officers with varied qualifications and forestry is not one of the major ones among them. As such, projections of the requirements are confined to the needs of SAUs only. For this purpose, it is assumed that the vacancy position will reduce from the current 43 per cent in 2009-10 to just 10 per cent by 2019-20.

Projections of teaching needs in forestry education in SAUs are shown in Annexure-7.9. The stock of 240 in 2010 would grow to 390 in 2020, i.e., about 15 per annum during 2010-20.

7.3.7 Forest-based Industries

Forest based industries like paper and pulp, plywood, etc., employ about 1.5 lakhs persons (ASI time series data industry codes 2021, 2023 and 2101). According to the establishment survey, about 10 per cent of the total employment comprised agro-forestry related qualified persons. The serial data from ASI for the period 2001 onwards do not show any growth in employment. In fact the growth rate is of the order of -1 per cent per year. It is, therefore, assumed that the employment in this sector at best remains stationary at the 2006-07 level. Projections of stocks for this sub sector have been made accordingly.

Projections of these stocks are shown in Annexure 7.10. The estimated stock demand for 2010 is 14,165, which would remain same in the next decade.

7.4. Summary of Demand Projections

The projection of stock of Forestry human resources to meet the needs of various segments of the economy and the consequential flows required from the educational system are summarized below.

7.4.1 Stock Projections

The overall stock of forestry human resources required to meet the demands in four distinct segments has been added up to give projections for various years up to 2019-2020. The three sets of projections – one a low projection and the other a high projection as well as a average projection are given in Annexure-7.11. The estimated stock requirements for average scenario in 2010 and 2020 are presented in Table-7.3. **The stock of forestry graduates and above increases from about 25,500 in 2010 to 29,000 by 2020, i.e., annual addition to stock is about 350.**

Table-7.3: Projected Stock Requirement of Forestry-educated Persons

Year	Diploma	UG	PG	PhD	UG & above
2009-10	16979	17512	4548	3399	25458
2019-20	17918	19788	5450	3806	29043

7.4.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 5005. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., about 8 per cent during 2006-10), the estimated demand-supply scenario in 2020 will be:
Supply: 8,148
Demand: 29,000
Gap: 83 % of the demand

7.4.3 Flow Projections

The corresponding annual outturns required from the educational institutions to lead to the stock worked out above are presented in Annexure-7.12. The above stock projections have been converted to annual flows required out of the educational system taking into account: (1) the growth from year to year (2) replacement needs calculated at the rate of 3 per cent of the previous year's stock and (3) the needs of higher education. The annual outturns required from the educational institutions to lead to the stock worked out above are presented in Fig-7.2.

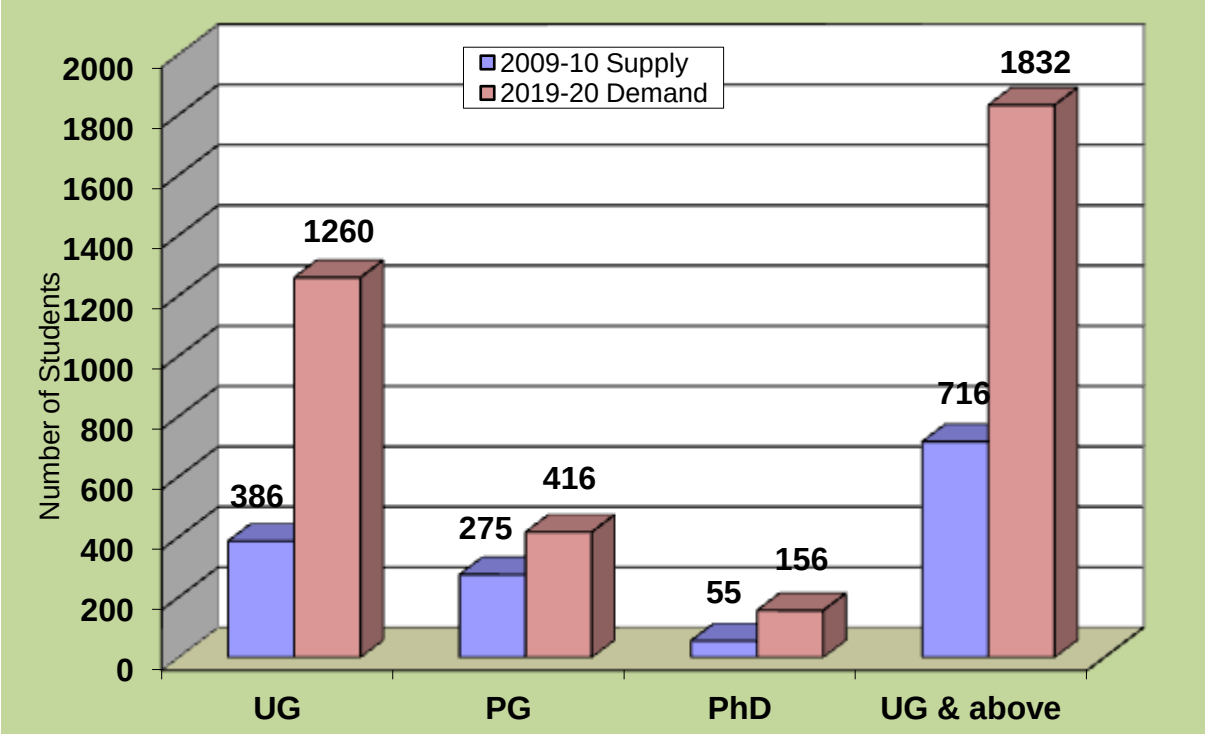


Fig-7.2: Current (2010) and Projected Outturn Required (2020) in Forestry

The outturn required from forestry educational institutions at graduate and above level is projected to increase from about 386 to 1260 in the case of under-graduates, 275 to 416 in the case of post-graduates and from 55 to 156 in the case of doctorates over the projection period, i.e., 2010 to 2020.

7.5 Institutional Mechanisms and Skill Requirements – Experts' Views

- Core forestry area is not attractive for students due to lack of its potential to provide employment. New areas such as Aroma courses, remote sensing and GIS are emerging. Other emerging areas for employment in this field are - forest certification, environmental science, wood and paper technology, products from medicines and herbs, nursery management, plantation management, forest protection, climate impact, carbon credits, etc.
- Molecular biology techniques are yet to be used in forestry propagation. A beginning has taken place and this may emerge as a strong field in the future. Clone forestry is growing fast, particularly in plantation companies like ITC.

- Pasture management is critical to support tribal population as the nomads use sheep and goat for grazing in the alpine pastures. There is no focused forestry activity on this at present. There are not enough trained people at the lower level. .
- One functional area that needs forestry human resources is the community forest resource management. Green India Mission envisages strengthening of village level Community Forest Management organizations (Vana Samrakshana Samitis- VSS). Various State Governments have established Vana Panchayats for Community Management of Forests. National Rural Livelihood Mission needs one graduate/diploma holder at each village. These units may provide a hope for future employment in forestry sector.
- Education requires practical orientation and constant interactions with industries. Students also need to have clarity in their understanding of basics in the subject- for example, in- depth understanding of plant taxonomy.
- More big industries are going for automation so as to improve the quality of their products to compete in the global market. This requires more quality graduates.
- Forest Development Authority and Forest Monitoring Agencies need additional human resources at least one each in each centre considering the recent public interest on mining and plantation activities. There is need for stronger monitoring mechanism from the public system. This needs additional human resources.
- Many forestry graduates are not getting proper jobs. Bulk of them is trying for PG only for lack of proper jobs after graduation.
- Paper industry need 800 trained technicians per year. Seven institutes in the country are now producing only 200 paper technology students per year. For paper mills, environmental issues are very important. Therefore, the paper mills need post graduates in Paper Technology as well in Environmental Science. The graduates are absorbed by Industry to deal with the issues of environment, wood and paper technology development and to limited extent on plantation development.
- It has been suggested that forestry should be introduced as a subject in Civil Services Examinations.

7.6 Conclusions

The stock of forestry graduates and above is estimated to increase from about 25,500 in 2010 to 29,000 by 2020. Against the current annual supply of about 720 forestry graduates, the demand will increase to about 1,830 by 2020, i.e., 1,100 additional graduates (860 UG; 140 PG and 100 PhD). In fact, the current intake capacity is about 1,300 and students are not readily opting for this course. Unfortunately, graduates in this discipline have no apparent economic sector to absorb, unlike in other subjects like horticulture, fishery, etc. Even in academic and research sector the situation is no good except in ICAR and SAUs, where the positions are filled with forestry graduates. As bulk of the senior officials managing various positions in forestry organizations are from general stream, they do not favour any of the positions to be mandated to this discipline. In absence of no such initiative and statutory support, the forestry graduates may not get most jobs that need them and they would drift to various other occupations. In such scenario, further expansion of education is not desirable.

The rural institutions like Van Vigyan Kendras and Joint Forest Management activities at grass root level and a host of government schemes aimed at forest and tribal areas, need forest trained persons at village level. This requirement can be met by diploma holders.

Chapter 8

Human Capital Assessment in Veterinary and Animal Husbandry Sector

8.1. Introduction

Livestock sector is an important sub-sector of Indian agriculture and is gradually emerging to play significant role in the food scenario and also contribute significantly to the country's development. Changing food consumption patterns among the population, particularly among the urban middle classes, in favour of quality dairy, poultry and other meat products coupled with growing exports of such products on the one hand, and the uncertain potential of traditional agriculture by itself to ensure food security to the masses have made the livestock sector an increasingly important factor on the agricultural scene. The contribution of the livestock sector to the Gross Domestic Product was 4.2 per cent in 2007-08 at 1999-2000 prices. While the contribution of agriculture as a whole to GDP has halved from about 35 per cent in 1980-81 to about 16 per cent in 2007-08, the share of livestock sector ***within agriculture*** doubled from 14 per cent to 26 per cent during the same period. Over the period 2000-01 to 2007-08, the GDP from livestock sector grew at a rate of 4.2 per cent per annum, and this has been achieved despite the fact that investment in this sector was not substantial.

Effective animal health management contributes to reduction in loss of output due to morbidity and mortality of animals thereby raising the output from livestock sector. Improved breeding techniques using exotic and cross-bred animals raise the quality and yield of animals. The ambitious goals of dairy development over the next ten years and more (discussed in the Chapter on Dairy Science and Technology) can be achieved only through improved quality and health of the animals. Further, improved animal breeding, nutrition and health are crucial for the growth of high quality meat processing industries, an important component of food processing industries on the rapid growth of which India's development plans have set a high premium.

8.2 Supply of Graduates

8.2.1 Education in Veterinary Science and Animal Husbandry

The importance of education in veterinary and animal husbandry sciences arises from its role in bringing about improvement in these two areas – animal breeding and animal health. The profession of veterinary personnel is a service and knowledge delivery profession in the area of animal health, animal husbandry, livestock and poultry productivity improvement, integration of animal husbandry with other agricultural farming systems, horticulture, aquaculture, forestry, sericulture, etc.

Education in the field of Veterinary Science and Animal Husbandry, though considered allied to agricultural disciplines, is somewhat different. The undergraduate course is of five years duration, whereas the duration is generally four years for all other courses. Unlike graduates from other fields, veterinarians have to register with the Veterinary Council of India (VCI). VCI is a statutory body constituted by the Government of India under the Indian Veterinary

Council Act, 1984, to regulate veterinary and animal husbandry practice and education in the country. Only those who possess recognized veterinary qualification and registered can practice in the country. Apart from such registration and maintenance of Indian Veterinary Practitioners' Register (IVPR), professional matters like recognition of veterinary teaching institutions, laying down the syllabus for the courses and conducting examinations for admissions against the Central quota of seats in the veterinary colleges are responsibilities that lie within the purview of VCI. In the case of other disciplines, it is the ICAR which discharges some of these functions.

Animal sciences covered at the agricultural educational institutions include specializations like animal genetics and animal breeding, animal physiology, animal nutrition, fodder technology and related areas. While veterinarians are necessary for treating the diseases of cattle and other animals, human resources in animal science disciplines is needed for research and its applications in animal breeding and animal nutrition to bring about improvement in the quality and yield of the livestock, milk or meat.

Forty eight colleges are offering courses in veterinary sciences and animal husbandry; 46 are part of the Agricultural Universities and ICAR, one is under general university and one is under private sector. In addition, 11 more are being established in 2011 (Annexure-8.1). The college-wise intake is given in Annexure-8.2 and summary in Table-8.1. The annual intake and outturn of veterinary graduates is currently about 3,520 and 2,700, respectively.

Table-8.1: Students Admitted and Passed in Veterinary Sciences Courses during 2009-10

	Dilpoma		**UG**		**PG**		**PhD**		**UG & above**	
	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass
Number of Students	4925	3136	2358	1761	933	797	230	125	3521	2683

8.2.2 Fields of Employment for Veterinary Personnel

Veterinary personnel find employment in the following areas.

a) Promotional and regulatory activities of the government and VCI. This includes the extension activities undertaken by the government.

b) Institutions for animal health as well as public health: these include veterinary hospitals, polyclinics, dispensaries, disease investigation centres run by State governments, NGOs, dairy plants and others in cooperative and private sector. This also includes private practice by qualified veterinary doctors. Some of the human health institutions also engage veterinarians to deal with diseases caused by animals.

c) Artificial insemination services done by government, cooperatives, NGOs, dairy plants, etc.

d) Veterinary services of the army (Remount Veterinary Corps) and various para-military organizations

e) Animal farms for various species run by Central and State governments as well as private farms for breeding animals (including poultry hatcheries)

f) Semen banks and sperm stations

g) Research institutions in Central and State governments like the ICAR institutions

h) Animal feed industry

i) Veterinary pharmaceutical industry, including equipment manufacturers

j) Dairy plants

k) Meat processing plants, slaughter houses

l) Financial institutions like banks and insurance companies

m) Wild life parks, zoos, race clubs and other entertainment industry

n) Others

8.2.3 Estimates of Current Stock of Veterinarians

While comprehensive information is not available from any single source, there are a number of sources that provide some bits of information on the number of veterinary graduates and above, but each has its own limitations, some of them serious. This does not permit an easy and authentic estimation of the current stock of available veterinary personnel in the labour force. The nature of the data from various sources is described in the following paragraphs:

8.2.3.1 Population Censuses

The population censuses have been providing some data on graduates in certain technical disciplines like engineering, medicine, teaching, agriculture and dairying, and veterinary science.

The number of graduates and above in veterinary science enumerated in the 1991 Census was 13,885 and the 2001 Census identified 26,642. Thus, the inter-censal decade recorded a Compound Annual Growth Rate (CAGR) of 6.7 per cent. The same rate of growth beyond 2001 would yield an estimated stock of 47,750 veterinary graduates at the end of 2009-10. However, growth would depend on the annual out-turns from educational institutions, which have been stationary around 1,900 per year. On this basis and assuming an attrition of one per cent per annum, the estimated stock in 2009-10 would be around 40,700. This is about 7,000 less than the inter-censal annual growth rate based estimate.

8.2.3.2 Veterinary Council of India

As mentioned earlier, the VCI maintains an Indian Veterinary Practitioners' Register (IVPR). As per the information provided by the VCI, there were 54,462 veterinary personnel with graduate and above qualifications in veterinary science and animal husbandry registered with them as of March 31, 2009 (55,307 up to the end of the calendar year 2009). Year-wise break-up by the end of 2009 is given in Annexure-8.3. It may, however, be noted that the year of registration with VCI generally reflects the year in which the original registrations with the respective State VCI were transferred to VCI.

It is not known as to how many of these registered persons are part of the active stock of veterinarians. Discussions with VCI indicated that there are only about 22,000 active registrants, working in Central and State government institutions. No information is available about the extent of self-employment, those working in private sector establishments, NGOs and of those who are no longer working. **It would be worthwhile to conduct an independent sample survey of the IVPR registrants to find out as to how many of them are active and in what activity they are engaged in.** In fact, a cursory examination of the information on date of birth of the registrants showed that the register contained some over 80 years of age, and a few over 100 years. It is clear that the IVPR (Indian Veterinary

Practitioners' Register) needs to be reviewed from time to time, and a mechanism evolved to update its contents.

A sample study of 10 per cent of the year of birth of all registered veterinarians available for different years on VCI's web-site indicated that on the whole about 22 per cent of all registered veterinarians are presently (in 2010) aged above 60 years. This percentage was very high in the initial years but came down gradually up to 2,000. Beyond that year, the percentage was very small around 3 to 4 on an average. Assuming that the active working life generally ends at 60 years (the retirement age in State governments varying from 55 to 60, but some may continue in private practice), and all those below that age are in fact active, it may be estimated that about 43,000 of the registered veterinarians were active during 2009-10.

8.2.3.3 Occupational Pattern Studies of DGET

The Directorate General of Employment & Training (D.G.E&T.) in the Ministry of Labour collects, under its Employment Market Information (EMI) Programme, data from establishments in the organized sector[44] on the occupation-wise and education-wise break-up of their employment once in two years (covering public sector establishments and private sector establishments in alternate years. In particular, data on veterinary graduates and postgraduates is also collected. Latest data available relate to 2002 for the public sector and 2003 for the private sector. The data are also subject to some non-response from the establishments, amounting to about 25 per cent in public sector and about 40 per cent in private sector. The data available from these reports are shown in Table-8.2.

The reports also indicate that about 65 per cent of the veterinarians were degree-holders, 32 per cent were diploma holders and the rest were certificate holders. The data from these studies seem to be considerably underestimating the number of veterinary graduates. The frame of establishments used for these studies are known to be incomplete and response is skewed with large establishments not providing the data to a larger extent than the smaller establishments.

Table-8.2: Number of Veterinarians in Organized Sector (2002-03)
(as per Employment Market Information Programme)

Occupation	Public Sector (2002)					Private sector (2003)	Total
	Central Govt.	State Govts.	Quasi-Govt.	Local Bodies	Total		
Veterinarians	1,626 (2,581)	13,126 (17,883)	1,204 (1,638)	714 (939)	16,670 (22,804)	700 (1,170)	17,370 (23,974)
Veterinary Assistants	370 (587)	14,684 (20,005)	1,091 (1,484)	105 (138)	16,250 (22,238)	600 (1,000)	16,850 (23,238)
Total	3,168	37,888	3,121	1,077	45,042	2,170	47,212

Note: Figures in brackets are estimates adjusted for non-response in the respective category of establishments. Total is an estimate after adjusting for non-response

[44] For the purposes of EMI Programme, organized sector comprises all public sector establishments irrespective of their size, and such establishments in private sector employing 10 or more workers. Thus, self-employed persons and employees in small private sector establishments are not covered.

8.2.3.4 Estimates of World Organization for Animal Health(OIE)

The *Organization International des Epizooties (OIE)* or the World Organization for Animal Health, Paris, publishes data on the veterinary personnel in different countries annually. The veterinarians as per this data increased from 37200 in 1997 to 45211 in 2008 and the year wise data for 1997-2008 is shown in Annexure-8.4.

Presumably, these data are on the basis of country reports received from the concerned government departments in India.

8.2.3.5 Previous Study of IAMR

A previous survey conducted by IAMR on the human resources requirements of agricultural sector in 2000 estimated the stock of veterinary and dairy science graduates and above at 46,350 in 2000 and 75,780 in 2010. These estimates, however, include dairy science stocks also and, henc,e not comparable with the other stock estimates.

8.2.3.6 Summary on Current Stock of Human Resource

An effort was made to estimate the stock of fishery science graduates from annual supply data from different sources (details given in separate chapter). The total stock of graduates and above in veterinary sciences from annual supplies is estimated to be about 40,232 in 2010.

In summary, the data available from various sources indicate that the available active stock of veterinary graduates and above in 2009-10 may be placed around 41,000.

8.3. Approach to Demand Projections

8.3.1 The approach

Three different approaches have been followed to obtain projections of stocks veterinarians up to 2020. The first begins with the estimated stock of 43,000 (on the basis of IVPR) in 2009-10 and projects it into the future under assumptions of certain growth rates. Between 2001 and 2010, the outturns-based stock of veterinarians grew at an average annual rate of 4.8 per cent. Livestock during 1997-2007 grew at an average rate of 0.8 per cent per annum (2.2% during 2003-07) while poultry grew at 6.4 per cent per annum (7.3% during 2003-07). GDP from livestock sector increased at a rate of over 4 per cent during the Ninth Plan (1997-2002) and by 3.6 per cent during X Plan (2002-07). It would appear that the stock required moves along with (even though a little faster than) GDP growth. The XI plan calls for a GDP growth of 6-7 per cent for the livestock sector as a whole. This is perhaps a little on the high side considering the achievements in the IX and X Plans. Two alternative GDP growth rates have, therefore, considered for the period 2009-10 to 2019-20 – a high rate of 6 per cent and a low rate of 4 per cent. It is assumed that the stock requirement of veterinarians would grow at the same rate as GDP. Projections worked out on this basis are shown in Annexure-8.5**.** These projections suggest that by 2019-20, the stock of veterinarians required would be 77,000 (on 6% per annum high growth) and 63,600 (on 4% per annum low growth). On an average growth rate of 5 per cent per annum, the stock requirement would grow to 70,000.

8.3.2 Normative Approach

A second approach is one based on norms. The basis for these projections is the assumption that the volume of animal health care services would depend on the number of animals. As a first step, therefore, the numbers of animals of various types have been projected to the year 2020, using linear regression on the data from Livestock Censuses from 1972-73 till 2003, and the provisional results from the Census 2007. In the case of poultry, however, the growth trend appeared to be one of exponential type and hence the projections have been worked out using exponential growth model. These projections have been converted to bovine equivalents and appropriate norms of bovine equivalents per veterinarian have been applied to obtain projections of stock demand for veterinary services. In the earlier study conducted by IAMR, 2 sheep/goats and pigs were treated as equivalent to one bovine, and 10 poultry were considered equivalent to one bovine. The second part of this equivalence concerning poultry seems to be a little high. Therefore, while the same equivalence pattern has been adopted for small ruminants, for poultry a more stringent relation of 100 poultry per bovine has been adopted. As regards the number of animals per veterinarian, the norm of 5,000 bovine equivalents per veterinarian suggested by the National Commission on Agriculture in 1976 has been adopted. Even though a norm of 3,000 animals per veterinarian has been mentioned in some discussions, it is considered that the norm of 5,000 is sufficient at this stage. In fact, with an active stock of 43,000 veterinarians in 2009-10, and the estimated bovine equivalent populations of 447 million, the current number of animals looked after by a veterinary graduate is about10,000, which is well above the desired norm of 5,000 animals per veterinarian. It is difficult to visualize that this number would reach anything below 5,000 by the year 2020. In view of this, two alternatives have been considered – one with the recommended norm of 5,000 animals per veterinarian and the other with the existing pattern of 10,000 per veterinarian. The corresponding projections for the stock of veterinarians required by 2019-20 would be 97,000 and 48,500, respectively. These projections have also been shown in Annexure-8.5. An average of these two projections suggest that by 2019-20, the ratio of livestock units per veterinarian would improve to at least 7,500 from the excising 10,000.

8.3.3 Mixed Methodology

The third approach adopted for human resources projections is that followed for other agricultural disciplines and considers the requirements according to the current levels and growth patterns in different segments of the veterinary sector as in Parnes model. The segments considered are: a) development, b) research, c) public and private animal health services, d) animal breeding and fodder, e) veterinary pharmaceuticals, f) miscellaneous and g) education. The method of making projections following this method is given in methodology chapter.

8.4. Demand Projections

8.4.1 Public Veterinary Services

As mentioned above, the number of veterinarians in the State and Central governments in 2009-10 was placed at 22,000 by the Veterinary Council of India. This has been taken as the starting point for estimating the stock demand in this segment. In view of the importance attached to the livestock sector in the context of national food security, it is expected that new programmes for livestock development will be in place and there would be some growth in

the government employment in the animal husbandry sector. Further, about 30 per cent of the posts being vacant, there is acute shortage in the veterinary hospitals and dispensaries. Two alternatives have, therefore, been considered for these projections – the first (low) assuming only 1 per cent growth per annum (same as the growth in the livestock population), and the other assuming a higher growth of 2 per cent per annum, allowing for filling some of the current vacancies (Table-8.3).

Table-8.3: Estimates of Projected Stock Demand for Public Veterinary Services

Year	Projected stock demand for veterinarians for public veterinary services		
	Low projection (1% per annum growth in employment	High projection (2% per annum growth in employment	Medium projection (Average of high and low projections)
2009-10	22000	22000	22000
2014-15	24290	25504	24897
2019-20	26818	29566	28192

Detailed projections for various years have been given Annexure-8.6**.** Break-up by level of qualification obtained on the basis of data from Establishment Survey. **The projected stock demand for 2020 is 28,200, which would increase from 22,000 in 2009-10. The annual requirement of veterinarians in public veterinary services is about 500 per annum.**

The existing infrastructure for public veterinary services in the country consists of veterinary officers in the dispensaries/mobile dispensaries/hospitals and polyclinics, district veterinary officers at the district level, circle veterinary officers and the divisional level and the corresponding superstructure of deputy/joint/additional/and directors of veterinary services in each State. There were about 9,578 veterinary hospitals/polyclinics, 20,443 dispensaries and 26,583 veterinary aid centres/stockman centres and mobile dispensaries in the country[45] in 2007. If each dispensary is manned by one veterinary doctor, each hospital by at least 2 doctors (a hospital may have 2 or 3 doctors and a polyclinic may have 8 to 10 doctors) on an average, the total number of doctors should be around 40,000 at a minimum and 50,000 in an ideal situation. This excludes the administrative superstructure at district, division and State and national levels which may account for a thousand veterinarians. As against this, the information from VCI indicates that there are only 22,000 veterinary doctors in government services leaving a number of vacancies. **This highlights the current gap between requirement and supply.** Further, the existing veterinary service delivery institutions in different States are far less than the actual requirements if one were to go by the ideal norm of one veterinarian per 5,000 livestock units. As these units increase, the demand for veterinarians would further go up.

8.4.2 Private Veterinary Services

Private veterinary services include those provided by non-governmental organizations and also individual private veterinary practitioners. Private veterinary practice is still in its

[45] Basic Animal Husbandry Statistics, 2008, Department of Animal Husbandry, Govt. of India.

infancy in India and by and large confined to metropolitan cities, and is undertaken by veterinarians who retired from government service. There are no precise estimates of the number of veterinarians providing private services. According to various estimates available, the number of private practitioners has been growing over the years. From an estimated 900 in 1993 (World Bank), the number of private veterinarians has grown to 1,055 in 1996 (FAO/OIE), 1,800 in 2,000 (OIE) and 2,060[46] in 2004 (OIE). Assuming that this rate of growth continued beyond 2004, the estimated number of private veterinary practitioners would be about 3,000 in 2008, 5,000 in 2015 and 8,000 in 2020.

Apart from private veterinary practitioners, there are NGOs operating livestock development programmes. BAIF Development Research Foundation has a Central Research Station, 1,850 cattle breeding centres (proposed to be increased to 5,000 by 2012) and Semen Freezing Laboratory and nation-wide network of centres providing livestock improvement services such as artificial insemination. It covers about 67,000 villages in 12 States and has a para-veterinarian for every 12 to 15 villages[47], thus employing about 5,000 para-veterinarians and about 500 veterinarians. There are also Goshalas operated in the non-government sector, such as the one created by Baba Sri Bhadariya Maharaj in the desert area of Pokharan. Accelerated development envisaged in the XI Plan demands greater attention to cattle health on the part of private milk and meat processing industries. Further, the current policy of the government is gradually to move to a private sector-oriented or to a public-private-partnership model for providing veterinary services. There is also evidence (for instance in Punjab) of large private cattle farms coming up, which eventually will require veterinary services.

In view of all these factors, the number of veterinarians engaged in private practice or employed in private sector (other than industry) is placed at 4,000 veterinarians in 2009-10, and is projected to grow to 10,000 veterinarians by 2020, and para-veterinarians from 6,000 to 12,000.

Projections for private veterinary services have been shown in Annexure-8.7. **The requirement of human capital would grow from 4000 in 2009-10 to about 10000 by 2020. The requirement during 2010-20 would be about 500 per annum.**

8.4.3 Research

Research in the field of veterinary science and animal husbandry, as in the other branches of agricultural education, is undertaken by a number of organizations – Central government organizations like ICAR, various state government institutions, SAUs, veterinary pharmaceutical industries, animal breeding farms and poultry hatcheries, etc. While the ICAR institutions are specifically mandated to conduct research, in the other organizations research is carried on concurrently with the main activities of the organization – e.g. teaching in SAUs, as a part of the State animal husbandry machinery in State governments and as a part of the R&D effort in the industries' production systems. Some of the research, particularly in the pharmaceutical industry and breeding institutions would be in the field of

[46] Cited in "Socio-personal characteristics of Private Veterinary Practitioners in Developing countries: A Study in West Bengal State of India" , by Arindam Sen and Mahesh Chander, Livestock Research for Rural development, (13), 6, 2001

[47] http://www.baif.org and speech of former President Dr. A.P.J. Abdul Kalam to the XXXVII Dairy Industry Conference, Feb 7-9, 2009, reproduced in Indian Dairyman, Vol. 61, No.3

animal bio-technology, covered separately in another chapter. As it would be difficult to separate the staff engaged in research activities in these organizations with other main activities, no effort has been made to do that, and the research activities of these organizations have been covered under the respective main activity.

Research institutions specifically and mainly engaged in research are covered here. They are primarily those functioning under the aegis of ICAR. Available data from ICAR indicate that there are 844 posts of scientists, senior scientists and principal scientists in animal sciences, of which 604 are filled (at the end of December 31, 2010), in various ICAR institutions (Annexure-8.8). Thus, vacancies account for about 18 per cent of the positions sanctioned. However, the number of posts specifically in veterinary subjects is much smaller (298). A conservative estimate of veterinary and animal science scientists in research in all public and private sectors would be about 1200 in 2010. While the government research apparatus is not likely to grow significantly in the near future, considering the importance of sustained research in veterinary health to combat newly emerging threats, a moderate growth, there is a need at least to fill existing large number of vacancies. Further, with increasing private sector participation, there will be enhanced research effort in that sector too.

Together, it is expected that the number of veterinarians needed by research will grow from 1200 in 2010 to about 2,000 by the year 2020. Projections for this segment are shown in Annexure-8.9. Thus the annual requirement of veterinary researchers is about 65 per annum.

8.4.4 Academic

The total staff sanctioned for teaching in agricultural disciplines in SAUs in 2009-10 has been estimated at about 5,300, but only 2,240 were filled in 2009-10 (Annexure-8.10). Thus, the existing staff strength was short of the requirement by about 47 per cent. Projections for the future years have been worked out assuming that the requirements would grow at the same rate as the outturn in graduate/post-graduate and PhD courses. This provides for filling of the vacancies to some extent. Projections of stocks required for education are shown in Annexure-8.11. **The stock of 2,200 in 2010 would grow to 3,300 in 2020, i.e., about 100 per annum during 2010-20.**

Finally, necessary adjustments have been made to take into account the fact that the need for out-turn at various levels is to meet not only the needs at that level of the economy but also the requirements to achieve the projected outturns at a higher level. Thus, for example, the out-turn of post-graduates should meet the needs of the economy for post-graduates but also the need for turning out post-graduates who will eventually meet the needs of doctorates. The manner in which these requirements have been computed is given above.

8.4.5 Industry

The industries with a significant presence of veterinarians are the dairy industry, the animal pharmaceutical industry and the animal feed industry, poultry and meat processing. Animal breeding in large farms is also becoming a common feature.

8.4.5.1 Dairy

Dairy industry, particularly the cooperative sector, also engages the services of veterinarians and animal nutritionists to enhance the quality and productivity of the milch cattle. Larger

dairy cooperatives like Dudhsagar Dairy (Mehsana District cooperative) and Amul Dairy (Kaira district cooperative) employ 100 to 125 veterinarians each. Rajasthan Milk Cooperatives Federation also has substantial programmes of animal husbandry and animal health. There are about 850 dairy plants – about 250 in cooperative, 550 in private organized sector and the others in government sector. Most of them, however, depend on the public animal husbandry machinery. Their number is projected to grow to about 1,400 by 2020 (see Chapter on Dairy Science). The total dairy sector utilization of veterinary human resources may be placed at about 500 graduates and 500 diploma holders now, which may go up to 900 graduates (a growth of 5% per annum) and 900 diploma holders by 2020 in view of the importance of animal health and quality improvement for the ambitious dairy development programme.

Detailed projections are given at Annexure-8.12. The stock requirement of human capital for dairy industry would grow from 500 in 2009-10 to about 900 by 2020, i.e. about 30 per annum during the period 2010-20.

8.4.5.2 Veterinary Pharmaceuticals

With the rapid growth in dairy and poultry industry, animal health has assumed considerable importance. There are about 150 pharmaceutical firms engaged in production and distribution of animal drugs and other medical equipment for treating animals. The pharmaceutical companies engage not only veterinarians and animal scientists but bio-technologists and pharmacy graduates as well for their research and development jobs. Establishment survey showed that, on an average, a veterinary pharmaceutical company engaged 8 veterinarians (5 graduates, 2 post-graduates and one doctorate), the total number would be 1200. The pharmaceutical industry has been presently growing at about 15 per cent per annum. Therefore, the number of veterinarians and animal scientists is likely to increase at least at a rate of 10 per cent per annum to about 3000 by 2020. Breakup by qualifications has been derived with data from Establishment survey.

Detailed projections are at Annexure-8.13. **The requirement of human capital for veterinary pharmaceutical industry would grow from 1,180 in 2009-10 to about 3,050 by 2020. The requirement during 2010-20 is about 190 per annum.**

8.4.5.3 Animal Feed Industry

Animal feed is an important input to enhancing animal quality. According to some estimates[48] there is a supply demand gap in fodder production – to the extent of over 60 per cent in the case of green fodder and about 25 per cent in the case of dry fodder. Currently (in 2010), the supply of fodder (green and dry together) is estimated at only 846 million MT against a demand of over 1650 million MT. The fodder demand is projected to 1764 million MT in 2020. A doubling of supply is required to meet the demand-supply gap by 2020. Only 50 per cent of the marketed feed is produced in the organized sector.

There are thousands of animal feed producers in the country. In Punjab alone it is mentioned that there are over 1500 units. Registered fodder producers are, however, few. According to Annual Survey of Industries, there were about 500 prepared animal feed plants registered under Factories Act in operation in 2005- 06. According to a mention made in the Focus

[48] Estimates made by State Planning Board, Government of Kerala, cited in IASRI's Agricultural Research Data Book, 2007

Group Discussion in NDRI, Karnal, there are now about registered 800[49] animal feed manufacturing factories in the country. While there is no regular data flow about the number of veterinary doctors and animal scientists these firms engage, the Establishment Survey conducted by IAMR indicated that on an average a feed plant employed 30 persons, of who about 7 comprise human resources relating to agricultural sciences. About 4 of them are graduates and post-graduates in animal sciences and veterinary fields and the rest are diploma holders. On this basis, and assuming that the operating factories now number about 600, it is estimated that the total human resources in animal and veterinary sciences in the animal feed units at present (2009-10) is of the order of 4,200, of who graduates and above are 3,200. Projections for the future have been obtained assuming that animal feed production will grow at a rate of 10 per cent per annum, which was the rate of growth of total employment in animal feed industry during the period 1998-99 to 2005-06 (according to Annual Survey of Industries).

Detailed projections for animal feed sector are given at Annexure-8.14. The stock requirement of human capital would grow from 2,250 in 2009-10 to about 5,800 by 2020. The requirement during 2010-20 would be about 360 per annum.

8.4.5.4 Animal Breeding

Till recently, organized cattle breeding has been within the realm of government. There are 7 Central Cattle Breeding Farms, one Frozen Sperm Production Institute, 4 Herd Registration Units, 5 Poultry Development organizations and one Central Sheep Breeding Farm. Similar organizations exist under the State governments. Semen Banks are more or less the exclusive preserve of the government. 37 of these are in the government sector, while only 12 are with National Dairy Development Board, dairy cooperatives and NGOs. NGOs like BAIF have full-fledged research centres and livestock farms for breeding. Poultry breeding is exclusively in the private sector. A phenomenon emerging in recent years is the establishment of large cattle farms in States like Punjab. This trend is likely to get strengthened in future.

According to the Establishment Survey, an average animal breeding farm employed a total of 24 persons, of who only 2 or 3 were graduates or above in animal sciences or veterinary sciences. The precise number of animal breeding farms is not known and not all of them have their own veterinary human resources. In view of this a very rough estimate of veterinary and animal science human resources may be taken as 1000 (Central and State government farms are covered under public services and ICAR institutes) in 2009-10, which may rise to 2000 by 2020.

Year-wise projected stock requirements are given in Annexure-8.15. The stock requirement of human capital for animal breeding farms would grow from 920 in 2009-10 to about 1,780 by 2020, i.e. 70 per annum.

8.4.5.5 Meat Processing

The XI Plan targets a GDP growth of 10 per cent per annum for the meat and meat products sector[50]. There are, however, 50 to 60 meat processing units registered under the Factories Act (2005-06) and employment in this sub-sector had grown at an annual rate of 11 per cent

[49] As emerged in the FGD at NDRI, Karnal

[50] Annual Surveys of Industries

during the period 1998-99 to 2005-06. Establishment surveys of IAMR showed that about 3 per cent of this employment comprises agri-human resources and that graduates and above comprise about two-thirds of the agri-human resources.

Projections up to 2020 have been made on this basis, and are shown in Annexure-8.16. The projected stock demand for 2020 is 2,647, which would increase from 1,020 in 2009-10. The annual requirement of veterinarians in meat processing sector is about 100 per annum.

8.4.5.6 Financial Institutions

Banks and other financial institutions like NABARD and insurance companies also engage veterinary and animal husbandry graduates for their credit and livestock insurance activities respectively. Employment of all officers in these institutions in livestock fields has been estimated around 3500 (in 2009-10) and projected to grow at a rate of 2.5 per cent. Establishment survey shows that about 90 per cent of them are graduates and the rest post-graduates.
Detailed projected stock requirement for various years are given at Annexure-8.17. The stock of 3,500 in 2010 would grow to 4,500 in 2020, i.e. about 80 per annum during 2010-20.

8.4.6 Others

The human resources requirements of the sectors covered above have been inflated by 10 per cent to take care of any other sectors not specifically covered.

8.4.7 Para-vets

The need for para-vets is seen in almost all sub-sectors – both in public and private sectors, more in private than public due to expansion of veterinary services in the private sector and also industry demand for low level trained persons at field level. Some states offer Veterinary Polytechnic course of two year after 10^{th} Class. Besides there are short duration courses of 1 to 4 months for community/village based service providers who also act as liaison between farmers and veterinarians. However, all most all these training or academic programmes are fully supported by government. A critical review of the para vet training programmes in Andhra Pradesh reveals farmers sustaining para vet services through payment is completely unrealistic and ineffective (Sastry and Ramalinga Raju, 2006). The study recommends more state support for training and public-private partnership in providing services to farmers. Considering their importance, the requirement of para staff in micro-level organizations is discussed separately.

8.5 Summary of Demand Projections

The projections of stocks of veterinary and animal husbandry human resources required to meet the needs of various segments of the economy and the consequential flows required from the educational system are summarized below.

8.5.1 Stock Projections

The overall stocks of veterinary and animal sciences human resources required to meet the requirements of various segments of animal husbandry have been added up to give projections for various years up to 2019-20. Two sets of projections have been worked out as explained in the segment-level projections – one a high projection and the other a low projection. Stock estimates based on these two factors along with an average of these two are given in Annexure-8.18. Average projected stock of veterinary and animal sciences human resources required for 2010 and 2020 is given in Table-8.4.

Table-8.4 : Overall Projections of Requirements Stocks of Veterinary Human Resources

Year	Diploma	UG	PG	PhD	UG and above
2009-10	23963	28772	8873	4521	42166
2019-20	38846	45395	15042	7319	67756

The stock of veterinary under-graduates, post-graduates and doctorates required in the country is projected to go up from 42,000 in 2010 to about 68,000 by 2020, i.e. about 2,500 per year during 2010-20.

8.5.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 40,232. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., 4.3 per cent during 2006-10), the estimated supply and demand in 2020 would be:

Supply: 48,433
Demand: 67,756
Gap: 28.5 % of the demand

8.5.3 Flow Projections

The corresponding annual outputs required from the educational system to lead to the above stocks are given in Annexure-8.19.The average annual flow required is given in Fig-8.1.

The projections suggest that by 2020, the annual outturn required from the veterinary science education system should be about 5,300 under-graduates, 1,850 post-graduates and 490 doctorates, rising from 1,800 under-graduates, 800 post-graduates and 125 doctorates in 2010.

The requirement of diploma holders is 2,000 in 2010 and 2,850 in 2020. The requirement for diploma holders in dairy sector is given separately in the dairy sector report.

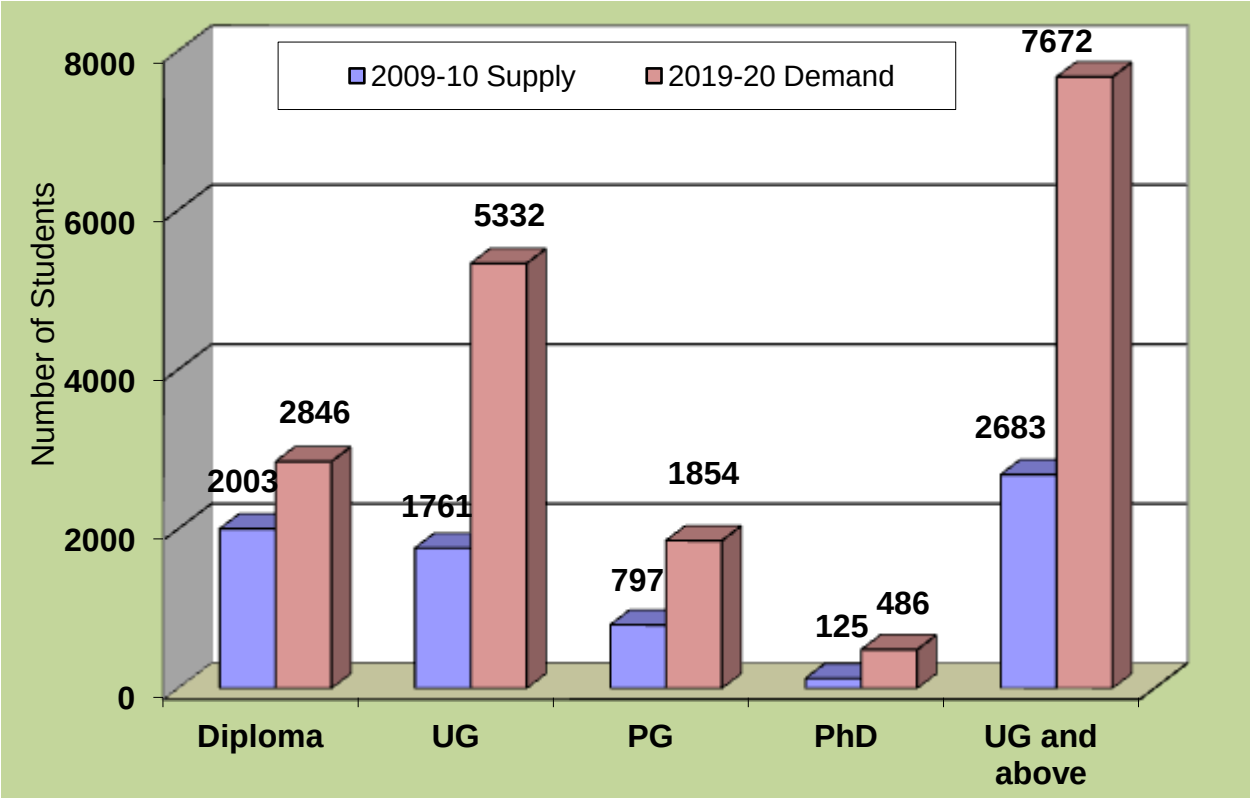


Fig-8.1: Current (2010) and Projected Outturn Required (2020) in Veterinary and Animal Sciences

8.6 Institutional mechanism and Skill Issues-Experts' Views

- In India, veterinary and animal husbandry services have been combined while in developed countries two subjects are treated differently. Some of the experts were of the opinion that in India also the two subjects should be treated as two different subjects. This may to some extent meet the requirement of the trained human resources in this sector.

- The traditional mindset in respect of veterinarians needs a change i.e., education should be comprehensive to include management IT skills, leadership quality, etc., so that the students with veterinary education could have better options for employment in both core veterinary sector and related organisations.

- The demand for veterinary graduates would increase as there would be more self-employment and also additional requirement for more veterinary clinics.

- **An adequate breeding policy is extremely essential. In the absence of such policy, healthy animals are not being produced.**

- **Qualified and trained people are needed who can handle the practical aspects relating to livestock such as artificial insemination, embryo transplant, and**

vaccination of animals, etc., with a professional approach. At present, the students coming out of the veterinary education lack practical orientation.

- **The pork industry has tremendous potential for growth but there is a dearth of scientific slaughter houses in the country.**

- The country has considerable goat population but goat milk is not being used.

- **Need more para-vets to provide veterinary services in rural areas. State must support development of such institutions under public-private partnership mode.**

8.7 Conclusions

The stock of veterinary under-graduates, post-graduates and doctorates in the country is projected to go up from 42,000 in 2010 to about 68,000 by 2020, i.e., an increase of about 2500 per year during 2010-20. The required annual outturn of 7,670 in 2020 as compared to the current annual supply of about 2,700, i.e., additionally 5,000 graduates (3600 UG; 1050 PG and 350 PhD) per year. The current supply of about 2700 graduates meets only two-third requirement now and this gap will double by 2020 unless there is large scale expansion in the veterinary education.

Considering the demand for veterinary graduates, the education system need to stabilize and consolidate the higher level education and nearly double the intake at UG level. Ten more colleges that are being established across the country would not meet the requirement. It may be noted that the existing colleges are not having sufficient faculty to teach as per the VCI guidelines. Thus, further expansion of education in this sector needs firm commitment on investment towards infrastructure so as to meet VCI requirements.

As public system is under-staffed and cannot meet the demand for vets and para-vets, it is necessary to open the education to private sector under PPP mode so as to maintain quality in education. Issues relating to animal health, animal breeding norms, maintenance of hygiene while processing of meat etc. are extremely important and need immediate attention. There is a great demand of functional skills among the students that are coming out of educational system.

The current annual supply of diploma holders is about 3,000. As the requirement for diploma holders in dairy sector is of order of 6,00,000 in total, there is urgent need to plan and establish large number of polytechnics to develop diploma holders across the country.

The need for para-vets is seen in both in public and private sectors, more in private than public due to expansion of veterinary services in the private sector and also industry demand for low level trained persons at field level. The study recommends more state support for development of para staff under public-private partnership.

Chapter-9

Human Capital Assessment in Fishery Sector

9.1 Introduction

Fisheries sector plays an important role in the national economy and in the socio-economic development of the country. This sector has a significant role in supplementing family incomes and generating gainful employment in the rural sector, particularly among the landless labour, small and marginal farmers and women, besides providing nutritional food to millions of people. According to Livestock Census 2003, as many as 14.49 million persons in the country depend on fisheries sector for their livelihood. The sector contributed (in 2007-08) about 0.8 per cent to the total GDP and 4.5 per cent to agricultural GDP[51]. Fisheries contribute substantially to seafood export resulting in significant foreign exchange earnings.

Globally, India occupies third position in fish production, and second in inland aquaculture, contributing about 4.7% to world fish production. India's share in global fishery trade is 2.5%. Fisheries hold out promise as a means to achieve food and nutritional security for the country. In India, about 910 million of the population is projected to include fish in their diet by 2020.

9.2 Supply of Graduates

9.2.1 Education and Research

The first training centre for inland fisheries was started in 1945 at Barrackpore, West Bengal. The inland Fisheries Course was later attached to Central Inland Fisheries Research Institute (CIFRI), Barrack pore in 1947 and to Central Institute of Fisheries Education (CIFE), Mumbai in 1967. The course has been highly popular in meeting the requirements of development and extension officers at block and district levels. The CIFE was created in 1961 at Mumbai to offer a two year post graduate Diploma on Fisheries Science (DFSc) for in-service officers of State Fisheries Departments.

Masters degree programme in fisheries management was started by CIFE in 1984. This institute has since been conducting Master's and Doctoral programmes in the disciplines of "Fisheries Resource Management'' and "Inland Aquaculture". Currently, Master and Doctoral programmes in Mariculture are also conducted by CIFE.

Fisheries education under the state Agricultural/ Veterinary University (SAU) system started only in 1969. Today 20 State SAUs, Central Agricultural University, CIFE and IIT,

[51] CSO, National Accounts Statistics, 2007-08

Kharagpur offer fisheries education in the country through 25 colleges (list given in Annexure-9.1). Indian Institute of Technology, Kharagpur (West Bengal) offers MTech. and PhD courses in Aquaculture Engineering. About a dozen universities offer MSc and PhD programmes in Marine Sciences, Marine Biology, Oceanography, Aquatic biology and Fisheries, Limnology, Freshwater Biology and Limnology Aquaculture and Industrial Fisheries. The current intake capacity in all the fishery science courses in the country comprising the graduate level, the post graduate level and the doctoral level add up to a total of about 1,005. Detailed intake of students in various fisheries colleges during 2009-10 are given in Annexure-9.2 and summary in Table-9.1. UG courses are offered in 23 colleges, PG in 18 and PhD in 9 colleges/institutes. Against an intake of 800 students, about 420 students are produced annually.

Table-9.1: Intake and outturn of Students in Fisheries Sciences during 2009-10

	Diploma		**UG**		**PG**		**PhD**		**Total**	
	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass
Number of Students	26	NA	552	285	206	109	34	30	792	424

A number of agencies such as State Fisheries Departments, FISHCOPFED, ICAR and Central Institutes, Universities, College of Fisheries, Krishi Vigyan Kendras, NGOs, National Institute of Agricultural Extension Management (MANAGE), Hyderabad and Administrative Staff College of India (ASCI), Hyderabad are imparting training in fisheries.

Research in the fisheries sector is carried out through 8 research institutes functioning under ICAR (CIFRI at Barrackpore, CIFE at Mumbai, CIFA at Bhubaneswar, CMFRI at Cochin, CIBA at Chennai, NBFGR at Lucknow, CIFT at Cochin and the Directorate of Cold Water Fisheries at Bhimtal) in addition to the SAUs.

9.2.2 Areas of Employment in Fisheries Sector

A number of sectors of the economy have openings for personnel qualified in fisheries sciences and technology. Some of the important sectors are:

- **Government**: Every State has a Fisheries department, in which graduates in fisheries education are appointed as Assistant Fisheries Development Officer/ Fisheries Extension Officer and District Fisheries Development Officer. They are also employed in central agencies like National Fisheries Development Board, Marine Product Export Development Authority (MPEDA), Fisheries Survey of India (FSI), Fish Farmers Development Agencies (FFDAs), Coastal Aquaculture Authority (CAA), CIFNET, Department of Animal Husbandry, Dairying and Fisheries (DAHDF), etc.

- **Private Sector**: Fishery Science Graduates are absorbed in fish processing companies, aquaculture farms, fish seed hatcheries; aqua-feed plants, fishing gear industries, deep sea fishing vessels, and pharmaceutical companies. There are also NGOs engaged in activities relating to fisheries development.

- **Academics:** Post graduates and doctorates in the subject are recruited to the faculty of Fisheries in colleges and universities. Scientists are recruited in various agricultural and

fisheries institutions under the ICAR, through an all India competitive examination (ARS) conducted by ASRB (Agricultural Scientists' Recruitment Board).

- **Entrepreneurship:** Financial support for fishery-related self-employment enterprises is offered by NABARD and other nationalized banks. NABARD gives financial support to the candidate having B.F.Sc. degree. The main areas for entrepreneurs are ornamental fish culture, aquaculture, hatchery and seed production, commercial pearl production, fish disease diagnostic center, consultancy services and establishment of agri-clinics.

- **Ancillary sectors:** There are a number of activities that support fishing industry. Net mending, boat building, and manufacturing of fishing accessories, aqua feed preparation, gelatin, fish oil antibiotic and aqua drug supply are some such industries associated with the fisheries sector. Fishing by trawlers in high seas, preservation and marketing of sea products also needs a variety of trained personnel.

9.2.3 Current Stock of Fishery Science Personnel

There is no direct source of data on the number of active fisheries science graduates and postgraduates in the country. As such, the current stock can only be estimated, as in the case of other agriculture related disciplines, indirectly by cumulating the outturn of fisheries graduates, post-graduates and doctorates over several years (as many as the active working life of a graduate, post-graduate or doctor) and adjust for attrition due to retirement, migration and such causes.

IAMR, in its previous study on agricultural human resources in fisheries sector, had estimated the stock of post-graduates in fisheries sciences as 967 and of doctorates at 130 in 1990. These stocks were projected to grow to 1,939 and 457 by the year 2010 on the basis of projected out-turns of the two categories during 1991 to 2009. In fact, in the earlier studies IAMR made no stock estimates for individual faculties at graduate level, but only at higher levels.

An effort was made to estimate the stock of fishery science graduates from annual supply data from different sources (details given separately in Chapter-15). The total stock of graduates and above in fisheries sciences, estimated from annual supplies, is about 5,144 in 2010.

9.3 Demand Estimation

9.3.1 Earlier Assessments of Requirement

There have been some isolated attempts on assessments of human resources requirements in this sector. Certain standardized human resources requirements have been formulated by CIFE on a unit basis (Annexure-9.3). Chidambaram (1985) estimated additional technical human resources in the next 10 years as about 1,82,000 comprising 23,000 graduates and postgraduates. Pathak et al. (1997) estimated human resources requirements during IXth Plan to be about seven million. Singh and Sontakki (1997) placed the human resources requirement for fisheries extension during IX Plan to be 40,000. Ghosh (1997) placed the requirement of fisheries graduates and postgraduates per annum to be around 1,600 and 400

respectively. Somavanshi and John (1997) estimated the requirement of certified human resources for exploitation of deep sea and oceanic resources by the end of X Plan to be around 1000. Diwan and Suseelan(1997) assuming that 1.2 million hectares of brackish water area will be brought under shrimp culture estimated requirement of 1.49 lakh Postgraduates and 4.48 lakh graduates for the Indian shrimp industry. Kohli (1998) has indicated requirement of about 750 teachers and 1,200 Technical Officers for fisheries education. While some estimates appear to be under-estimates, others seem to be on the higher side.

Demand projections of fishery human resources have been attempted separately for various sub-sectors of the fisheries sector.

9.3.2 Fish Processing

The Vision 2015 Document of Ministry of Food Processing Industries envisages a growth of processing content 15% of the production by 2009-10 and to 20% by 2014-15.

This pattern of growth forms the basis for projections in the processing sector. An alternative, in which the recent trends in employment in the processing sector are taken to simply continue till 2019-20, is also considered. These broad parameters form the basis of projections of requirements of fisheries human resources up to 2020.

In the first place, the volumes of fish production to be achieved till 2020 have been projected using the growth rate of 6 per cent per annum envisaged in the XI Plan as well as the lower alternative of 4 per cent per annum as explained earlier (given in Annexure-9.4).

The total fish production has thus been projected to grow to 143 lakh tonnes in the high scenario and to 114 lakh tonnes in the low scenario by 2020. With the processing content assumed to grow as envisaged in Vision 2015 document of Food Processing Industries and continue that trend till 2020 the volumes of fish processing would grow to 36 lakh tonnes in the high scenario and 29 lakh tonnes in the low scenario.

These projections have been considered in the context of data on fish processing industry units as available from the Annual Surveys of Industries (CSO). Annual Survey of Industries data for various years are available up to 2005-06. Based on the trends during 2000-01 to 2005-06, the number of fish processing units and the number of persons engaged in them have been projected till 2009-10 using linear regression. These projections are shown in Annexure-9.5.

The past trends based on CSO data, when projected into the future (linear growth postulated) would indicate that, by 2020, about 460 units would be processing fish, with an employment of about 60,000 persons. However, the targets based on Vision 2015 of Food Processing would require significantly higher levels as calculated below:

a) Number of fish processing units in 2007-08 (as per Annual Survey of Industries) is 327.
b) Quantity processed in 2007-08 is 9,27,000 tonnes (about 13% of production in 2007-08).
c) Average quantity per unit in 2007-08 is 2,835 tonnes.

Using these parameters, the number of processing units and employment therein has been projected till 2019-20 for the low and high processing scenarios is shown in Annexure-9.6.

Thus, the targeted amount of fish processing is expected to engage a total of 1.58 lakh persons by 2020 in the high growth scenario and 1.26 lakhs in the low growth scenario, as against 60,000 obtained through simple projections of past trends. It may be concluded that total employment in fish processing in 2020 would be in the range of 60,000 to 1.58 lakhs depending upon the attainment of targets. Given the emphasis on fishery development, continuation of past trends does not seem to be a plausible option. Therefore, for further analysis, the other two projections only would be considered.

Results of establishment survey conducted by IAMR provide the distribution of employment of fish processing units by levels of fishery-related education. **The norms developed by CIFE indicate that each processing plant of 10 tonnes of fresh fish per day capacity would need about 70 semi-skilled workers, 10 skilled workers and 5 technicians.** Using these two sets of information, the distribution of employment in fish processing industry by level of education/training has been derived and is shown in Table-9.2.

Table-9.2: Distribution of Employment in Fish Processing Units

Level	per cent of persons with the
No fisheries-related qualifications	11.20
Certificate/trained	76.12
Diploma	4.76
Graduate	6.57
Post-graduate	1.17
Doctorate	0.18
All levels	**100.0**

Applying this distribution to the projected total employment in fish processing units, the projected levels of employment by level of fishery education has been derived, and are shown separately for Low and High projections in Annexure-9.7.

The average of the high and low projections estimates that the stock requirement in 2009-10 is about 4040. This would increase to 11,240 by 2019-20. Thus, fish processing units would need about 700 fishery graduates per annum during 2010-20.

9.3.3 Fish Seed Hatcheries

High quality fish seed is vital in sustaining healthy growth of fisheries. The current level of fish seed production of about 25 billion fry in Indian hatcheries is considered to be inadequate and short of requirement by an equal amount. Fish seed production has been projected up to 2020 assuming a growth of 5 per cent per annum (the average growth rate observed between 1997-98 and 2007-08). According to the data received for the project, only 150 hatcheries are in operation at present. As the current production is about 24,000 million fry per year the average production works out to about 160 million fry. Assuming that the

future hatcheries would continue to be of same average capacity, the number of hatcheries required up to 2020 have been estimated and shown in Annexure-9.7. The data also depicts the requirements of technical personnel according to the level of education. The estimates have been made on the basis of norms from CIFE. According to these norms, a fish seed hatchery of capacity 10 to 50 million fry would need a breeder, a hatchery manager, a chemist and an aquaculture engineer (all assumed to be of graduate level), 12 technicians (assumed to be of diploma level) and 10 skilled farmers (assumed to be of certificate level or trained). Considering that the average hatchery is of 160 million fry capacity, these requirements of graduates and diploma holders have been doubled while those of skilled workers have been tripled keeping in view the capacity and economy of scale of hiring the personnel by the industries, and higher norms of 8 graduates, 24 diploma holders and 30 skilled farmers have been adopted.

In addition, there are small hatchery units which are known as circular Chinese hatcheries. These units are producing about 50 million fry per annum on an average with a total no. of 1600 hatcheries. Similarly there are 1200 hatcheries using Happa with an average production of 4 million fry each. In Happa nurseries farmers themselves rear small fries to a marketable size and then use them or sell to other farmers. These small units may not employ graduates but there is a scope for consultants, technicians and skilled farmers, i.e. certificate holders or informal training. According to the CIFE norms, a hatchery with 2-5 million fry/year capacity would require 6 technicians and 4 skilled fish farmers, while a hatchery of 10-50 million fry annual capacity would require 10 skilled fish farmers and 16 technicians. It is assumed that the number of hatcheries of these tow types would also grow by 5 per cent per annum as all larger hatcheries.

The requirements estimated on the above basis for each type of hatcheries have been aggregated and year-wise projections are shown in Annexure-9.8. The stock requirement of human capital in fish seed hatcheries with UG and above qualifications increases from 1,330 in 2010 to 2,170 in 2020, i.e. about 75 per annum during 2010 to 2020.

9.3.4 Fish Feed Industry

Adequate availability of quality fish feed, and its balanced application, is essential for the healthy growth of aquaculture industry. There are about 30 to 40 fish feed industrial units with an installed capacity of 1,50,000 MT. According to the information from CIFE, 20 major units currently employ 100 fishery professionals and would require an additional 250 by 2020. Assuming that the remaining 20 are of medium size requiring 4 fishery professionals each (1 Post-graduate and 3 Graduates as per the CIFE norms) for plants.

Thus, the requirement of fishery professionals in feed industry is assessed at 180 at present and 500 by 2020, i.e. the net addition to the stock is about 25 per year.

9.3.5 Aquaculture

In the fisheries sector, aquaculture is the most important sub-sector from the point of view of future growth of the sector. Aquaculture has grown rapidly in the recent past and holds out the key to the future development of export earnings and employment and generation, besides helping in achieving food and nutritional security. There is a potential area of 1.2 to 1.4 mha of brackish-water resources for aquaculture of which only

about 1.5 lakh hectares (i.e. 10 %) is under actual culture and the bulk (90%) is used for other purposes. According to the statistics of aquaculture units registered with Coastal Aquaculture Authority of India (CAA), which is mandatory after the enabling act was passed in 2005), there were a total of 18,630 such units by the end of March 2010 (shown in Annexure-9.9).

Even though unregistered units are required to be closed, there is a possibility that some units set up before 2005 are continuing. It may, therefore, be assumed that there are about 20,000 aquaculture units in the country today. Annual Report 2008- 09 of CAA gives the data of the units registered up to March 2009 by their size (Annexure-9.10).

It may be observed that more than 80 per cent units are small which are below two ha. Norms available for the project data indicate that no fishery graduates are required for such small units, while one graduate is needed for each farm of size 2-10 hectares and two graduates for a farm of 10 ha or more. On this basis it may be estimated that in 2009-10 there are about 3,200 units in the size class 2-10 ha and 60 larger units 10 ha or more each leading to a requirement of a total of 3,320 graduates in 2009-10.

Separate norms have been provided by CIFE for brackish water aquaculture farms of 1, 5, and 50 ha. According to these, a one ha farm would require seven skilled fishermen and eight technicians, while a five ha farm would require ten skilled farmers and six technicians and a 50 ha farm would need 100 skilled farmers and five technicians. On this basis, the number of skilled farmers and technicians required for brackish water aquaculture have been projected, assuming that the norms for one ha farm will hold good for all 0-2 ha farms and that the norms for 5 ha farms would hold good for all 2-5 ha farms. The number of farms above 5 ha is very small and hence omitted from the calculations. These calculations would indicate that the requirements of aquaculture of below graduate level technicians and skilled farmers in 2009-10 would be 97,000 skilled farmers (certificate/trained) 91,000 technicians (diploma holders) and 2,150 graduates. Projections for subsequent years up to 2020 have been worked out a) with an annual growth rate of 8 per cent being the same rate of growth as is envisaged for inland water fish production, as a high projection, and b) with an annual growth rate of 6 per cent as a rate only slightly better than what has been achieved during 2000-01 to 2007-08 (5.2%).

The two sets of projections for high and low growth for aquaculture are given in Annexure-9.11. The average projected stock demand for 2020 is 4,130, which would increase from 2090 in 2009-10. The annual requirement of graduates in this activity is about 170 per annum.

9.3.6 Deep Sea Fishing

As mentioned earlier, future stepping up of marine fish production would depend on increased levels of deep sea fishing, particularly in the Economic Export Zone (EEZ). The number of deep sea trawlers has been steadily increasing. However, the number of deep sea vessels with on-board facilities is still small. As per the Department of Animal Husbandry, Dairying and Fisheries[52] about 90 resource specific deep sea vessels were licensed to operate by 2006-07. According to MPEDA, there are only about 60 deep sea vessels available presently. It is assumed that the number would grow to 200 by 2020. Data received from

[52] Department of Animal Husbandry and Dairying, Annual Report 2007-08

Aqua invest meet at CIFE indicate that each deep sea vessel would require 3 professionals. On this basis, it is estimated that this sub-sector needs about 200 fishery science professionals at present, which is projected to increase to 600 by 2020. The existing CIFE norms for deep sea vessels (over 35 m) are 15 deckhands (fishermen) apart from professionals and technicians. On this basis, the requirement now would be 900 deckhands, which is expected to grow to and 3,000 by 2020. This is apart from the fishermen and technicians required by the smaller fishing vessels and inland fishing boats.

Annexure-9.12 presents the detailed projections of requirements for the deep sea fishing. The stock requirement of human capital would grow from 180 in 2009-10 to about 600 by 2020, i.e. about 35 per annum during 2010-20.

9.3.7 Development and Extension

Development of fisheries is primarily the responsibility of State Governments, though the National Fisheries Development Board and MPEDA also play an important promotional role. KVKs play a prominent role in extension work.

As per information provided during the Focus Group Discussion at CIFE, State government Departments of Fisheries currently have a total sanctioned strength of 4,846 positions, of which 3,762 have been filled and 1,084 are vacant. In addition to these vacancies, the departments have projected a need for an additional 2,838 posts by 2020 taking the total to 7,684 by that year. Considering the recent trends in state government employment, it is unlikely that there would be expansion of this size (Table-9.3).

What is more reasonable to expect is that the current vacancies would be filled and a few more created by then taking the total employment to 5,000. MPEDA has projected that their human resources needs would grow from the present 49 to 79 by 2020. KVKs, which have a total employment of 87, need another 400 fishery professionals by 2020. This too is not likely to happen, and at best a level of 100 would be reached. The National Fisheries Development Board has about 15 executive and above level professionals in fisheries. The Fish Farmers' Development Agencies, numbering about 450, also have a collective strength of about 12,000 fisheries related skilled persons and professionals.

Table-9.3: Human resources Requirement in Various Fishery Organizations

Organisation	No. Sanctioned	No. in Position	Vacant	Additional requirement by 2020	Total strength needed in 2020
State Depts.	4846	3762	1084	2838	7684
NFDB	15	15			15
Fish Farmers Development Agencies	12,000 (est)	6000 (est)	6000 (est)		12,000
MPEDA	59	49	10	20	79
KVKs	-	87	-	400	487

Sources: 1) CIFE – 2) websites of respective agencies for NFDB and FFDA

Two possible scenarios have been considered for future projections the first assumes that the additional projections as required by the respective agencies would materialize, giving a high projection, while the second assumes that only the existing vacancies and replacement requirements would be filled giving a low projection variant. Breakdown by qualifications in either case has been obtained with the help of data from the establishment survey of IAMR, and the estimates are shown in Annexure-9.13.

The number of fishery graduates, post-graduates and doctorates required for extension work (through KVCs and extension departments) is projected from 3,820 in 2010 to 6,200 by 2020, i.e. about 200 per year during 2010-20.

9.3.8 Research and Academic

Human resources in fisheries research and education is given in Annexure-9.14. The ICAR Institutions which generally engage scientists for doing the research work in the field of fisheries have a total sanctioned strength of 679, but only 431 are filled at present[53] at the level of Scientists and above (Table-9.4). Of these, the number of sanctioned posts of principal Scientists, Senior Scientists and Scientists in the fisheries disciplines was only 397 (Fish & Fishery Science 360, Fish Pathology, and Fish Processing Technology 36. Assuming that filled posts of scientists are in the same proportion as the total posts it may be concluded that in April 2010, there were only 270 researchers in fisheries in ICAR. There is only the possibility of filling up of vacant posts and the number may go up to 400 by 2010.

It is estimated that there are currently about 410 fisheries science teachers in various colleges. Research in fisheries sciences is also undertaken in the SAUs with fisheries faculties through various research stations.

Table-9.4: Sanctioned and Vacant Positions in Fisheries Science as on March 2010

	Sanctioned	In position	Vacant
ICAR institutes	679	431	248
SAU's	682	413	269
Total	1361	844	517

The gross current strength of research personnel in SAUs and other organizations in fisheries sciences has been taken as 700 to grow to maximum 1,100 by 2020 as per present policy, no expansion is likely to take place. One fourth of them have been taken as post-graduates and three-fourths as doctorates. The numbers have been projected to grow at the annual rate of 2 per cent per annum, a rate half that of the rate of growth of all graduate and above outturn projected.

Fisheries Survey of India, which has a sanctioned strength of 67 has 20 vacancies and projected their additional needs[54] as 18 to take the total strength to 85 by 2020.

Thus, the total number of research personnel required for fishery research purposes is taken as 720, which is likely to grow to 1200 by 2020.

[53] ICAR (PERMISNET II, 23 April 2010)

[54] Information provided at the Focus Group discussion at CIFE, Mumbai.

9.3.9 Financial Institutions

The current strength (March 2008) of nationalized banks in India is about 8.38 lakhs, of which about 3.35 lakhs are officers. Establishment Survey showed that about 3.9 per cent of the total employment (or, 10% of the officers in banks, as officer strength is 40% of the total employment) in banks comprised graduates and post-graduates in agriculture and allied sciences. About 89 per cent of them were graduates and 3 per cent post-graduate, doctorates forming a mere 0.2 per cent, the rest being diploma/certificate holders in agri-related fields. Employment of officers in public sector banks has been projected to grow at a rate of 2.5 per cent per annum from its present level of 3.40 lakhs (2009) to 4.5 lakhs in 2020. On this basis, the number of all graduates in agriculture and allied sciences has been projected to grow from 35,100 in 2009-10 to 45,000 by 2019-20.

Of them, the number of officers with fisheries qualifications has been estimated assuming that it would be in proportion to the annual intake in different agricultural sciences. Thus, the total number of such officers at present is about 300. In addition, financial institutions like NABARD, insurance companies also have such officers. Together, it has been assumed that there are about 500 fishery science officers in 2009-10 in the financial institutions sub-sector.

On a conservative basis, it has been assumed that the number of fishery science officers would rise from the current level of 500 to 750 by 2020. About 10 per cent of them are assumed to be post-graduates and the rest graduates.

9.3.10 Other Sectors

There are several other sectors where fisheries science personnel find employment or self-employment to a limited extent. **For example, between April 2002 and September 2010, a total of 178 agri-clinics specifically for fisheries related activities have been sanctioned. Focus Group Discussions have revealed that quite a few post-graduates and graduates of fisheries science find employment overseas, particularly in the east African and Gulf countries. The demand from all such sectors, such as civil services, fishing equipment industry NGOs, agri-clinics and other self-employment, and global demand has been taken as 5 per cent of the total demand assessed for the sectors discussed above**.

9.4 Summary of Demand

9.4.1 Stock Demand

Projections of the stock of fisheries human resources up to 2020 in the high and low scenario are given in Annexure-9.15. Average stock projections for marine and aqua sectors are given in Annexure-9.16 and 9-17, respectively. In this calculation, human resources in government, banks, research and academic sectors are considered in the ratio of 60:40 between aqua and marine sectors. The average stock required in both the sectors is given in Table-9.5. The stock required would be 28,410 in 2020, which would grow from 13,870 in 2010.

Table-9.5: Projected Stock Requirement of Fisheries Human Resources

Year	Diploma	UG	PG	PhD	UG & above
2009-10	132186	10567	2320	984	13871
2019-20	251146	22288	4651	1468	28407

9.4.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 5,144. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., 2.6 per cent during 2006-10), the demand-supply scenario in 2020 would be:

Supply: 6,705
Demand: 28,407
Gap: 21,702 (76.4% of the demand)

9.4.2 Flow Demand

The above stock projections have been converted to annual flows required out of the educational system, taking into account: a) the growth from year to year, b) replacement needs calculated at the rate of three per cent of the previous year's stock, and c) the needs of higher education. These flow projections have been generated separately for the marine, aqua and are given in Annexures-9.18 & Annexure-9.19 respectively. The annual supply in 2010 and flow demand for graduates in 2020 in fisheries science (both Aqua and Marine) is shown in Fig-9.1.

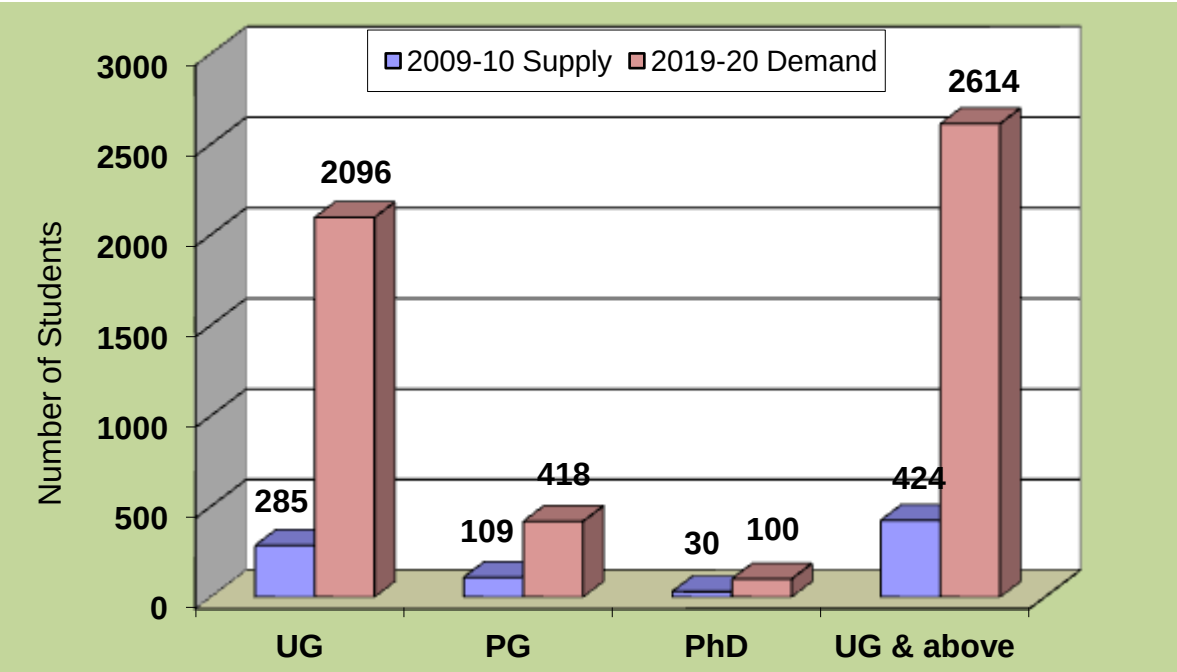


Fig-9.1: Current (2010) and Projected Outturn Required (2020) in Fisheries Sciences

The projections suggest that by 2020, the annual outturn required from the fishery science education system should be about 2,100 under-graduates, 420 post-graduates and 100 doctorates. **The annual flow requirement of 2,610 by 2020 comprises of 1,000 in aqua sub-sector, 1,600 in marine sub-sector.**

9.5 Institutional Mechanism and Skill Needs- Experts' Views

- Rice and fish are the staple food of many in the states of the country. These states include West Bengal, Kerala, North-East, Orissa, Lakshadweep, Andaman & Nicobar, etc. There is a tremendous demand as well as potential for production and processing of fish in the country especially in these areas. At present, neither the fish production is as per demand nor there adequate processing facilities. Andhra Pradesh is supplying fish to various places including the fish producing areas like North East.
- The most of the fishery related operations such as boat management and fish processing, etc., are employing non-agricultural persons. There is a demand for human resources at cheaper rates which is one of the reasons as to why professionals do not like to join such operations.
- It has been reported that quality of students joining the fisheries education is coming down. Students are more attracted towards veterinary courses as compared to fishery courses. Thus, students who join fisheries generally do not come by choice. Even when they join the courses in fisheries, they go for higher studies like MBA or they try for jobs in Middle East and other African countries where there is a demand for fishery educated personnel with higher incomes.
- **In fishery sector demand is more in navigation and Marine Engineering and also fishing technology**.
- Rural areas, especially in Kerala are developing fast even in smaller towns super markets are coming up which have potential for employment in fishery sector. There is a scope of growth of aquaculture but all these areas are labour intensive and professionals generally do not get employment.
- **It has been reported that fisheries is not a separate subject in the civil services examination.** There is a demand that this subject should be included as a separate subject for the competitive examinations. It would also attract the students towards this sector.
- Extension services in fisheries sector are inadequate. Wherever such services are available persons giving extension services are not fully trained and lack complete knowledge of latest technology.
- Fishing culture technology is being experimented in public which attracts lot of criticism till it is successful. Farmers resist the experimentation because fish culture takes a longer time as compared to the catching and selling of fish on day to day basis. Since fish culture takes about six months, farmers are unable to sustain themselves. In case fish culture has to be experimented and developed, there is a need for more government support.
- Researches going on in the sector should be disseminated in a simple language so that farmers can understand the new innovations.
- **Fishery departments are having acute shortage of staff due to which quality of education is hampered**.

- The professionals in fisheries are getting attracted towards self-employment. A number of students passing out from fisheries colleges are taking up self-employment in seed production, growth promotion, etc..
- In some of the states, for example, Jharkhand where there is a demand for fish, there is no feed industry.
- Because of the mechanisation of boats and increased storage capacity, the productivity has increased 2 to 3 times. There is a need for increasing the number of long line trawlers with adequate freezing facilities.
- **For deep fishing there is a lack of adequate landing centers. The technologies and skills for long line trawlers and fishing in deep sea water is also required**

9.6 Conclusions

The stock required would be 28,410 in 2020, which would grow from 13,870 in 2010. The required addition stock is about 1500 per annum.

The current supply of about 420 graduates per year is too less as compared to the requirement of 2,600 by 2020, i.e., additionally 2,180 graduates (1,800 UG; 310 PG and 70 PhD). The industry needs trained graduates but can't afford to meet the graduates' expectations in terms of wages and working environment. For this reason, industry prefers diploma holders, and there aren't any.

In 2020, the demand for graduates is more in marine (1600) than in aqua (1000) sub-sectors, where as the demand for diploma holders is more in aqua (21,600) as compared to marine (1100) sub-sector. In other words, marine sub-sector needs more qualified personnel; where as aqua sub-sector needs more para-professionals.

Demand from academic and research sectors is high for PG and PhDs - from current supply of 140 to 520 by 2020. In view of high vacancies in these two knowledge sectors, there is a need to increase investments in fisheries research so as to increase research opportunities and quality human resource production.

The estimates of demand are subject to a number of variables. Firstly, the base data for 2009-10 in some sub-sectors have been derived on the basis of available norms and might not have been actually realized as the industries do not employ professional graduates as per the norms, and are not likely to employ in future also till there is a modification in policies and implementation. Secondly, fishery graduates have a competition from graduates from other fields such as life sciences as well as from diploma holders and persons trained informally. Thirdly, the demand for professionals may not grow at the same rate as the production due to technological innovations and productivity gains. Moreover, the present structure of aquaculture industry may not continue in the same manner. For example, if the future production takes place in the smaller farms, such farms may not employ any fishery graduate. Considering all these imponderables the actual demand may be somewhat low. Moreover, substitutability of skills and skill levels by diploma holders or informal training or experience may also depress the demand. As such, the estimates presented above may only be taken as indicative till the sector is given special focus in policies and programmes.

Chapter 10

Human Capital Assessment in Dairy Sector

10.1 Introduction

India is emerging as a mega dairy market of the 21st Century. It is an important source of rural employment and income in the country. The growth of dairy sector in India during the last three decades had been impressive at more than 5 per cent per annum. India is the largest producer of milk in the world. Milk is also one of the biggest contributors to the value of agricultural output. Dairy science has to be linked with food security as India will remain livestock and agriculture country in the 21st Century.

10.2 Supply of Graduates

10.2.1 Development of Dairy Education

Dairy sector of the agriculture includes a number of activities such as milk production, collection, processing, production of wide-ranging dairy products, packaging, storage, transport, distribution, etc. It also involves activities like quality control and safety, increasing shelf life, milk and milk production safety and hygiene so that it could be consumed with its total nutritive value.

Dairy education in India is offered in 19 colleges / institutes in State Agricultural or Animal Science Universities and Institutions (Annexure-10.1). In addition, three new colleges are being established by Gujarat government during 2011. The institutions offer BTech in Dairy Technology. Intake capacity for dairy science education is shown in Annexure-10.2.

It can be observed from the Table-10.1 that total intake of these colleges is about 750 per annum (487 in UG, 174 in PG and 90 in PhD). During 2009-10, number of students admitted and passed is about 751 and 310, respectively. National Dairy Research Institute (NDRI), Karnal and Bangalore and Seth M.C. College of Dairy Science, Anand have been identified as Centres for Excellence. Colleges at Karnal and Anand have established modern commercial dairy with the financial support of National Dairy Development Board. The automated dairy plant – Vidya Dairy became operational at the Dairy Science College, Anand in 1994 with an objective to provide practical training to the students doing B.Tech. Course. Post-graduate courses and Ph.D. courses are also offered by NDRI, Karnal and Anand Agriculture College.

Table-10.1: Intake and Outturn in Dairy Science Colleges during 2009-10

	Diploma		UG		PG		PhD		Total	
	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass
Number of Students	131	67	487	255	174	30	90	25	751	310

Besides, short-term diploma courses ranging from one year to two years are offered by Allahabad Agriculture Institute, Naini, Allahabad and Indira Gandhi National Open University, New Delhi. Concerns have been expressed at various forums about the quality of education and its relevance to the labour market. It has also been pointed out that the students are not attracted towards the dairy science courses. Industries have expressed their concerns about the suitability and employability of the students who come out of the most of these institutions imparting education in dairy science with special reference to their practical knowledge and application of learning. The 37th Dairy Industries Conference at Goa in February, 2009 recommended the following:

- Need to upgrade all veterinary and diary science colleges in terms of infrastructure facilities and human capital.
- Need to establish a separate dairy council of India to monitor dairy education and to register graduates like VCI.
- Need to extend certificate programme in dairy management presently running for cooperative sector to private sector and micro-financing industries.
- Need to develop e-content of the courses and introduce web-based courses.
- Need to introduce a 5 year integrated courses leading to B.Tech. and Management.

10.2.2 Areas of Employment in the Dairy Sector

The growth of dairy industries in the last two decades has created demands for indigenous production of dairy equipment, increased quality standards and production of varieties of milk products. This has resulted in the progressive development of diary equipment manufacturing industries, technical consultancy organizations, processing units, etc. It has also given impetus to research and teaching. Besides universities, the corporate sector is hiring researchers for continual development, modifications and innovation in their products. Such notable expansion of the diary sector and its related industries has opened up vistas for career development. The pass-outs from various universities and colleges as dairy technologists can look forward for a career option in Diary Farm, Fodder/Feeds, Pharmaceutical Firms, Veterinary Services, Pollution Control, Gobar Gas Plants, Breeding Farms/Semen Banks, Consultants, Dairy Federations, Dairy Cooperatives, Milk/Frozen Dairy Product Plants, Packaging Materials, Fabricators/Equipment, Plant Manufacturers, Electrical/Electronic Instruments, Refrigeration Equipments, Transporters, Testing Equipments, Additives/Chemicals, Government/Private Institutions dealing with any or all activities of milk production/processing/ regulation of quality/ standards/ checking/ health care and allied activities, and other areas of operations relating to fluid milk industry and frozen dairy products.

From the above, it can be observed that primarily dairy industry, animal food industry, research and education absorb most of the alumni. There is also a demand overseas, especially from Middle East and African countries. It is pertinent to mention here that students are in demand for these countries, mostly from the premier institutions like NDRI, Karnal and Anand.

10.2.3 Estimated Stock of Dairy Graduates

There are no readily available estimates of stock of active dairy science and technologists in the country. The Census includes data in respect of graduates in dairy science and technology among graduates in agricultural science, while the National Sample Survey Organization does not categorize dairy graduates, or for that matter agriculture graduates too, separately. The IAMR, in its earlier study on human capital requirements for agriculture, made estimates of the stock of various categories of agricultural human capital. The limitations of these estimates in relation to dairy science and technology are

- At the graduate level, no stock estimates were attempted for different branches of agriculture. Only two categories were considered, viz., agriculture (including all disciplines other than veterinary science) and veterinary science.
- At the post-graduate and doctoral levels, estimates of stock were made separately for dairy technologists (covering dairy technology, dairy chemistry and dairy bacteriology/microbiology), but dairy science was included among animal sciences, presumably for want of separate data.

In view of this, what is available is the estimated stocks of post-graduate and doctorate dairy technologists in 1990 and their projections till 2010 on certain assumed growth in the intake and outturn of these categories after 1990. According to these estimates, the active stock of post-graduate dairy technologist was 373 and that of doctorates was 146 in 1990. These stocks were projected to 1,797 and 475 respectively by 2010. In retrospect, these appear high as the current annual intake, even in both dairy science and technology taken together does not exceed 100 at post-graduate level and 50 at doctoral level (as may be seen from Table 11.2 of IASRI data book 2009).

An effort was made to estimate the stock of dairy science and technology graduates from annual supply data from different sources (details given separately in Chapter-15). The total stock of graduates and above in dairy sciences, estimated from annual supplies is about 6062 in 2010.

10.3 Human Capital Demand Projections

10.3.1 Milk Production and Processing

The XI Plan has set certain targets for growth in dairy sector. These targets are discussed in detail in the following paragraphs:

10.3.1.1 Milk Production

Milk production in the country is estimated at 105 million tonnes in 2007-08. The XI Plan assumes a growth of 5 per cent per annum in the milk production, which will lead to an annual production level of 126 million tonnes by 2011-12. If this rate of growth is sustained till 2020, the production will be around 150 million tonnes in 2015 and 190 million tonnes in 2020.

On the other hand, the growth rate actually achieved over the period 2000-01 to 2008-09 is only 3.9 per cent per annum. Moreover, the growth has not been uniform across States. Only 4 States (Andhra Pradesh, Bihar, Gujarat and Orissa) recorded a growth rate in excess of 5

per cent per annum over the ten year period 1998-99 to 2007-08. In other major milk-producing States (Punjab, Haryana, Maharashtra, Madhya Pradesh, Rajasthan, the growth rate has been 2 to 3 per cent per annum only, and negative in Karnataka and Kerala (Annexure-10.3).

Therefore, an alternative growth scenario is also considered - one which assumes a 4 per cent growth rate. It is also possible to visualize a more optimistic though not likely, scenario with a higher growth rate of 6 per cent per annum. **The projections have accordingly been attempted for the three alternative annual rates of growth of milk production, viz. 4 per cent, 5 per cent and 6 per cent (Table-10.2). These alternative scenarios imply the following future levels of milk production which have been calculated on the basis of assumed compound rates of growth of milk production:**

Table-10.2: Expected Milk Production in 2010, 2015 and 2020 Under Varying Patterns of Growth

Year	Expected levels of milk production (in million MT) with an assumed annual growth rate of		
	4%	5%	6%
2009-10	114	116	117
2014-15	139	147	156
2019-20	169	188	209

10.3.1.2 Processing and Capacity Utilization

Most of the milk produced is consumed as liquid milk or processed in unorganized sector. **At present only 30 per cent of the milk processed** is in the organized sector – public sector, cooperatives or organized private sector. **In countries like Israel and Holland, over 90 per cent of the milk produced is processed.**

> Vision 2015 of the Food Processing Industry aims to increase the processing content of milk from the 13% in 2003-04 to 25% by 2009-10 and 30 per cent by 2014-15. This rate of growth (7.4% per annum) will take the processing content to 39% by 2019-20. The projections attempted have adopted this growth scenario in processing content.

Apart from a few large processing plants in the public sector, dairy industry is to a large extent in the cooperative and private sectors. Over the years, the private sector has been improving its share of the processing capacity and has now overtaken the cooperative sector. Growth in number of Diary Plants Registered under MMPO Act, 1992 during 1996 to 2007 are shown in Annexure-10.4 and Fig-10.1.

The average capacity of dairy plants has been a little less than 150 thousand liters per day in the case of cooperative sector, 100 thousand liters per day in the case of private sector and around 250 thousand liters per day in the case of other plants. There has been a steady but slow trend in the direction of higher plant capacities in both cooperative and private sectors. A continuation of this trend is likely to see overall higher processing capacity per plant.

It is assumed that the average processing capacity of the dairy plants will be about 150 thousand liters per day by 2020 from around 117 thousand liters per day in 2007. This assumption is due to the current discussions about a 'White Revolution'.

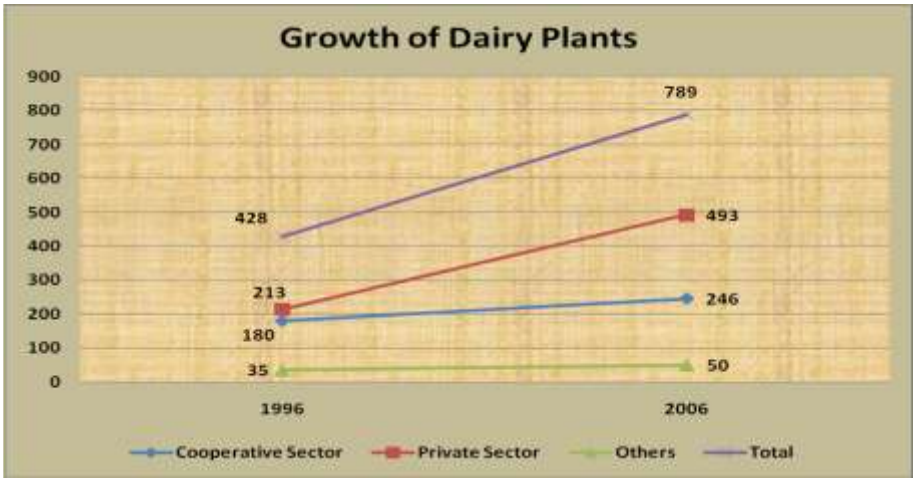


Fig-10.1: Growth of Registered Dairy Plants under MMPO

Available data also indicate that at present only about 50 per cent of the installed processing capacity in the organized sector is utilized. This has to improve and **it is assumed that by 2020 near full (80-90%) utilization of the capacity would be achieved gradually.**

10.3.2 Human Capital Projection for Dairy Processing Sector

Human capital projections for the processing sector have been derived through the following steps:

- Projecting number of dairy plants based on future milk production, processing content, average capacity of dairy plants and capacity utilization
- Projecting the total number of dairy personnel using per dairy plant requirement of technical personnel (Norm and establishment survey, expert opinion and focus group discussions.)
- Projecting the number of dairy personnel by level of education using establishment survey data

10.3.2.1 Projection of Number of Dairy Plants

On the basis of above assumptions the required number of Dairy Plants in the organized sector has been projected till 2020 on the basis of projected levels of milk production (assumed rates of growth), percentage of milk production processed (using dairy processing targets envisaged in the vision documents and interpolated for intermediate years using linear

trends), average processing capacity of plants (assumed levels as above and capacity utilization (as projected using linear growth). These projections are given in Annexure-10.5.

Similar exercise has been carried out with milk production growth scenarios of 4 per cent and 6 per cent and the resultant projections of dairy plants of average size going up to 1,50,000 litres capacity by 2020 are given in Annexure-10.6. The data shows that the projected number of dairy plants would vary from 1,333 under the 4 per cent growth alternative to 1,482 under 5 per cent alternative and 1,644 under 6 per cent alternative.

10.3.2.2 Projection of Human Capital in Dairy Plants

The approach used to convert the projections of the number of dairy plants into projections of dairy science and technology personnel is normative in essence as stated earlier. Based on the Focus Group Discussions held at NDRI, Karnal, it is assumed that an average plant of 1,00,000 litres per day capacity would have 5 sections, operate 3 shifts and require a total of 25 dairy science and technology personnel. This norm has been verified by the data thrown up by the Establishment Survey conducted by IAMR as a part of this study. Out of over 3500 establishments from which data has been received, 152 are milk processing plants. Together they had an employment of about 28,000, of which about 4,500 are dairy science and technology personnel. This again yields a per plant number of under 30. On the basis of the expert opinion and focus group discussions, a conservative approach has been followed and projections have been worked out taking into account 25 technical personnel per plant as the data indicate that there are a few veterinarians and food science personnel also in dairy plants. Establishment survey shows that out of total agri- personnel, about 20 per cent are from fields other than dairy. Thus, the number of dairy graduates is 25 per dairy plant.

The stock of dairy science personnel required in dairy plants worked out on the basis of this norm, for each of the three growth scenarios considered is shown in Annexure-10.7.

Thus, by 2020, the required stock of dairy science professional to man the dairy processing sector would rise to 37,000 under the planned scenario, 33,000 under a less optimistic but realistic growth pattern and 41,000 under a more optimistic scenario. As a reasonable via media, the average of the first two may be considered as the most likely set of projections.

A significant point brought out in the Focus Group Discussion at Karnal was the huge imbalance in the employment of technicians in dairy plants across the country. It was pointed out that North India with 175 plants employed only 52 technicians and East India has 50 plants with only 15 technicians, whereas West India has 208 dairy plants with 1500 and South India has 75 plants with 1200 technicians.

The following Chart shows the distribution of the dairy science personnel by level of education derived from the project Establishment Survey. About 67 per cent are graduates, 4 per cent are post-graduates and 2 per cent are doctorates. About 12 per cent are diploma holders and 15 per cent were certificate holders /informally trained persons.

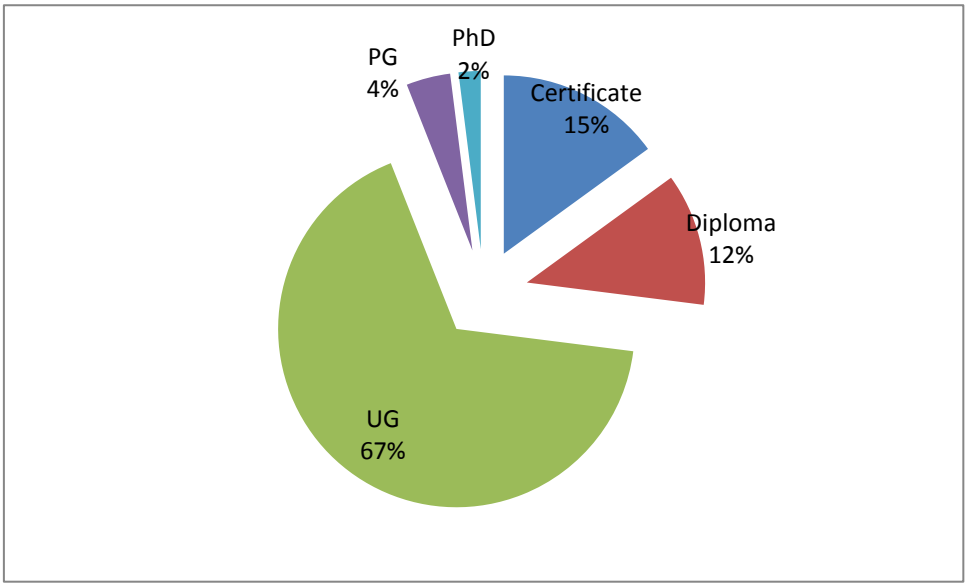


Fig-10.2: Distribution of Dairy Science Personnel in Dairy Plants

Applying this pattern to the projected levels of stock required using Parnes's approach, the requirement by level of education have been derived and shown in Annexure-10.8 and Fig-10.2. The demand for dairy graduates and above increases from about 14,800 in 2010 to about 23,100 at 5 per cent growth or 25,500 at 6 per cent growth by 2020. In average scenario, the net requirement for stock addition would be about 950 graduates per annum during 2010 to 2020.

10.3.3 Milk Procurement (Chilling plants, testing facilities)

The processing industry can prosper only if milk production and procurement grows as planned or even better. **At present only about 30 per cent of the marketable surplus flows to the organized processing sector (cooperatives and private sector plants). This needs to be increased to 70 per cent.** Enhancing milk production is possible through improving the quality of cattle through appropriate breeding practices (larger number of semen banks, increase in AIs and raising their quality, availability of AIs at the doorstep of the milk-farmer, better facilities for prevention and treatment of animal diseases through enhanced veterinary services, better animal feed, and extension services). This calls for a substantial increase in the number of animal scientists (geneticists and breeders and animal nutritionists on the one hand and veterinary personnel on the other). The likely demand for such personnel has been considered in the relevant chapters on veterinary science and animal sciences.

The need for dairy personnel arises in procuring milk of appropriate quality and handling it till it reaches the processing plant. An emerging phenomenon that is fast gaining ground is the use of bulk chilling equipment at the stage of milk procurement. This calls for such equipment at the village level itself. Similarly, quality of the milk procured is an important element in the chain, and this calls for quality testing at the local level itself. While thorough quality control is possible only through well-equipped laboratories required perhaps at regional level, availability of equipment to test the quality on certain standard parameters at the local level will ensure that milk of high quality flows to the processing plant.

Projections of dairy science human capital demand for milk procurement have been made under the following assumptions.

- There are about 6 lakh villages in the country. It is assumed that bulk chilling plants and basic quality testing facilities will be extended to half the villages, i.e. 3 lakh villages by 2020.
- Each village level chilling plant will need the services of a diploma/certificate holder with knowledge of chilling equipment and testing facilities will require another.
- Elaborate quality testing facilities may be set up at about 100 important locations in the country (beginning with 10 in 2010) by 2020, each manned by two graduates in dairy science/technology and four certificate/diploma holders.

The projected requirements on this basis are shown in Annexure-10.9. The demand is for 20 graduates in 2010 growing to 200 by 2020, i.e. about 18 per annum during 2010-20. On the other hand, the stock for diploma holders would grow from 20,000 in 2010 to 6,00,000 in 2020, i.e about 58,000 per annum during 2010-2020.

10.3.4 Research and Academic

Data on faculty and scientists in various dairy science colleges and departments of SAUs is given in Annexure-10.10 and is summarized in Table-10.3. SAUs have 361 faculty against sanctioned strength of 726, i.e. nearly 50 per cent positions being vacant.

Research in dairy sciences is undertaken primarily in the ICAR institutions, State Agricultural universities and large private industrial establishments in the dairy sector. The needs of industrial units have already been covered under projections for processing. According to the data available from ICAR, indicates that at NDRI, Karnal, the premiere dairy research institute, only 149 scientists, not all necessarily dairy scientists, were in position against the sanctioned strength of 200 as on 1 April 2010. The total number of posts of principal scientists, senior scientists and scientists in dairy chemistry, dairy engineering, dairy microbiology and dairy technology sanctioned in ICAR as a whole was only 65 on 1 April 2010 (as per PERMISNET II). The overall stock of scientists engaged in dairy research in all institutions all over the country is taken as 500 in 2010, which is projected to grow to 1,400 by 2020.

Table-10.3: Sanctioned and Vacant Positions in Dairy Science Research and Education as on March 2010

	Sanctioned	In position	Vacant	per cent Vacant
ICAR Institute (NDRI)	200	149	51	34.2
SAU's	726	361	365	50.5
Total	926	510	416	42.4

In the field of education, the total number of teachers in dairy science is assumed to grow from 200 in 2010 to about 600 by 2020.

In both education and research together, the distribution by level of education is taken as 60 per cent doctorates and 40 per cent post-graduates. **In research and academic put together**

the stock would grow from 700 in 2010 to 2000 in 2020, i.e about 130 per year during 2010 to 2020.

10.3.5 State Departments

In the State governments dairy development is handled as a part of the Animal Husbandry departments, which are mainly dominated by the veterinary services and animal husbandry including cattle breeding programme. Further, in view of the personnel policies pursued by the governments, not much increase, if at all, is likely to take place in government employment. In view of this, **the total stock of dairy science and technology personnel in animal husbandry departments of all the States has been taken as 500 in 2010 without any growth till 2020**. Replacements, however, have been indicated in the final flow estimates.

10.3.6 Financial Institutions and Others

Employment of graduates and post-graduates of all agricultural disciplines in banks and other financial institutions has been projected to grow from 35,000 in 2010 to 45,000 in 2020 (See chapter on veterinary science). Of this, assuming that the share of dairy scientists would be in proportion to their share in university intake, i.e., about 2.5 per cent, their stock has been estimated at about 900 in 2010 projected to grow to 1,200 by 2020.

Including all other sectors, like insurance, public administration, defense, etc., the stock demand is taken as 1,000 in 2010 which is expected to grow to 1,500 by 2020. Their distribution by level of education is taken as 90 per cent graduates and 10 per cent post-graduates, on the basis of the pattern observed in the establishment survey of IAMR.

10.3.7 Global Demand

A common observation made at various meetings with experts in dairy science and technology is that a sizeable proportion of the doctorates, post-graduates and even some graduates find employment overseas every year.

It has been stated that there is considerable demand for these professionals from African and Middle-east countries in dairy and food-processing industries. In the FGD organized at NDRI Karnal, it was stated that 50 per cent of the last ten years' outturn are abroad. **In view of this, it should be recognized that India, because of its demographic advantage, is emerging as training ground for not only for India but for the world labour market as a whole. The educational system should take note of this phenomenon while planning its outputs.** While translating the above stock demand projections into flow demands, a higher rate of replacement needs should be allowed. However, the labour market for dairy scientists does not seem to reflect any shortages due to emigration.

10.3.8 Qualitative Changes

The requirements have to be seen in the light of important changes taking place in the processing industry as pointed out in the Focus group discussions held at various places specially in Anand and NDRI, Karnal, and their impact on human capital requirements. These are:

- Increasing automation in the industry, enabling diploma or even certificate holders with specific skills to operate the equipment
- Increasing requirement of IT skills as a conjunct to technical skills
- Gradual shift of processing into organized sector
- Increasing use of bulk chilling equipment
- Emergence of organized dairy farming

It is possible that as a result of these changes, the human capital pattern may shift in favour of diploma or even certificate holders with specific IT enabled specialized skills.

10.4 Summary of Demand Projections

10.4.1 Stock Projections

The projections of all the sub-sectors of employment of dairy personnel have been aggregated and shown in Annexure-10.11 for different growth scenarios and summary for average growth is given in Table-10.4.

Table-10.4: Projections of Aggregate Stock Demand for Dairy Science Personnel up to 2020

Year	Diploma	UG	PG	PhD	UG & above
2009-10	4943	14813	1930	1064	17807
2019-20	638530	24457	3181	2282	29920

Thus, the number of graduates and above in dairy science and technology has been projected to grow from 17,800 in 2010 to 29,920 by 2020. A large demand for diploma and certificate holders has been projected to cater to the needs of quality milk procurement by the organized sector. This need has been emphasized inter alia during focus group discussions when end to end approach was emphasized.

10.4.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 6,062. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., 9.5 per cent during 2006-10), the demand-supply scenario in 2020 would be:

Supply: 7,269
Demand: 29,920
Gap: 22,651 (76% of the demand)

10.4.3 Flow Estimates

The above overall stock estimates have been converted into flow estimates i.e. the year to year additional requirement. This flow estimate would include the increment in the stock demand, replacement needs (Retirements, migration etc.) and outturn needs of higher education.

In this exercise replacement needs have been estimated at 3 percent of the stock of the beginning of the year. The flow estimates thus derived are shown in Annexure-10.12. The annual flow for the years 2009-10 and estimates for 2019-20 is shown in Fig-10.3.

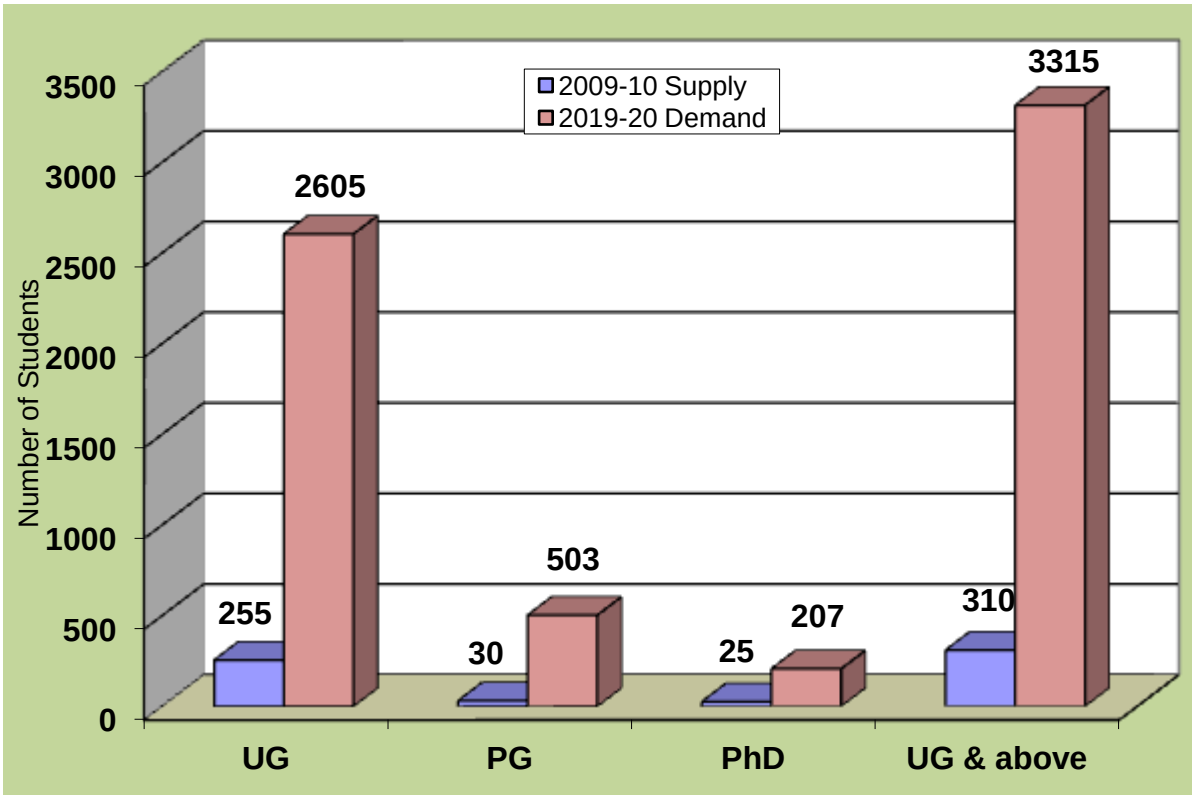


Fig-10.3: Current (2010) and Projected Outturn Required (2020) in Dairy Sciences

The outturn of dairy science and technology professionals (graduates and above) from educational institutions is about 310 in 2010 and the requirement would increase to 3,300 by 2020. The intakes have to be correspondingly higher depending upon the drop-out factor. **As dairy is second largest rural sector in the country, the human development need to expand commensurate with its potential and need.**

10.5 Institutional Mechanism and Skill Need- Experts' Views

- It has been pointed out that there is a need to establish Dairy Council of India on the lines of Veterinary Council.
- **Integrated B.Tech. dairy programmes for five years should be started which should provide a complete package with six months to one year internship and practical experience.** There is a strong need to establish college-industry linkages for ascertaining continues needs of the industries and subsequently revising the course curriculum.
- **At present the dairy science education is not producing entrepreneurs. Students lack business abilities and communication skills.** Dairy Science course should be able to develop entrepreneurial skills.
- Consultancy is coming up in a big way. The unorganized sector dairy centers are taking help of consultants in case of any need as individually they are not be able to appoint a dairy professional.
- Quality of education has to be monitored. From the total requirement from dairy technologists, at least 10 per cent are needed with post-graduate qualifications as they are needed for research and development programmes. It is to mention here that the corporate sector is taking up research in a big way.
- **There is a demand for food security, food quality, food safety and total quality management. In case Food Security and Standards Act is accepted and implemented, dairy technologist are needed for value additions, supply chain management and supervising automated plants etc., The international level standards have to be maintained which require professionals at various levels.**
- There are about 800 dairy plants in the country, but only 18 per cent milk is handled at organized sector. In the unorganized sector, there is a dearth of trained human capital with adequate qualifications.
- There is a shortage of faculty as students after passing out from the institutions prefer to join Corporate Sector, go abroad, try for competitive exams, join MBA etc., One of the reasons for this phenomenon is low salaries and prestige to the sector.
- There is also a need for training and retraining of existing faculty as per the market demand and changes in the course curriculum.
- India does not have a proper national breeding policy or fodder development policy. In spite of the higher rates of milk production, milk yield is very low as compared to other countries.
- New areas have emerged in diary sector such as **impact of climate change on animal and milk production. Shelter management is also coming up as a challenge for the dairy sector where there is a requirement of professionals from dairy science.**
- There is a growing concern about the alteration of milk and milk products. Besides increasing shelf life of milk and value addition, adequate supply chain, production losses, low extent of processing and fortification of milk are some of the areas which require

immediate attention. Basic areas which would require trained professionals are milk production management and procurement, milk processing management, management and marketing, management of Intellectual Property Rights, patenting and trade, technological innovation and research, production as per international standards and so on. A national minimum competency is required, if India wants to make itself visible at the international scenario. Other related areas that would require professional human capital are equipment design and maintenance, supervisors for operations, food packaging and shop floor level supervisors.

10.6 Conclusions

The demand of graduates and above in dairy science and technology has been projected to grow from 17,807 in 2010 to 29,920 by 2020, with annual increase of nearly 1,200. A large demand for diploma and certificate holders has been projected to cater to the needs of quality milk procurement by the organized sector.

The current supply of about 310 graduates can only meet less than 15 per cent of estimated demand. To meet the demand of graduates, annual out turn need to be increased to about 3,300 by 2020, i.e., additionally 3,000 graduates (2,350 UG; 470 PG and 180 PhD).

The demands for dairy sector have been projected keeping various factors in focus which include the growth of the sector, its contribution to the economy, expansion plans, technological innovations, out turns of students and their employment pattern, demands from the industries etc., Professionals are needed for this sector with various levels of education including certificate/ diploma courses to highly qualified persons with M. Tech and Ph.Ds. At present only big industries are employing professionals. Other industries specially unorganized sector is hiring people on a low salary and providing on the job training. Professionals are not appointed in chilling plants or testing labs. **If India has to achieve the specified targets by 2020 with international level standards in quality control and food safety, professionals in Dairy science have to be appointed.**

High proportion of posts in Universities, institutions and Govt. departments are lying vacant which is jeopardizing the quality of education. This issue has to be looked after.

The requirement for diploma holders is highest in this sector. There is a potential requirement to train about 60,000 diploma holders annually so as to meet the large requirement for these persons in the area of dairy production and management in the rural sector. There are no systems in place to train and develop persons on this scale. This needs to be addressed in the coming Plan on priority. If education in this sector has to expand, a suitable policy for faculty development is essential.

Chapter-11

Human Capital Assessment in Agricultural Engineering

11.1 Introduction

Importance of engineering inputs for increasing productivity and reducing human drudgery in farming operations is well known in the literature. Agricultural engineering industries have helped the farmers by manufacturing improved farm equipment and processing machinery by adopting suitable designs. In the GATT and WTO regime, the Indian industries have access to modern technology. However, preponderance of small farmers, the importance of indigenous technology is critical and therefore this requires an appropriate policy for the development of agriculture engineering education and research (Singh, 2000). In order to achieve efficiency and higher productivity of Indian agriculture, interventions from the agriculture engineering discipline are critical in the form of agricultural mechanization, irrigation and drainage and soil conservation engineering, agricultural processing, energy in agriculture and transfer of technology (CIAE, 2007).

"Agricultural engineering has most commonly been defined as the application of engineering principles to agriculture. It thus involves many different established branches of engineering and associated disciplines … established in many countries" (KREPL,2008). Agricultural engineering is the discipline that applies to engineering science and technology to agricultural production and processing. Agricultural engineering combines the disciplines of animal biology, plant biology, and mechanical, civil, electrical and chemical engineering principles with a knowledge of agricultural principles. It utilises the knowledge of engineering for making agricultural machinery (David, 2004).

11.1.1 Growth of Farm Mechanisation

Estimated growths of some major farm equipment are presented in Table-11.1. In general, the farm machinery sector is growing at about 10 per cent per annum.

Table-11.1: Growth in Farm Implements

Farm Implements	Number in	Estimated annual	Growth per
Tractor	2748686	370000	4-5 %
Combine Harvester	427000	3000-4000	
Thresher	1614153	20000	10%
Rotavetor	NA	50000	50%
Self Propelled Vertical Conveyor Reaper	11595000	1200	
Zero Till Seed Drill	NA	15000	5%
Multi Crop Planter	116000	300-400	
Power Tiller	272000	60000-70000	10%
Laser Land Leveller	913256	2000	
Rice Transplanter	NA	600-800	
Power Spray / Manual Spray	NA	$ 100 Mn	10%
Power Weeder	NA	25000	
Drip Irrigation Equipment	NA	$ 275 Mn	20-25%

11.1.2 Regional Distribution of Farm Mechanization

- Punjab, Haryana and western Uttaranchal are major states where farm mechanization is concentrated; these manufacturers are now searching for a higher level of farming technology which increases their productivity.
- Farm mechanization in the southern part of India has increased considerably over the decade but still has a long way to go before adapting to a higher level.
- Uttar Pradesh and Bihar are some of the future potential states who have started using farm implements with support extended by the Government.
- West Bengal, Orissa and the North eastern states are in the process of adopting farm mechanization.

11.2 Supply of Graduates

11.2.1 Agricultural Engineering Education in India

Agricultural engineering education was introduced first in the country in1942 at the Allahabad Agricultural Institute, Naini, Allahabad, Uttar Pradesh and subsequently Bachelor of Technology (B.Tech.) degree was initiated at the Indian Institute of Technology (IIT), Kharagpur, West Bengal. Later, with the establishment of State Agricultural Universities (SAUs) during 1960's, agricultural engineering got boost and now there are 39 institutions (including six affiliated colleges and IIT, Kharagpur) providing agricultural engineering education.

Agricultural engineering education is now provided in 40 colleges – 34 in SAUs, five affiliated to SAUs and One central institution (IIT-Kharagpur). About 37 colleges are now offering Bachelor degree, 27 colleges offering Master degree and about 13 institutions offering PhD. List of colleges providing agriculture engineering education is given in Annexure-11.1. The annual intake and outturn is estimated to be 2,490 and 1,510, respectively in the year 2009-10 (Annexure-11.2 and summary in Table-11.2).

Table-11.2: Intake and Outturn of Students in Agricultural Engineering during 2009-10

	Diploma		UG		PG		PhD		Total	
	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass	Adm	Pass
Number of Students	31	NA	1954	1218	475	262	58	27	2487	1507

The Vision 2025 document of Central Institute of Agricultural Engineering (CIAE, 2007) presents the future challenges in agricultural engineering research.

'which will greatly depend on developing appropriate technologies for timeliness, precision, maximizing input utilisation efficiencies, reducing losses, value addition and conserving energy and natural resources'. The document puts emphasis on mechanisation of hill agriculture, horticulture, value addition, nutritional security, greater use of renewable sources of energy, human comfort and safety and gender issues to reduce drudgery in farm operations and agro-processing.

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The Vision document clearly envisages taking off the trajectory of Indian agriculture in to profitable, sustainable and globally competitive enterprise through engineering interventions of farm mechanisation, value addition and energy management in production and post harvest activities. The mission is to fulfill the Vision by increasing farm mechanisation, value addition and use of renewable energy sources in agriculture from the present levels of 20 per cent, 10 per cent and 5 per cent to 60 per cent, 30 per cent and 20 per cent, respectively by the year 2025 (Vision, 2025).

Agricultural engineering discipline has made substantive contribution R&D activities, designing equipments and machineries thereby increasing production. However, there are numerous problems associated with management of agriculture engineering education in the country. There has been dearth of suitable faculty and researcher for teaching and R&D activities and in many universities positions are lying vacant for quite sometimes (20% of sanctioned posts are vacant). This has serious repercussion to the agriculture engineering education and industry.

11.2.2 Current Stock of Human Resource in Agricultural Engineering

An effort was made to estimate the stock of agricultural engineering graduates from annual supply data from different sources (details given in separate chapter). The total stock of graduates and above in agricultural engineering, estimated from annual supplies is about 23,207 in 2010.

11.2.3 Sectors of Employment

A recent study undertaken for few developing countries in Africa sponsored by FAO (Kerpl, 2008) reveals the sectoral distribution of agricultural engineering professional as:

1.	R&D and teaching	13%
2.	Extension and advisory	17%
3.	Industry and agricultural services	32%
4.	Government sectors	18%
5.	Miscellaneous others	20%

In India, some of the specialties of agricultural engineers include (Agri-Engineering, 2002):

- the design of agricultural machinery, equipment, and agricultural structures
- crop production, including seeding, tillage, irrigation and the conservation of soil and water

- animal production, including the care and processing of poultry and fish and dairy management
- the processing of food and other agricultural and bio-renewable products and food engineering.
- bio-resource engineering, which uses machines on the molecular level to help the environment.

One of the major areas in which agricultural engineers are employed is the manufacturing of agricultural machineries of various sorts. Government departments dealing with soil conservation and research and development organisations including private establishments also generate significant demand for agricultural engineering human resources. Agricultural engineers are also employed in unorganized sector or self-employed or are on own account activities but it is difficult to capture them in these activities owing to absence of data sources. There is agricultural engineering or soil conservation department in every state government including at district level. Statewise data (wherever available) has been collected and estimates have been made on that basis. Similarly, for scientists and teachers, database from ICAR for scientists and for teachers' data from agricultural universities has been taken for projections.

Agricultural engineers may perform tasks as planning, supervising and managing the building of dairy effluent schemes, irrigation, drainage, flood and water control systems, perform environmental impact assessments etc. A large numbers of agricultural engineers work in universities or for government agencies or state agricultural extension services. Agricultural engineers work in production, sales, management, research and development or applied science.

11.2.4 Future Drivers of Growth

- India is a growing economy and to support a growing population require efficient machinery that would increase the yield of food grains and commercial crops.
- Farmer spending has increased due to higher food prices.
- Government subsidy on agricultural machinery is on the increase and more and more equipments would be included for subsidy in the future
- Labour is in short supply also compounded by government National Rural Employment Guarantee Programmes. Besides, demand of labour from the construction industry is increasing so more and more rural labourers are coming to the city; this has also helped wages to increase sharply making it unviable.
- It is expected that the percentage of population involved in agriculture will come down from the present 64 per cent to a close 40 per cent by 2020; this would increase the need for mechanization.

11.2.5 Service Centres for Farm Machinery

One of the major constraints of increasing agricultural production and productivity is the inadequacy of farm power and machinery with the farmers. Efficient agricultural operations are possible only when adequate agricultural mechanization infrastructure is created in rural

areas. As small farmers cannot afford to purchase the machinery, custom-hiring facility can be of significance to both unemployed youth and the farmers. This can be true for processing activities and repair and maintenance service for agricultural machinery. Setting up of Agro-Service Centre that include Agro-processing enterprises and Service centres for repair and maintenance of agricultural machinery in the rural areas would be major foucs in the coming years as government of India envisages promoting such enterprises (Kulkarni, 2010).

11.3 Demand Projections

11.3.1 Estimated Stock of Agricultural Engineers

One of the major problems of arriving at an estimate of the stock of agricultural engineering human resources is that there are no readily available estimates from any sources. Neither Census nor NSS provides level of data for agricultural engineering human resources. IAMR (2001) did some exercise of projection of agricultural human resources by disaggregated levels but again such exercise is limited to post-graduates and doctorates.

Demand comes from variety of factors namely, input demand, intermediate demand and final demand of products and services. It becomes extremely difficult to estimate demand for human resources when relationship between inputs and outputs and intermediate demands is not clear. This needs to be understood in a dynamic input-output framework.

11.3.2 Development and Promotion

Agricultural engineers are employed in government departments in particular drainage, soil conservation, land reclamation projects, and for flood control. Every state government has department of soil conservation. Departments at the district level employ technical persons having background of agricultural engineering (either degree or diploma or certificate courses).

On the basis of information available in respect of a few States (Annexure-11.3) it has been estimated that on an average 4.5 persons of agricultural engineering are employed in a district. On this basis, the total number of agricultural engineers employed is estimated to be of the order of 2,858 personnel in all 635 districts in the country in 2009-10. It has been observed that large number of positions is vacant in the state departments owing to various reasons. In some states the vacancies as per cent of sanctioned positions is as high as 30 per cent. It is assumed that the same situation holds true in soil conservation department also. Therefore, two different scenarios have been considered for projections, one assuming that only 50 per cent of vacant positions will be filled by 2020 and the second that all the vacant positions will be filled-up by that year. In order to estimate the requirements at different levels of education (certificate, diploma, degree holders, post graduates, doctorates personnel), the pattern derived from the analysis of Establishment Survey data conducted by the IAMR has been applied.

Detailed projections are given at Annexure-11.4. The number of agri-engineering graduates, post-graduates and doctorates required for development /extension work (through KVCs, and various government departments) is projected to go up from 2800 in 2010 to 3000 by 2020, i.e. about 60 per year during 2010-20.

11.3.3 Equipment Manufacturing

According to Annual Survey of Industries (ASI) conducted by the Central Statistical Organization, registered factories producing farm and food machinery and equipments employed 62,362 persons in 1998-99 and 63,280 persons in 2000-01. The corresponding employment for the year 2005-06 was 67,636. During the period 1998-99 to 2005-06, **the growth had been at an annual rate of 1.5 per cent only, but during 2000-01 to 2005-06, the annual rate of growth of employment had been of the order of 2.9 per cent. During the later years from 2002-03 to 2005-06, the growth had been more impressive at 8.5 per cent per annum.** Since the growth in agriculture machinery employment is faster in recent years and likely to continue, the projections for this sector have been made keeping this fact in focus and three different growth scenarios (low, high and average) have been made assuming 3 per cent, 8 per cent and 5.5 per cent growth rates respectively. These total employment projections have been split into projections by different levels of technically educated persons using the establishment survey data.

Detailed Projected stock demand in manufacture sector is shown in Annexure-11.5. These projections estimate that the stock requirement in 2009-10 is about 12,300. This would increase to 21,500 by 2019-20. Thus, industry would need about 900 per annum during 2010-20.

11.3.4 Education and Research

Actual data of teachers in agricultural engineering faculty in agricultural universities is about 660 for 2009-10 against sanctioned positions of over 1000 (Annexure-11.6). For projections, it is assumed that about 80 per cent vacant positions will be filled by 2020. This way, the total stock comes out to be 800 by 2020 (Annexure-11.7). Break-up of these numbers as postgraduates and doctorates has been obtained in the ratio of 20:80.

Likewise, the number of agricultural engineering scientists engaged in research in 2009-10 has been estimates as about 500 of which 365 was in ICAR institutions and the rest in other institutions including private sector. It is assumed that the stock will increase by 1 per cent per annum. This makes estimated stock of scientists 552 by 2010 (Annexure-11.8).

Detailed projections for research and teaching are given at Annexures-11.7 & 8, respectively. **The projected stock demand for academic and research by 2020 is 1350, which would increase from 1150 in 2009-10. The annual requirement for stock of teachers and scientists in agri-engineering is about 20 per annum.**

11.3.5 Other Sub-sectors

In the absence of specific data for other sectors like NGOs, self-employment, etc. the total stock requirements obtained for the sectors covered above have been raised by 10 per cent to take account of the uncovered sectors.

11.4 Summary of Demand Projections

The projection of stock of agricultural engineering human resources to meet the needs of various segments of the economy and the consequential flows required from the educational system are summarized below.

11.4.1 Stock Projections

The overall stock of agricultural engineering human resources required to meet the demands in various subsectors in the LOW, HIGH and average scenarios are given in Annexure-11.9. Thus, in an average scenario, the number of agricultural graduates, post-graduates and doctorates has been projected to grow from about 18,000 in 2009-10 to 28,500 by 2019-20 (Table-11.3).

Table- 11.3: Overall Stock Projection in Agri-engineering Sector

Year	Diploma	UG	PG	PhD	UG & above
2009-10	2022	11654	3800	2033	18086
2019-20	3366	19405	6201	2880	28485

11.4.2 Demand – Supply Gap in Stock

In 2010, the actual stock from supply is 23,207. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., 9.7% during 2006-10), the demand-supply scenario in 2020 would be:

Supply: 33,859

Demand: 28,484

With the supply exceeding demand, it would lead to unemployment in this sector. However, the projected demand can be met by restricting the outturn growth rate to about two per cent per annum in the coming decade.

11.4.3 Flow Projections

The stock requirements have been converted to annual flows required out of the educational system taking into account (1) the growth from year to year (2) replacement needs calculated at the rate of three per cent of the previous year's stock and (3) the needs of higher education. The corresponding annual outputs required from the educational institutions are given in Annexure-11.10. Average supply in 2010 and flow projection for 2020 is shown in Fig-11.1.

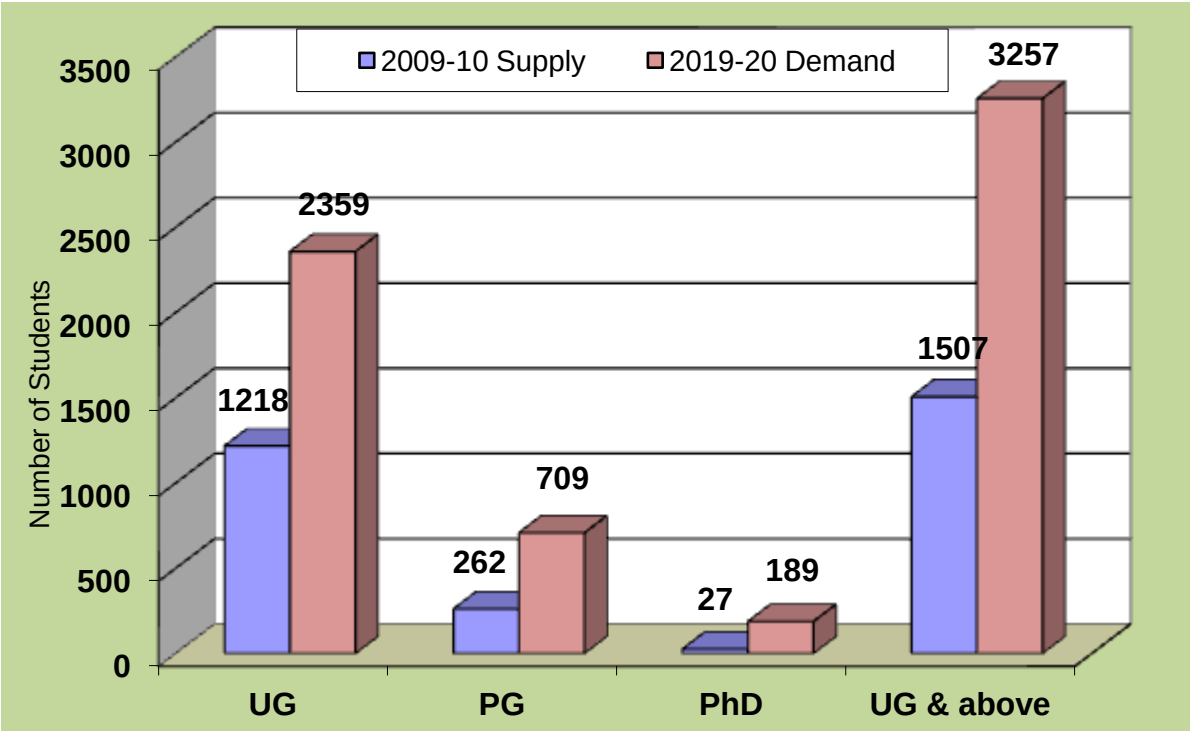

Fig-11.1: Current (2010) and Projected outturn required (2020) in Agricultural Engineering

The current supply of about 1,500 in 2010 is short of the requirement by 1,700 in 2020. To meet the requirement, the educational institutions need to produce annually about 3,260 agricultural engineering under-graduates, post-graduates and doctorates by 2020.

11.5 Institutional Mechanisms and Skill Needs- Experts' Views

- Human resources needed to match various government programmes like watershed development, drip irrigation, and a number of central government programmes being implemented by DRDA and various state agencies across the country. Micro management scheme now covers mechanization, water management, etc. About 1000 Customer Hire Centres are to be set up by NCDC. It has proposals for more than 400 service centres. Trained personnel are needed to handle these jobs.
- FICCI report on food processing indicates growth in food industry from $118b to $250b by 2015. It also pointed deficiencies on quality of technical human resources (50% companies not satisfied with technical skills; 72% companies view that there is lack skill to use modern technology; 52% are of the opinion that quality standards are not met and delivery system is poor; 60% feel that students passing out from various educational institutions are not able to prepare adequate designs, etc.). The report projected need for 23 lakh skilled technical human resources in Food processing sector at all levels including 9.5 lakh production engineers/managers, 8-12 lakh for quality control & R&D and balance in regulating legal aspects and other areas. Besides, it also projected the need for 27 lakh technical support staff. However, there is no specific mention for human resources in agri & food engineering.
- No proper information on export of agri-engineering equipment other than tractors.

- Local products need to be propagated. For instance *Poha* is a local product which has vast scope for local as well for export but it is .not considered as an item of production and packaging.
- Environment engineering is emerging as new area.
- Maharashtra is going to set up agro centres in districts with multi disciplinary team of agri graduates. Ideally need one agri engineer per district under this scheme alone.
- Major issue is how to keep meritorious students in R&D and academics. Five years' back about 7% of ICAR Scientists were agriculture engineers. It has gone down now. Only research at SAUs is from AICRP funds. Ideally, R&D human resources should be 1-5 times than now. R&D to grow more including private sector. Students passing out from the universities try to join corporate sector due to high salaries and good working conditions.
- Testing needs more human resources. Sometimes it takes more than 24 months to test a machine because of lack of human resources.
- Curriculum to include practicals on advanced agri equipments.
- Rural engineering to be included in agricultural engineering. Rural Development departments in particular would need this.
- Entrepreneurship development to begin at college. Also courses like project planning, finance, etc. to be taught
- A number of researches are being conducted by industries but these remain with them and do not come out. Sometimes Industries do not want to disclose and therefore do not employ students for training in R&D. This leads to lack of interaction between industries and educational institutions. Such linkages remain confined to sales, marketing and support services departments of the industries only. Some way out is needed.
- Labs are outdated. Industry exposure needed to both students and teachers. However, many industries are not ready to take students. Industry may be given incentive or subsidy from govt to take students.
- ITIs at Tehsils/ group of block level can produce Diploma students in Agri Engg.
- Skill part is weak. Degree programmes may evaluate skills imparted and learnt as is done in UK. Experiential learning is only demonstrative now.
- Electives can provide some functional skills in areas like modeling, GIS, Greenhouse design, Environment Engg, etc. UG course may have 1-2 electives at least.
- Need to offer short term specialised training of 2-3 months to be useful at micro level on the lines of finishing school concept.
- Training, Research and Extension requirement is not allowing specialisaion in SAU system as faculty are moved between units.
- Dual degree programs of 10 semesters may attract some good students.
- Students (BTech/MTech) project thesis should have co- supervisors from industries
- Need more teaching material. Need to promote books & teaching aids.
- Customer hire services to come in future. Rs 10 lakh investment for every 10,000 people – would provide 2 direct jobs and 3 indirect jobs for agri-engineers.

11.6 Conclusions

The requirement of agricultural engineering graduates, post-graduates and doctorates has been projected to grow from about 18,000 in 2009-10 to 28,500 by 2019-20. The current stock from supply of 23,207 is in excess of demand by about 5,200.

The supply of graduates is just sufficient to meet the current requirements. The project forecasts indicate 50 per cent increase in the number of students required by 2020- from about 1500 per year now to about 3200 per year by 2020, i.e., additionally 1,750 graduates (1,140 UG; 450 PG and 160 PhD). The intake capacity is available for about 2500 students. The additional requirement and also creation of new colleges to produce another 1500 graduates by 2020.

Considering the excess stock now (in 2010), the simulation results have shown that demand supply would balance if the future increase in annual supply is limited to 10 per cent in place of 50 per cent seen now. As the intake capacity is already available for about 2,500 students, selective expansion of education is needed to produce another 500 graduates by 2020. The needed requirement can be met by capacity utilization, and to certain extent by expansion of capacity in some existing colleges and also at higher levels. There is need to increase PG/PhD holders by three times (Pg/PhDs of 300 in 2010 to 900 by 2020) so as to meet the national requirement. As human resource development at PhD level is related to research, the academic programs demand strengthening research.

Number of government programmes on agriculture and rural development envisage promotion of farm mechanization and precision agriculture, which requires large number of diploma holders and vocationally trained persons. This needs diploma holders at least in the ratio of three for every graduate, at the minimum. This norm translates to large requirement. This aspect is discussed in detail in chapter on human resource requirement at micro level.

Automation in agriculture can provide boost to the sector and can provide hope for a number of problems in Indian agriculture like small land holdings, low productivity, shortage of labour etc. The need is to identify, adapt, and develop machines and equipments suitable to Indian conditions. This would require quality human resource with specific skills.

Chapter-12

Human Capital Assessment in Agri-Biotechnology Sector

12.1 Introduction

Adam Smith, in his classic 'Wealth of Nations', wrote, "A true wealth of a nation is measured not by how much gold it possesses but by what it can produce". By this yardstick, biotechnology brought an unprecedented global revolution, through which the world's hunger and diseases alike can be mitigated by creating new mechanisms. The Indian Biotechnology industry has an interesting evolution that has spanned over three decades. The milestone of the evolution of biotech industry in India began in 1978, in Bangalore, when the country's first biotech company, Biocon, was established.

In recent past, two major Indian economic sectors, viz. agriculture and industry have been getting exposed to an entirely new set of technologies while using biotechnology tools. This frontier technology becomes important in a developing country like India where agriculture, with stagnating productivity, aims for higher growth. The country needs to prepare itself in terms of appropriate human resource and the state- of –the –art infrastructure. India is one of the first few countries, among the developing countries, to have recognized the importance of biotechnology as a tool to advance growth of agricultural and health sectors as early as in 1980s.

12.2 Supply of Graduates

12.2.1 Development of Biotechnology Education

Biotechnology is a multi- disciplinary area on the educational scene and programs have been developed to meet the growing demand for trained human resources for any meaningful biotechnology activity in the country. Various Indian Universities, like the Jawaharlal Nehru University, Institutes like IITs, and SAUs are offering M.Sc/ M.Tech teaching programs in biotechnology in India with the support of the Department of Biotechnology (DBT). In response to the demand for education in the sector, educational facilities in bio-technology at under-graduate and post-graduate levels mushroomed all over the country over the last decade in the government and non government sector. Most of these courses are run by institutions in the private sector without adequate and appropriate infrastructure, in terms of class-room and laboratory space, equipment, library, adequately qualified teaching staff, etc. leading to decline in quality standards. The expansion in the courses in biotechnology offered by many public and private educational institutions is unrelated to the actual market demand but because of the demand from the society based often on the word in town that biotechnology has a great future. At Post Graduate level, the courses offered by various academic institutions across the country are given in Annexure-12.1.

The rapid growth of biotechnology industry has resulted in students taking up in biotechnology courses from academic institutions. The number of biotechnology graduates in India has gone up from 1,000 in 2003 to over 15,000 in 2009 as reported by

BioSpectrum. Another survey conducted by IIM, Banglore, in 2007 has reported an output of 10,000 students per year at UG, PG and doctoral level from 250 colleges with predicted annual growth rate of 20 percent. There are about 400 educational institutions (100 in public and 300 private) in the country producing 14,000-15,000 students every year.

The contribution of the State Agricultural Universities in biotechnology education is limited. 27 colleges in SAUs are providing education in agri-biotechnology. The year wise intake and outturn in biotechnology courses is given in Annexure-12.2. The intake in 2010 for under-graduate, post-graduate and doctoral programmes are presented in the Table-12.1. In SAUs, the intake at UG level is for BTech (Biotechnology) and at PG level it is for MSc/PhD in plant and animal biotechnology sciences. Where as in affiliated colleges UG refers to BSc (Biotechnology) course and they do not have PG/PhD course. As SAUs are producing about 730 students per year, their share in out turn of bio-technology students in the country is less than 10 per cent.

Table-12.1: SAUs Intake Capacity in Agri-biotechnology at Various Levels in 2010

	UG		PG		PhD		Total	
	Adm	**Pass**	**Adm**	**Pass**	**Adm**	**Pass**	**Adm**	**Pass**
Number of Students	592	558	195	156	35	20	822	734

Expert consensus indicates that there is adequate enrollment currently at the post-graduate and under-graduate levels, however the quality is inconsistent. Areas such as intellectual property rights, regulatory issues and industrial training have received inadequate attention. There is a consensus that there is an urgent need to augment the number of PhD programme in the Life Sciences and biotechnology.

In order to build a successful biotechnology sector, a large talent pool is required in multiple scientific disciplines such as molecular and cell biology, chemistry, physics, engineering, bioinformatics, medicine, agriculture, microbiology, technology transfer & commercialization, bioentreprise & biofinancing and intellectual property rights management. Product and process development are inter-disciplinary in nature and deficiencies in specific areas may weaken the whole sector. Though the Indian industry is strong in product development and marketing for commercial benefits, biotechnology in India still lacks the infrastructure required to take up R&D in areas like molecular modeling, protein engineering, drug designing, immunological studies, preclinical studies, clinical trials, etc.

12.2.2 Areas of Employment in the Biotechnology Sector

India, as an agriculture-dominated economy with a population of above one billion, offers huge market for biotech products. Strengths of Indian biotech industry include a good network of research laboratories, abundant trained human resources and knowledge base, well developed core industries such as pharmaceuticals and agro-products. The placement opportunities are available in contract research, bioinformatics, and local production of biotech products, which are expected to give a major boost to the Indian biotech industry.

The entire chain of operations where qualified bio-technology human resources is needed is shown in the Fig-12.1.

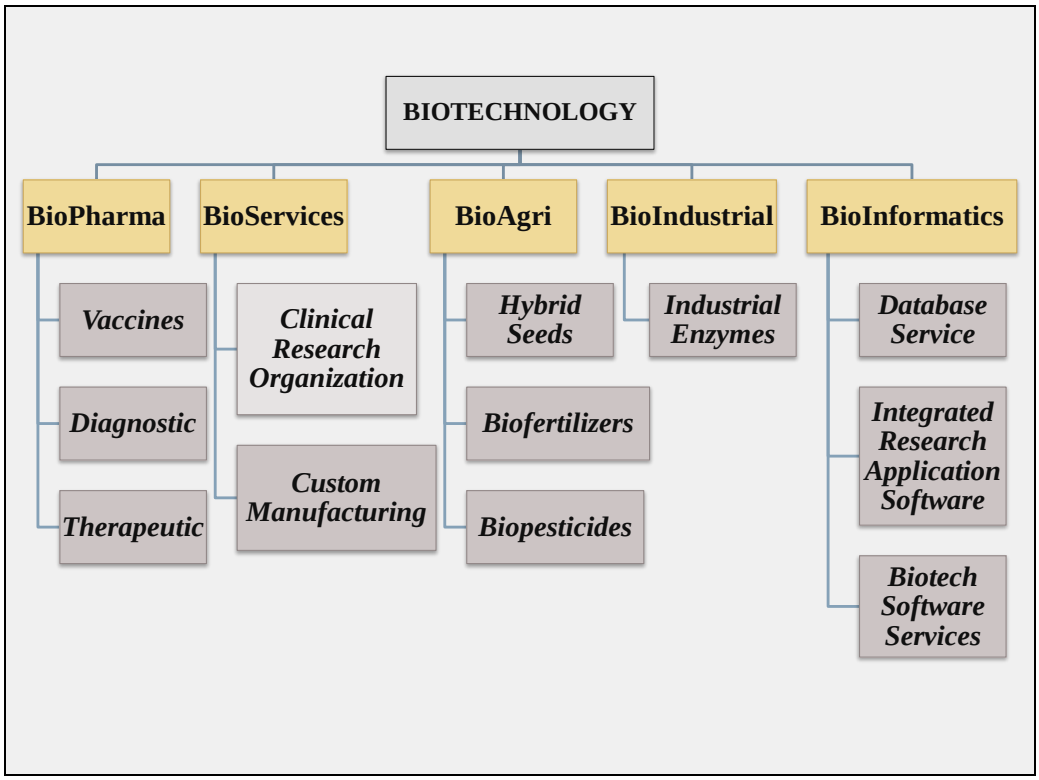

Fig-12.1: Key Segments in Indian Biotechnology Industry

Most of the biotechnologists (PG and above) are employed in research and development in various research institutes and R&D departments of the industries involved in biotechnological work. Laboratories and Institutes employing Biotechnologists include Centre for Cellular and Molecular Biology, National Botanical Institute, National Chemical Laboratory, Tata Energy Research Institute, Central Aromatic Plants Institute, Indian Institute of Science, Indian Agricultural Research Institute, CSIR, National Environment Research Institute, National Institute of Immunology, Central Drug Research Institute, IITs, etc. Some of the important government funded research institutions employ about 324 biotechnology professionals and the institute wise details are given in Annexure-12.3.

Biotechnologists also work extensively in the production departments of the industries. Generally, biotechnology graduates from engineering stream are given preference for production jobs. Some industries employ biotechnologists in their marketing department also to develop business in the sector where their product would be most required. They also help to identify biotechnological development opportunities for the industry. Some of the major companies providing employment to bio-tech professionals are: Hindustan Lever, Thapar group, Indo American Hybrid Seeds, Bincon India Limited, Bivcol, IDPL, Indian Vaccines Corporation, Hindustan Antibiotics, Sun Pharma, Cadila etc. The potential areas for employment in biotechnology sector are: bio-pharmacy, bio-agriculture, bio-industrial, bioinformatics, and bio-services.

The Indian biotech industry employs over 20,000 scientists (Bio-Spectrum survey, 2007). According to the 8th BioSpectrum-ABLE study of Indian Bio-Tech industries, 2010, the industry is growing at a rate of 17 % with revenues of Rs. 6,631 crores.

The western part of the country is the home to top bio-agri companies such as Monsanto, Mahyco and Ajeet Seeds. Nujiveedu Seeds is an important seed industry leader from south India. While the BioSpectrum-ABLE study is not optimistic about the industry going back to the days of heady growth of 30 per cent or more, most industry leaders agree that the industry is maturing and the annual growth is more likely to be around 20 per cent in the near future.

The Indian agriculture-based economy, offers huge potential in commercial research and production and so the technical trained personnel. Genetically modified, cotton has entered the Indian market. Field evaluation of transgenic plants is underway and it is expected that several transgenic crops such as canola, tobacco potato, soybean, squash, and tomato etc is flooded in the Indian market. Several production units have been established in India to manufacture plant tissue cultures. The production of bio-pesticides and bio-fertilizers is on the rise. Agriculture biotechnology, bio-fertilizer, bio-pesticide, bio-resources, plant bio-technology, medicinal and aromatic plants, animal biotechnology, aquaculture & marine biotechnology etc are the main areas where a biotechnologist is required.

Hybrid Seeds: Research to develop new genetically improved (transgenic) seeds and plants such as brassicas, mung bean, and cotton has been successfully done. There are about 450 public and private seeds companies in the country.

Tissue culture: Tissue culture pilot plants (Micro propagation Technology Parks) have been functioning at Pune & Delhi. This technology has been successfully used for mass multiplication of plants for horticulture. Plant tissue culture activities in India have been commercially successful in production of ornamental and flowering plants, which have a large global export market.

Biofertilizers and biopesticides: Development of new types of bio-fertilizer and bio-pesticide formulations, including mycorrhizal fertilizers has been successfully completed in the country.

Veterinary pharmaceuticals: The veterinary pharmaceutical industry with over 150 companies is growing fast to cater to the rapidly increasing domestic market and export demands.

12.2.3 Estimated Stock of Biotechnologists

There is no direct source of data on the number of active biotechnologists in the country. As such, the current stock can only be estimated, (as in the case of other agriculture related disciplines), indirectly by cumulating the outturn of biotechnology graduates, post-graduates

and doctorates over several years (as many as the active working life of a graduate, post-graduate or doctor) and adjust for attrition due to retirement, migration and such causes.

IAMR, in its previous study on agricultural human resources, had estimated the stock of post-graduates in biotechnology, which includes agri. chemicals and microbiology as 1,328 and no estimation was made for doctorates in the year 1990. These stocks were projected to grow to 2,257 by the year 2010 on the basis of projected out-turns from the SAUs during the years 1991 to 2009. No corresponding estimates of graduates were made. In fact, IAMR made no stock estimates for individual faculties at graduate level, but only at higher levels.

An effort was made to estimate the stock of agricultural engineering graduates from annual supply data from different sources (details given separately in Chapter-15). The total stock of graduates and above in agri-biotechnology, estimated from annual supplies, is about 1,697 in 2010.

12.3 Demand Projections

The general approach adopted for human resources projections in different segments of the agri-biotechnology sector is that embodied in Parnes model. The segments considered are a) development, b) research, c) tissue culture, d) seed sector, e) veterinary pharmaceuticals, f) miscellaneous and g) education. The replacement needs are taken as 1 per cent of the previous years' stock and the other details are given in the methodology chapter.

12.3.1 Opportunities for Employment

Opportunities for biotechnology students exist in agri-based industries involved in production of transgenic plants, seed industries, tissue culture units, agri chemicals such as bio-fertilisers and bio-pesticides, environmental amelioration, pharma industries for diagnostics, vaccine, clinical research organizations and bio-informatics industry. Opportunities exist in research and development, production and manufacturing, quality control and analysis, technology transfer and management knowledge-based marketing, setting up of new enterprises, consultancy organizations for preparing of techno- economic feasibility reports. The jobs for marketing are 20 times more in number as compared to R&D as well as more monetarily rewarding. Biotechnology is a knowledge-driven technology, which is influenced by the flow of new ideas and concepts in the development of new tools for research and new processes for manufacturing.

12.3.2 Earlier Studies

According to Bio-spectrum 2007 study, the demand for bio-technologists in 2006-07 was 6,892 in the 280 bio-tech companies in that year, of which about 1,034 (15%) would be in the agri-biotech companies. Growing at a rate of 20 per cent, the demand by the bio-tech industry would reach a level of 74,000 for all bio-technologists and 11,000 for agri-biotechnologists. At a less aggressive growth of 10 per cent per annum, the demand is likely to reach 24,000 for all bio-technologists and 3,600 for agri-biotechnologists, and a medium growth scenario of 15 per cent per annum (which is also the rate predicted by the 8th Bio-Spectrum-ABLE study, 2010) would lead to the most likely demand of 42,000 for all bio-technologists and of 6,400 for agri-biotechnologists by 2019-20 (Annexure-12.4).

12.3.3 Development Sector

The Department of Bio-technology in the Central government is the nodal organization for policy and programme formulation for the development of bio-technology in the country. The department has scientist strength of 56. Bio-technology is still in its nascent stage in the country and even though some States like Gujarat have an aggressive biotechnology missions and policies, there is as yet no corresponding human resources committed to the development of the sector. Whatever human resources are there are a part of the larger departments like departments of agriculture, horticulture, animal husbandry and science and technology in general. Moreover, unlike the departments of agriculture and horticulture or animal husbandry, the scope for permeation of bio-technology to the lower formation of government administration is limited. Hence, while the sector is set to grow rapidly in years to come, human resources allocated to its development and promotion in the Central and State governments taken together, which does not exceed 100 now is not likely to go beyond 200 by 2020. The number of bio-technologists engaged in development of agri- and animal-biotechnology would be still smaller.

Projections of bio-technologists for promotion and development are given at Annexure-12.5. The number of agri-biotechnology post-graduates and doctorates required for development work is projected to go up from 100 in 2010 to 200 by 2020, i.e., about 10 per year during 2010-20.

12.3.4 Research

The autonomous institutions attached to the Department of Bio-technology (such as the National Institute for Plant Genome Research, Institute for Bio-resources & Sustainable Development, National Agri-food Bio-technology Institute, National Centre for Cell Science, Rajiv Gandhi Centre for Bio-technology, etc.) are engaged in a wide range of research activities in bio-technology. Together, they engage a total of 178 scientists and 72 technical staff and 139 research fellows – a total of less than 400, of whom about half may be taken as agriculture related.

The ICAR institutes have a sanctioned strength of 183 bio-technology scientists – 74 in animal bio-technology and 109 in plant bio-technology. Allowing for some research activity in other government and private institutions, the total number of research staff in the field of agricultural is not likely to exceed 700 (of whom agri-biotech may be 300) in 2009-10 and is not likely to go beyond 1500 (of whom agri-biotechnology may claim 500) on a very optimistic forecast. (There will be many bio-technologists engaged in tissue culture and seed and pharmaceutical research and animal breeding, but they will be covered separately).

Projections of Agri-biotechnologists for various years have been given in Annexure-12.6. The projected stock demand for 2020 is 500, which would increase from 300 in 2009-10. The annual net addition of agri-biotechnologists to the stock is about 20 per annum.

12.3.5 Tissue Culture

The Indian micro propagation industry (Tissue Culture) is just two decade old. The constitution of Department of Biotechnology (DBT) and the subsequent ‘Hi-Tech industry’

technology adapted in plant tissue culture encouraged several corporate houses to venture into this area on commercial scale.

The demand for tissue cultured plantlets is growing rapidly. India, with its low cost skilled labour as well as scientific human resources (both of which are essential for tissue culture) has a natural advantage. Additional favourable factors are the wide range of plant biodiversity in the country and favorable tropical climate (which enables greenhouses with low energy consumption). The total expenditure made by the DBT during the last plan period is shown in Annexure-12.7.

Till date about 45 commercial tissue culture production units (Annexure-12.8**)** have been recognized by the Department of Biotechnology (DBT), Govt. of India under the National Certification System for Tissue Culture Raised Plants (NCS-TCP). Most of the tissue culture units are located in Maharashtra, Andhra Pradesh, Karnataka and Kerala. These companies have been so far largely concentrating on exploiting the international markets and are facing a number of constraints such as short shelf life, stringent quality requirements and uncertainty of rejection of consignments etc.

As projected by the XI Plan Working Group on Horticulture, the demand for Tissue culture Plants (TCP) is likely to increase from 72 million plants in 2003-04 to 112 million in 2007-08 and 220 million plants in 2011-12. This implies a 15 per cent annual growth in the number of TCP plants likely to be demanded and also the number of units producing these plants. Two growth scenarios have been assumed – one with a high 15 per cent growth as projected by the Working Group and the other with a lower growth trajectory at 10 per cent per annum. On this basis, the demand per plants and the number of units have been projected as follows under the two growth scenarios (Annexure-12.9) and are summarized in Table-12.2.

Based on the establishment survey conducted by IAMR, the requirement of agriculture biotechnologist in a tissue culture unit was found to be about four personnel per unit on an average i.e. one post graduate/graduate and at least three diploma holders on an average. Therefore, the year wise projected employment growth by educational qualification in TCP units under low and high growth scenarios are shown in Annexure-12.10.

Table-12.2: Requirement of Biotechnology Personnel in TCP Units

Year	**Demand for biotechnologists**		
	Diploma	Graduate and above	Total
2003-04	84	28	112
2007-08	135	45	180
2009-10	180	60	240
2019-20 (High)	728	243	971
2019-20 (Low)	467	156	623

Thus, the requirement of short term certificate/diploma holders has been projected to grow from 180 in 2009-10 to 467 by 2020. The demand for professionally trained graduate and above biotech professionals has been projected to grow from 60 in 2009-10 to 200 by 2020. Thus the annual net addition to the stock is about 15 per annum. Detailed projections are given in Annexure-12.10.

12.3.6 Seed Sector

Indian seed sector has over 3,800 varieties and hybrids of different crops suitable for varied agro-climatic conditions registered in National catalogue, 108 Notified Seed Testing Laboratories with well established Seed Regulatory & Legislative frame works and Proactive Government Policies and Programmes. Seed sector, in both public and private sectors, are working in harmony and showed considerable growth from about 5.7 million quintals in 1991 to about 21.5 million quintals in 2009 meeting the requirement (Agriculture situation in India, 2009). Though public sector produces bulk of seed of varieties and self pollinated crops, private sector is engaged in hybrid seeds and it too is playing a major role in producing large volumes of certified seeds of varieties for crops such as paddy, soybean, jute and hybrids of jowar, maize and bajra. Share of public and private sectors contribution is approximately 30 per cent & 70 per cent, respectively in terms of market turnover. Indian seed industry was about 900 million US dollars in 2002 (2% share out of global market of 25 Billion dollars) and it grew to about 1500 million US dollars in 2009. The current turnover of Indian Seed Industry is Rs 12,000 crores which is likely to touch Rs 15000 crores by 2015. Global seed business is likely to reach to 75 billion dollars by 2020.

Apart from the National Seeds Corporation, State Farms Corporation of India, State seed corporations and other institutions in the public sector, there are about 400 to 500 private sector establishments (according to the website http/seednet.in) in the field of seed production. Of these, 12 are mega units (turnover of Rs. 300 crores or more), 15 are large (turnover Rs. 100 to 300 crores) and 75 are medium (turnover between Rs. 15 to 100 crores) and the others are small. Information provided by the seed industry association indicated that while the small plants do not engage any research staff, a mega plant needs 50 R& D personnel (10 Ph.D, 15 M.Sc. and 25 B.Sc.), a large plant 30 (3 Ph.D., 7 M.Sc. and 20 B.Sc.) and a medium plant 5 (2 Ph.D, 2 M.Sc. and 1 B.Sc.). Thus, the total R&D requirement of the seed sector in 2009-10 would be 1500. This comprises bio-technologists as well as agricultural scientists. Assuming that the two groups are equally represented, the number of bio-technologists in seed R&D in 2009-10 may be taken as about 750. Similar exercise for the Quality Control activities of the seed sector leads to a current requirement of 1050 biotechnologists of various levels in 2009-10.

The seed sector has been growing in recent years to 12 to 15 per cent per year. Discussions with major players in the sector indicated that the sector is poised for a rapid growth of around 15 per cent in future too. However, employment may not increase at the same rate due to factors like mergers of companies and automation. Two scenarios have therefore been assumed, a high scenario with 10 per cent growth in employment and a low scenario with a growth of 5 per cent per annum. Based on these assumptions, the demand for biotechnologists has been projected as shown in Annexure-12.11 and summary results are shown in Table-12.3.

Table-12.3: **Number of Biotechnologists Likely to be Required by the Seed Sector**

Year	Demand for biotechnologists				
	Diploma	Graduate	Post-graduate	Doctorate	Total
2009-10	175	790	560	275	1800
2019-20 (Low)	285	1287	912	447	2931
2019-20 (High)	454	2049	1452	712	4667

The stock requirement of human capital requirements for the seed sector would grow from 1800 in 2009-10 to about 4300 by 2020, i.e. about 250 per annum during the period 2010-20.

12.3.7 Veterinary Pharmaceutical Sector

The veterinary pharma industry is another important area requiring veterinary bio-technologists. Veterinary pharmaceuticals include formulations, production of drugs, feed supplements, mineral mixtures and allied products, vaccines, therapeutics, and diagnostics as well as animal health related equipment. Animal biotechnology is the application of scientific and engineering principles to the processing or production of materials by animals. The use of biotechnology in animal sciences is in the areas of artificial insemination, embryo transfer, ovum pick up (OPU), and in Vito maturation and fertilizations, diagnostics and veterinary medicines. Realizing the great potential of biotechnology in rapid improvement of animal health and production, the National Biotechnology Centre (NBC) was established at IVRI during VII plan by ICAR in collaboration with Department of Biotechnology, Govt. of India in the year 1986 with the emphasis on post-graduate education and training in biotechnology and conducting research in identified areas of immune-biotechnology. Later, the NBC was identified as Centre of Excellence in Veterinary Biotechnology by ICAR under the National Agriculture Technology Programme (NATP) funded by World Bank.

Driven by growing demand for dairy products and healthy animal food and poultry products, increasing pet care, emergence of new diseases, changes in animal production practices, new product introductions and ongoing food safety concerns, the industry's prospects are indeed bright. A new emerging opportunity is to tap the growing export market for veterinary bulk drugs.

Presently, over 150 companies are engaged in the production of veterinary Pharma products (Indian Dairy.com,health care and Vet Pharma) in the country. Zydus Cadila, Alembic, Vetnex, Virbac Animal Health India, Intas Pharmaceuticals, Intervet India, Concept Pharmaceuticals and Wockhardt are some of the major players in India who have stakes in the animal healthcare market. Their global counterparts include Pfizer, Merial, Schering Plough, DSM Nutritional Products, BASF Animal Nutrition, Bayer Animal Health, Elanco, Novartis and Ceva Sante.

The industry pharmaceutical industry as a whole registered 14.25 per cent growth in 2008-09 and the segment still is the single largest contributor (65%) to the Indian biotech industry (Indian Pharmaceutical Association, Vol47,2010). The total Bio-pharma industry grew from Rs. 69 billion in 2007-08 to Rs. 79 billion in 2008-09. **The size of the animal health care market is estimated to be about Rs. 16 billion, and is growing at a steady rate of 5 to 6 per cent per annum.**

The establishment survey of IAMR indicated that average number of biotech professional in each pharmaceutical company is 3, and all of them are graduate and above. The 150 companies, thus, employed about 450 biotechnologists in 2009-10. With a growth rate of 5 per cent per annum, the number is expected to increase to 730 by 2019-20. On the other hand with a higher growth rate of 10 per cent, the requirement can touch 1,170 by that year.

Detailed projections are given in Annexure-12.12. The average stock of 450 in 2010 would grow to 950 in 2020, i.e. about 50 per annum during 2010-20.

12.3.8 Academic Sector

The total staff sanctioned for teaching biotechnology discipline (21 SAUs), in 2009-10 has been estimated at about 400, of which 50 per cent is found vacant (Data was available only for 4 SAUs indicating 78 sanctioned teaching faculty). On pro rata basis, the existing staff strength for 21 SAUs is estimated around 200. Projection for the future years have been worked out assuming that the current vacancies will be filled to meet the requirement of the bio-tech personnel and the requirement would grow at the same rate as the outturn of the biotechnology graduates and above.

The projected stock demand for academic sector for 2020 is 400, which would increase from 200 in 2009-10. The annual requirement of teachers in academic sector is about 20 per annum.

12.3.9 Others

The requirements of bio-technologists in the sectors covered above have been inflated by 10 per cent to take care of any other sectors (other than education) not specifically covered.

12.4 Summary of Demand Projections

The projections of stocks of agri- and vet-bio-technology human resources required to meet he various segments of the economy and the consequent flows required from the educational system are summarized below:

12.4.1 Comparison of Stock Requirements

As mentioned earlier, the stock requirements of the industrial sector have been obtained in two different ways; a) based on the overall growth rate in the demand and b) on the basis of demand in three specific segments, viz. tissue culture, seed sector and veterinary pharmaceuticals. Table-12.4 presents a comparative picture of the demand projections arrived at in these two ways.

Table-12.4: Biotech Personnel Requirements by Sub-sectors and Trend Based

Year	Sub Sector Wise Requirements				Requirement on basis of overall trend Based
	TCP	Seed	Vet. Pharma Companies	Total	
2009-10	240	1,800	450	2,490	1,573
2014-15	435	2,597	650	3,682	3,163
2019-20	797	3,799	950	5,546	6,362

It may be seen that the trend based projections start lower than aggregated segment-wise projections but end up being higher in 2019-20.

12.4.2 Stock Projections

The overall stocks of agricultural biotechnology human resources required to meet the requirements of various segments of biotechnology have been added up to give projections for various years up to 2019-20. Two sets of projections have been worked out as explained in the segment-level projections – one a high projection and the other a low projection. An average of these two estimations is presented in Annexure-12.13. Summary results for average scenario are presented in Table-12.5.

Table-12.5: Overall Projections of Requirements Stocks of Biotechnologists (Average)

Year	Diploma	UG	PG	PhD	UG & above
2009-10	391	1150	887	951	2988
2019-20	1064	2467	1879	1862	6208

Thus, taking the average of the high and low projections, the total stock of agri-biotech human resources is projected to grow from 3000 in 2009-10 to 6200 by 2019-20. The number of graduates are expected to more than double in the next ten years.

12.4.3 Demand-Supply Gap in Stock

In 2010, the actual stock from supply is 1,697. Assuming the outturn levels will grow at the same growth rate as observed during the last five years (i.e., 25 per cent during 2006-10), the supply in 2020 would grow to 13,383. The estimated demand of 6,208 would be met by increasing the out turn by about 20 per cent per annum.

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12.4.4 Flow Projections

The corresponding annual outputs required from the educational system to lead to the above three scenarios of high, low and average scenario are presented in Annexure-12.14. The annual flow demand for the average scenario is presented in Fig-12.2.

The projections suggest that by 2020, the annual outturn required in the agricultural biotechnology should be about 580 under-graduates, 320 post-graduates and 130 doctorates, rising from 560 under-graduates, 150 post-graduates and 20 doctorates in 2009-10.

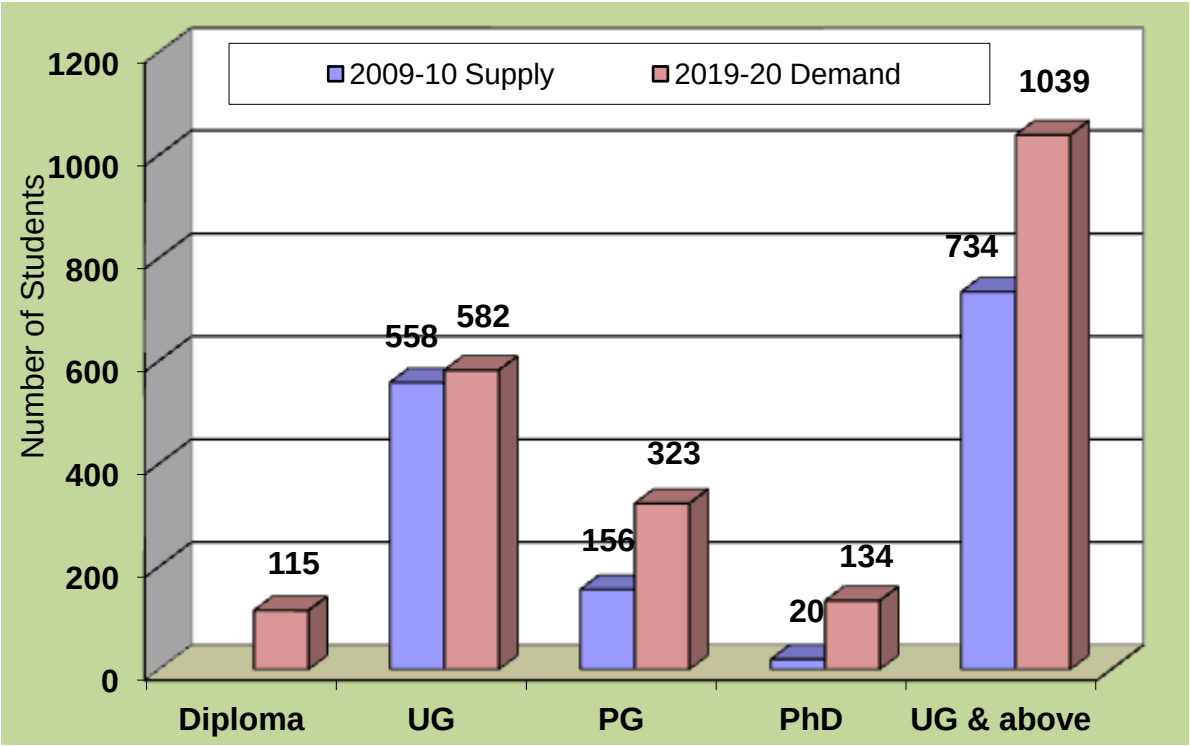

Fig-12.2: Current (2010) and Projected Outturn Required (2020) in Agri-biotechnology

12.5 Institutional Mechanisms and Skill Needs-Experts' Views

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- Agri. Biotechnology Sector (ABT) is about two decades old and is relatively late starter in India with about 30 per cent share in total BT industry in the country, balance 70 per cent being medical and pharmaceutical areas. India is ranked among the top 12 biotech destinations in the world and the Indian biotech sector is the third largest in the Asian region. The biotechnology sector in India is growing rapidly at a rate of over 40 percent annually. Biotech industries have not made profit in the past two decades and they started showing profits in the last 2-3 years only. This is largely influenced by mergers and acquisitions. Although, the industry has began maturing the number of units is going down.
- **There is high social craze for biotechnology courses, and hence, there is a mushrooming growth of colleges providing courses in bio-technology sector especially at post-graduate level. As a result of this mushrooming, the quality of education has gone down.**
- In developed countries, due to more automation, bio-technology related analysis is cheaper as compared to India. Multi-national companies, therefore, look to imported research and do not employ many bio-technology scientists locally.
- Globally, Biotechnology industry is capital intensive, with about $500 billion investment and 178000 employees (E&Y report, 2005), the capital per employee is of about 1.5 crore rupees which is very high. Thus, potential for high level employment is limited. The number required at higher level (PhD) is limited to academics and research. Majority of the professionals get employment in ICAR and CSIR institutes. The R&D activities in biotechnology are confined to only a few public sector organizations and even very few

private companies have own research wings in BT area as most companies import technologies from overseas.

- **It has been observed that tissue culture has the potential in the future but at the same time this sub sector need only trained certificate and diploma holders. Generally in one tissue culture industry unit there is one graduate or post-graduate and others are certificate/diploma holders or informally trained persons.**
- Agriculture biotech is the next niche industry. There are lessons to learn from IT growth promoted by government policies and support. Government should provide similar package, programmes, subsidies and incentives to Agri biotech sector.
- **There is limited scope for Agriculture biotechnology. However, there is more potential in veterinary biotechnology as it is similar to human medicine like drugs and vaccine development.** The major demand areas in Biotechnology are: Molecular biology, Microbiology, Immunology, Genomic science, Tissue culture, organic chemistry, Bio informatics, Bio processing, and chemical processing etc.
- Most of the private companies have no strong R&D. Very few numbers of PhDs are needed in research and there should be more emphasis on diploma courses on biotechnology in the country and these courses have to be carefully watched for their course contents, practical aspects, etc.
- The private BT companies do not need high level BT students. More job opportunities are at lower and middle levels, i.e. for technicians in areas like Tissue culture, Vaccine development, bio-fertilizers, etc. Such requirements can be met through certificate training with syllabus based on industrial requirements and expert's opinion.
- The course curriculum should include industry orientation-internship-short term training and colleges without any laboratory should be discouraged to offer courses in the sector. Role of academic institutes is for creation of skilled human resources, conduct innovative research, and have strong industry interaction. **Public Private Partnership is necessary to improve the quality of the education.**
- Biotech companies generally pick up bioscience students to deploy them in quality control work; molecular biology, microbiology and biochemistry students for R&D activities. Biotechnology professionals are preferred for genomic type work. Seed industry uses bioscience students in core research labs. Such students should have knowledge of practical aspects such as plant breeding, etc.
- It has been stated that there is dearth of trained good quality teachers. Need has become more intense due to mushrooming of private colleges. Special training programmes should be organized for updating the knowledge of teachers.
- Many a times non-agri professionals are performing better than agri professionals because of attitudinal problems. Agri-graduates do not want to work on fields and try to leave as early as possible. It is also easier to train non-agri. students as in case of agri-students, industries have to make them unlearn the previous learning and train them according to the industry's needs as a second step.
- Indian Seed sector is of about Rs 8500 crore and is now growing @15 per cent p.a. International seed business is about 42 $billion and is growing @ 7-8 per cent p.a. MNCs are at least two decades ahead to us on seed biotech research and it needs massive effort from both public and private systems in the country to catch up. We need to have our own approach and may pool resources to speed up the process. ICAR need to have serious thought on this as it is common challenge to all.
- All private R&D laboratories register with DSIR in DST. ICAR may also do it for agriculture's R&D work. This is one way of getting to work with private sector.

- Top 6-7 seed companies only have biotechnology labs. In the BT area, seed companies need hard core basic scientists like microbiologists, molecular biologists from general universities for basic lab based work. Agri-biotechnologists along with breeders are employed in field based R&D work.
- The seed companies have problem with agri-graduates in many states as they are not inclined to work in private sector, irrespective of place of work and salary and their preference is always for government job. But the experience from some states like Gujarat and Maharashtra is different as students from rural back grounds are performing better.
- Industries find diploma students either as good as UGs or better in some cases. They are satisfied with the diploma students and most of them are invariably from rural back ground and they are comfortable in working with the farmers. Some industries employ general graduates with rural back ground and train them on job.
- Girls are not taken for fieled jobs in industry and most girls are in seed testing lab, BT lab and office.
- Government should organize programmes, subsidies and incentives to Agri biotech sector similar to that provided to IT. Establishment of Biotech parks, high quality academic and research centres, schools to provide industry based training PPP mode are some such initiatives.

12.6 Conclusions

The total stock of agri-biotech manpower is projected to grow from 3,000 in 2009-10 to 6,200 by 2019-20. The stock of graduates is expected to double in the next ten years. The annual supply of graduates would have to increase from current 730 to about 1,040 by 2020, i.e., additionally 280 graduates (170 PG and 110 PhD).

The supply of PG and PhD holders is a concern. Employers are not happy with the quality of graduates. Besides, the current annual supply of 156 PGs and 20 PhDs is too low compared to requirement of 320 PGs and 130 PhDs by 2020. Emphasis be given to expand PG and PhD courses. This in turn would strengthen research and academic sectors. Moreover, ICAR also need to have a long term strategy to develop strong R&D progamme in partnership with industry so as to meet global challenges.

No expansion is projected at UG level. In fact, there is need for review of UG education in this area. Various national S&T bodies and eminent biotech educationists strongly recommend not offering biotechnology at under-graduate level.

However, at lower level, there is an urgent need to have large number of finishing schools to provide skills in areas like tissue culture, micro-propagation techniques and other such areas to attract rural youth, particularly women, to have establish enterprises. Both academic and research institutions can be mandated to develop such entrepreneurs and also provide technical support in the initial stages of enterprise development. This can be best served through a separate national scheme with priority funding to establish such enterprises.

ICAR may have a window to register and promote R&D in agri-biotech sector. This will serve the twin purpose of industry-academia interface as well as collaboration in research and development efforts. This would also pave way to have a long term strategy to develop strong R&D progamme in partnership with industry so as to meet global challenges.

Chapter-13

Opinions Reflected by Stakeholders on Agriculture Issues (Survey Results)

13.1 Introduction

As mentioned in the project methodology, execution of the Project began with a massive data collection effort to develop a basis for estimation of agricultural human resources. The data collected included both quantitative and qualitative. The targeted respondents had been agricultural establishments, individual agricultural graduates in such establishments, and agricultural graduates in recent years.

13.2.1 Coverage

Attempts have been made to give a wide coverage to all types of categories and stakeholders during survey. The individual experts have been covered from State Agricultural Universities, ICAR institutions, government departments as well as other establishments in public and private sectors. 4881 experts functioning in various disciplines like agriculture, dairy technology, food technology, animal husbandry, veterinary science, horticulture, etc. have been covered.

Education-wise coverage shows that about 45 per cent of the experts had been with doctorate degrees, while 23 per cent were under-graduates, 25 per cent were post-graduates and 7 per cent diploma holders. A good coverage has been given to women (18%) functioning in various disciplines. Coverage of individual experts is from all the social categories of the population.

In tracers' study, alumni are from various agricultural universities and colleges graduates during 2005 to 2010. About 6000 alumni were approached and 2100 have responded, which includes under-graduates (45 per cent), post-graduates (32 per cent), doctorates (18 per cent) and 5 per cent diploma holders. These graduates belong to various disciplines of agriculture with fair representation by gender and rural / urban background.

3439 establishments engaged in agriculture, dairy, food processing, bio-technology, financial institutions, etc. have been covered. About half of the establishments had been in public sector while the rest are in private sector, cooperative and self-employed. Location-wise, 56.2 per cent are in rural areas and 43.8 per cent in urban areas. The establishments have been covered from all the states of the country.

Summary tables pertaining to results of individual, tracer and establishment surveys are presented separately as Annexures in Chapter-18.

13.2 Major Results

13.2.1 Survey of Experts employed in agriculture and allied sectors

- More than 90 per cent of respondents reported that they got employment within six months of their graduation. This phenomenon has been observed in all major disciplines covered under the study.

- On reasons for opting agriculture as their area of study, about 40 per cent respondents indicated that they joined the course because of their interest in the subject. Rest of the respondents gave various other reasons such as best suited to their qualifications, family pressure, etc.

- Discipline-wise analysis provides interesting results. Three-fourth of the respondents from the bio-technology discipline indicated that they studied the subject because of their interest (71 per cent) followed by forestry (61 per cent), and food technology (56 per cent).

- Employees from diary technology and veterinary and animal husbandry thought that these sectors have more employment opportunities.

- On the adequacy of education in agriculture and allied sectors, only 40 per cent respondents felt that education was fully adequate. Rests were of the view that the education was partially adequate (52 per cent) or not at all adequate (7 per cent). The respondents from universities and colleges were of the view that education imparted was adequate, while those from other organizations have slightly different option. Discipline-wise analysis indicates that in almost all the disciplines, experts felt that some modifications were needed to make students more employable.

- On the curriculum, between 82 to 90 per cent were of the view that syllabus need to include advance theories and current knowledge of the subject, more practical skills with practical oriented syllabus, better and continuous industry interactions, managerial skills as well as a course on information technology. There was a feeling that courses in agriculture and allied fields should also be linked with agri-business courses. An indicative list of courses suggested by the experts which may have better employment potential are given in the end of this chapter. It may be mentioned that some of these courses are already available in the educational institutions but they need to be imparted with a more practical orientation and functional skills in specific disciplines.

13.2.2 Results of Tracers' Studies

- The alumni survey shows that 59 per cent of the respondents were employed in salaried jobs, 38 per cent were pursuing higher studies and the rest three per cent were looking for a job. This indicates that unemployment among graduates is generally negligible now and there is a demand for agricultural graduates. Discussions organized at various places revealed that there was good job demand for students from agriculture and allied sectors and unemployment in this sector is low, although

some of the students were employed private industry at low initial emoluments. That was one of the reasons why they always looked for getting a better employment, particularly in nationalised banks or government. Because of this, there was high employee turnover in industry.

- Discipline-wise, some variations in the pattern of activity status can be observed. In Animal and Veterinary Science and Forestry Sector, about three-fourths of the respondents were employed in organized sectors. Unemployment was relatively more (5.8%) among agri-bio-technology graduates.

- Differences in the pattern of activity status between two genders have also been observed; a greater proportion of female graduates (47.4%) go in for higher studies than males (34.5%). Correspondingly, more of men (62.9%) were in salaried employment than women (48.9%). Females also had a slightly higher percentage in the unemployed group. In-depth discussions with respondents' indicated that female graduates have a number of constraints in taking up jobs at places, especially when they are supposed to work outside their native place. Many a time their parents do not allow them to go out for work and salaried jobs are not as per their job aspirations. During the Focus Group Discussions, it was also stated by the industry representatives that women graduates are employed by them for desk and research work only and they prefer males for field work. The fact that a greater proportion of females pursued higher studies than men could be due to these factors as well as their preferences for jobs in government institutions.

- It has been observed that the alumni in salaried employment rising gradually with their exposure to the labour market. For example, while only 30 per cent of those who passed in 2010 were in salaried jobs as against 81 per cent passed in 2005. Correspondingly, the proportion of those pursuing higher education gradually increased from 17 per cent in the case of 2005 alumni to 66 per cent in the case of 2010 alumni. Overall unemployment rate is low; 4 to 5 per cent for recent alumni and 2 to 3 per cent for those with some exposure to labour market.

  The above results show that probably students take some time to settle down in their careers after passing out. The results also call for a re-look at the education at graduation level as a substantial proportion of graduates pursue higher education before settling in a job. The first degree education should be made comprehensive and complete enough to make the alumni ready for the labour market in all respects, including soft-skills. An important result thrown up by the data is that self-employment is virtually a non-option for graduates with less than half a per cent going for their own ventures. There is a need to identify sector-specific self-employment ventures in demand and programmes should be designed accordingly for motivating and training of students to go for entrepreneurship.

- Data indicate the activity status of respondents by their educational level. Graduates in salaried employment and those pursuing higher studies are roughly in the ratio of 2:1, indicating that about 40 per cent of the graduates go for post-graduation, while the remaining take up jobs. At post-graduate level this ratio changed to 1:1 which shows that after completing post-graduation about half of the students go for employment while the rest go for higher education. At doctoral level about 70 per

cent are in salaried employment and others are in temporary research jobs or waiting for a job.

- Information about current status of respondents indicates substantial regional variations. It has been observed that in certain States the proportion of alumni in salaried employment was very high. For example, in the States of Bihar, Haryana, Gujarat, Kerala, Rajasthan and Uttarakhand, more than 80 per cent of the respondents were in salaried employed. The percentage of respondents pursuing higher studies was more in the States of Jammu & Kashmir, Jharkhand and Orissa (more than 60 per cent). Unemployment appears to be more in Jharkhand, Madhya Pradesh and in the North-eastern States, being over 5 per cent. Jharkhand, in particular, had the highest proportion of unemployed at 17 per cent.

- There is mixed reaction on graduates' perceptions towards the quality of education. About one-third of the alumni did not respond to this query. About 40 per cent of the respondents felt that the education was either partly adequate or not adequate. Inadequacy of education was reported more in courses like agricultural engineering, animal and veterinary science, forestry and horticulture courses. On further probe, it was observed by the students that the education system needed to be employment oriented and it should focus upon skill building besides enhancing the knowledge base. These results agree with the result of the establishment survey and discussions with the industry circles.

- The responses of the alumni in regard to their future plans show their aspirations. About one-third of the alumni would like to go in for research and one-fourth for teaching. These two sectors along with government jobs together were the preferred areas for about three-fourth of the alumni. It is also interesting to find that about 18 per cent of the alumni were desirous of taking up self-employment in bio-technology, bio-farm and seed sectors, but after some work experience.

13.2.3 Results of Establishment Survey

- The 3,439 establishments covered employed, on an average, 65 persons per establishment. Among the establishments engaged in different activities related to agriculture and allied sciences, those in dairying had the largest number employed (118 per establishment). Financial establishments have much higher average (418 per establishment) as the banks provided data at national level.

- The bulk of the employment (94.5 per cent) comprised male employees. The percentage of women remained low in almost all the sectors. This indicates the occupational segregation of labour market.

- Establishments were asked to indicate the growth in their employment over the previous five years, i.e., from 2004-05 to 2008-09. Data shows the pattern of change in employment. Not all establishments provided the data for all the five years. For validity of comparison, therefore, only those establishments which reported data for all the five years (715 establishments in all) have been taken into account. It is seen that the total employment has increased at a compound annual growth rate of 13.8 per cent per annum over the five year period.

- Data indicates the distribution of employees by educational qualifications and gender. Among all employees, about three-fourths were with general qualifications and remaining one-fourth were with some qualifications in agriculture and related fields. The latter is made up of 12.6 per cent under-graduates, 3.2 per cent post-graduates, 1.4 per cent doctorates and the rest 9.1 per cent being below under-graduate level. The results show that even establishments that are solely involved with agriculture and allied activities employ persons with non-agricultural qualified persons to a significant extent. Although it is mainly due to the fact that every establishment engages non-professional personnel for various activities such as administrative, financial, etc., it is also probably due to shortage of agriculturally qualified personnel, their high turn-over and high remuneration demanded by them. This phenomenon was brought out prominently during Focus Group Discussions. It may also be noted that a substantial percentage (14 per cent) was with informal training and diploma holders, indicating the demand for para professionals. Highly qualified (past-graduates and doctorates) are preferred for research and they are less likely to be hired by establishments for field or general work. It is significant to note that a larger proportion of women employees have professional qualifications in comparison to their male counterparts.

- Data on distribution of employees engaged in various types of major activities by their disciplines, indicates that, in the establishments covered, about 29 per cent were under-graduate and above in agriculture, 12 per cent in animal and veterinary sciences, 8 per cent in horticulture, and 5 per cent in agricultural engineering. Other disciplines in specific agricultural sciences like fisheries, dairy science, forestry, bio-technology had a share of less than 5 per cent each. Going by the major field of activity of the establishment, it is seen that the discipline of agricultural sciences features prominently in all activities, with the exception of animal sciences and dairy-related activities, whereas other disciplines are generally concentrated in areas specific to them. In establishments engaged in horticultural activities, however, 37 per cent of the graduates and above were in the discipline of agricultural sciences, while the horticulture accounted for only 27 per cent. Horticulture as a discipline gained popularity and has expanded in recent years only. In the past, agricultural scientists were engaged in jobs for horticulture scientists.

- Establishments indicated their human resources requirements for 2020. 1700 out of 3439 establishments provided this information. It is seen that the total employment of graduates and above in agricultural and allied sciences, as envisaged by the 1,700 reporting employers, is likely to increase from about 42,000 in 2009 to about 45,000 by 2020 or by just 7 per cent over the entire period of about 10 years. The rate of growth seems to be low, considering the growth in total employment (of all graduates in all disciplines) had been of the order of 14 per cent per annum during the previous five years. It may be mentioned here that establishments especially in private sector were reluctant to disclose their expansion plans and future requirements. In the government sector, due to governments' policies, the establishments did not foresee much growth even if there is a need for human resources.

- Data provides information about vacancies arising due to retirements, transfers, expansion, etc. and the extent to which they were filled. It is seen that generally about 10 to 20per cent of the total number of positions in establishments appear to fall

vacant each year and about 50 per cent vacancies remain unfilled in that year. In general, there is delay in filling vacancies.

- Establishments indicated their expansion plans and other changes envisaged in their respective organizations. A great majority of the establishments (85%) indicated that they would expand the organizations, diversify products, introduce technological changes and modernize the organizations. Activity-wise analysis shows that while agriculture related organizations are more likely to change, forestry related establishments are least likely to change. It may be noted that most of the forestry related establishments are government organizations. It is also pertinent to mention that technological change and organizational modernization generally comprise the more likely scenario from expansion and product diversification. This is indicative of skilled human resources requirements in future.

- Establishments expressed concern on the skill gaps they noticed among the agricultural graduates available from the market. Out of 3,439 organizations, about 75 per cent reported skill gaps at graduates level and about 70 per cent at post-graduate level. They were of the opinion that to meet the industries' requirements students should have more advanced theoretical as well as technical knowledge with practical orientation. This requires more interaction between educational institutions and industries. Many also opined that students should have managerial and information technology skills.

13.3 Emerging Skill Needs

Survey as well as focus group discussions indicate the need for specific skill up gradation as well as development of functional skills in agriculture and allied sectors. Discussions show that there is a need to upgrade the traditional skills and provide training in new emerging fields. Sector specific skill needs have also been discussed in respective chapters. Here an indicative list of skill development needs across the sectors that has been summarized form discussions is given below:

13.3.1 Skills Needed Across the Sectors

- Financial Management
- E-Marketing
- Soft skills such as communication, team dynamics, leadership, self- confidence etc.
- Information Technology
- Remote Sensing
- Nano- technology
- Entrepreneurial and managerial skills
- Continuous Knowledge enhancement
- Training in new technologies
- Hands-on Skills (Practical Orientation)

13.3.2 Sector-wise Skill Development Needs

13.3.2.1 Agriculture Crop Sector

- Disease and pest control
- Soil health testing
- Quality control
- Organic Farming
- Knowledge on high yielding varities
- Green house technology
- Irrigation, fertilizer technology
- Maintenance of Machine /tools
- Soil and water conservation
- Grading/Testing of produce
- Fodder development
- Commercial farming
- Value addition of Agri. Produce
- Wasteland development
- Agri. Marketing
- Agri. Clinic
- Food Processing
- Seed identification, grading and management

13.3.2.2 Horticulture Sector

- Nursery management
- Green house technology
- Disease and pest control

- Packing technology
- Biotech and tissue culture
- Drip irrigation
- Grading of produce
- Testing of produce
- Repair of machine
- Organic farming
- Soil testing
- Grafting
- Fruit processing
- Diversification of cropping
- Pre-& Post-harvest management
- Marketing of horticulture produce
- Raising of tray nursery
- High density planting
- Precision farming and high technology horticulture
- Fruit and vegetable preservation techniques
- Floriculture and sericulture
- Medicinal and aromatic plants and their processing and packaging

Floriculture

India targeted an annual turnover of $ 1 billion in terms of exports from flowers. There is upsurge of floral arrangement in the Indian market as well. To meet the needs of the industry specific skills in flower growing, maintenance and flower arrangements needed. It also provides opportunities for self employment.

13.3.3 Forestry Sector

- Management of forest produce
- Remote sensing
- Identification of forest tree and species
- Conservation of plant
- Afforestation of waste land
- Processing of minor forest produce
- Eco-tourism and Agro-tourism
- Training of village level carpenters
- Maintenance of seed orchards
- Collection of seeds
- Processing of seeds
- Training of forest tree breeders
- Saw mill maintenance
- Land scape gardening
- Managing forest service centres

13.3.2.4 Veterinary and Animal Husbandry Sector

- Artificial insemination
- Live stock production and management
- Poultry production and management
- Preparation and preservation of milk products
- Animal health and nutrition
- Embryo development
- Goat rearing

- Marketing skills
- Hygiene and safety
- Fodder Development
- Animal breeding
- Processed foods

Food Processing- The Sunrise Industry

100% FDI is allowed in the industry. The industry is expected to grow to US $ 280 billion by2015 and generate large scale employment. It is looking for links between farms and factories. Entrepreneurial skills specially in rural population needed (TOI, March 26, 2011).

13.3.3.5 Fishery Sector

- Fish feed
- Fish pathology
- Latest technologies
- Fish Development and handling
- Eco system approach and modelling
- Fish processing and packaging
- Hygiene and safety
- Knowledge of ornamental fish and their development

13.3.3.6 Agriculture Engineering

- Development of appropriate tools and equipments suiting to Indian scenario, small and marginal farmers etc.
- Use of renewable energy resources
- Maintenance of machinery and equipments
- Guidance to farmers- knowledge building
- Knowledge and adaptation of machines and tools used elsewhere
- Integrated energy management
- Reduction of agriculture inputs, drudgery and improve quality of products.

Chapter-14

Human Capital Requirements at Micro Level

14.1 Introduction

This chapter discusses the human capital needs, planning, development and utilization at micro level on the basis of issues in agriculture mentioned earlier in chapter 2 and also reflected in the stakeholders' perceptions in the individual sector reports as well as opinions/ perceptions expressed in the nationwide surveys. The genesis to identify the human capital needs at micro level lies in the fact that there are a number of activities that are unorganized and do not get covered by established institutional systems. Their requirements are large and have been indicated through focus group discussions organized across the country. The survey results also indicate that a number of organized activities by establishments are out-sourced to micro level organizations/ individuals which require trained human resources.

14.1.1 Definition of Micro-level

Micro-level here refers to organizations at grass roots, bulk of which may not be organized. The focus of this chapter is on assessing the need for trained para-workers including a broad quantification following a normative approach. It may be mentioned here that the need for diploma holders in different sectors for the industry, government etc. has been discussed in the respective sector specific chapters. This chapter broadly indicates the need of para-personnel to meet the local requirements for various services at micro level to cater to the requirements of farmers and others functioning in agriculture and allied sector operations.

14.1.2 Nature of specific services to be provided

At lower level the requirements are at operational level i.e. persons with specific skills who can be termed as **'bare foot technicians'**. These people are required to work at micro level in close association with farmers and micro level establishments. Such people may not necessarily have higher level of degrees but specific skills to handle day-to-day work and guide farmers as per specific area needs. For example, dairy and animal science personnel would be required at operational level to handle, for example, artificial insemination activity, embryo development, health management of livestock, animal nutrition etc. Similarly, in agriculture, these operational level workers may have to advise the farmers about plant protection, soil health, appropriate use of fertilizers and pesticides, post-harvesting management techniques, agriculture marketing and so on. These technicians also have to provide various other services to farmers as per their needs. Thus, these para- workers may liaise between farmers, service providers and related businesses or professionals upstream. Besides, they may also provide low level technical services like crop advisory, seed preparation, fertilizer dose, testing activities, micro finance, artificial insemination, basic veterinary preventive health services etc. Such personnel may also help in basic processing and packaging of basic pre and post harvest activities. Envisaging such micro-level institutions/operations in future, the report attempts to identify their human capital needs.

14.2 Demand Estimates

14.2.1 Service Centers for Farm Machinery

One of the major constraints of increasing agricultural production and productivity is the inadequacy of farm power and machinery with the farmers. Efficient agricultural operations are possible only when adequate agricultural mechanization infrastructure is created in rural areas. As small farmers cannot afford to purchase the machinery, custom-hiring facility can be of significance to both unemployed youth and the farmers. This can be true for processing activities and repair and maintenance service for agricultural machinery. Setting up of Agro-Service Centre that include Agro-processing enterprises and Service centres for repair and maintenance of agricultural machinery in the rural areas would be major focus in the coming years as government of India envisages promoting such enterprises (Kulkarni, 2010). Ideally every village would need one. As there are none at present, it is envisaged that these centres would have priority support from government and financial institutions in the future on commercial terms. Therefore, the study envisages beginning with establishment of 2-3 in each in a block in the 12th plan and there after increasing their number to one per village.

14.2.2 Entrepreneurship and Agri-clinics

The Ministry of Agriculture, Government of India, in association with National Bank for Agriculture and Rural Development (NABARD) launched a centrally sponsored scheme called "Agri-Clinics and Agri-Business Centers" in April 2002. Agri- Clinics are being established to provide expert services and advice to farmers on cropping practices, technology dissemination, crop protection from pests and diseases, market trends and prices of various crops in the markets and also clinical services for animal health etc. which would enhance productivity of crops/ animals. Agribusiness Centres are supposed to provide input supply, farm equipments on hire and other services. These centers are established with the financial help provided by the financial institutions in terms of loans.

The National Institute of Agricultural extension Management (MANAGE) was the nodal agency to train the agricultural graduates and monitor their progress under this scheme. Necessary financial assistance is also provided to the agripreneurs to obtain loans for setting up of their enterprise units. Details of agriventures established under this scheme are given in Table-14.1.

Table-14.1: Establishment of Agri-ventures

SNo	Year	No. of candidates trained	No. of Agri- ventures established	Success Rate
1	2002-03	2400	416	17.3
2	2003-04	1828	457	25.0
3	2004-05	2925	783	26.8
4	2005-06	2894	1415	48.9
5	2006-07	3149	1081	34.3
6	2007-08	2742	1039	37.9
7	2008-09	2503	1010	40.4
8	2009-10	2564	1111	43.3
9	2010-11 Up to Dec31	2055	942	45.8
	Total	23060	8254	35.8

Source: E-Bulletin November- December2010 (Agripreneur, Volume II, Issue 6)

Lack of financial assistance in time from banks, lack of support from training institutions and inadequate business skills continue to impede the progress and success of entrepreneurship in agriculture. It has come to light that a number of such centers could not survive due to lack of sufficient support. Their success rate however is increasing from 35 per cent to about 45 per cent during the last five years. The efforts are on in Planning Commission to identify the strategies to improve the survival of these centers.

Since agri-clinics are growing and are slowly evolving as strong micro level organizations in the unorganized sector, there is vast potential for many graduates to work in them either for employment or self-employment. The project survey indicated that many small business organizations, in fact depend on expert consultants for technical and market advisory services. These micro organizations would also function as intermediaries for corporate and govt. departments in agribusiness operations. Besides, a number of govt. programs need professional support of these micro-organisations at grass root level. In the coming Plan periods govt. is planning to have many schemes to promote entrepreneurship, micro-finance, and private participation in technology transfer. Considering the future potential for such opportunities and growth of more than 1,000 such units per annum, the country would need, on a conservative estimate, about 5,000 graduates and 2-4 times this number of para staff for such enterprises.

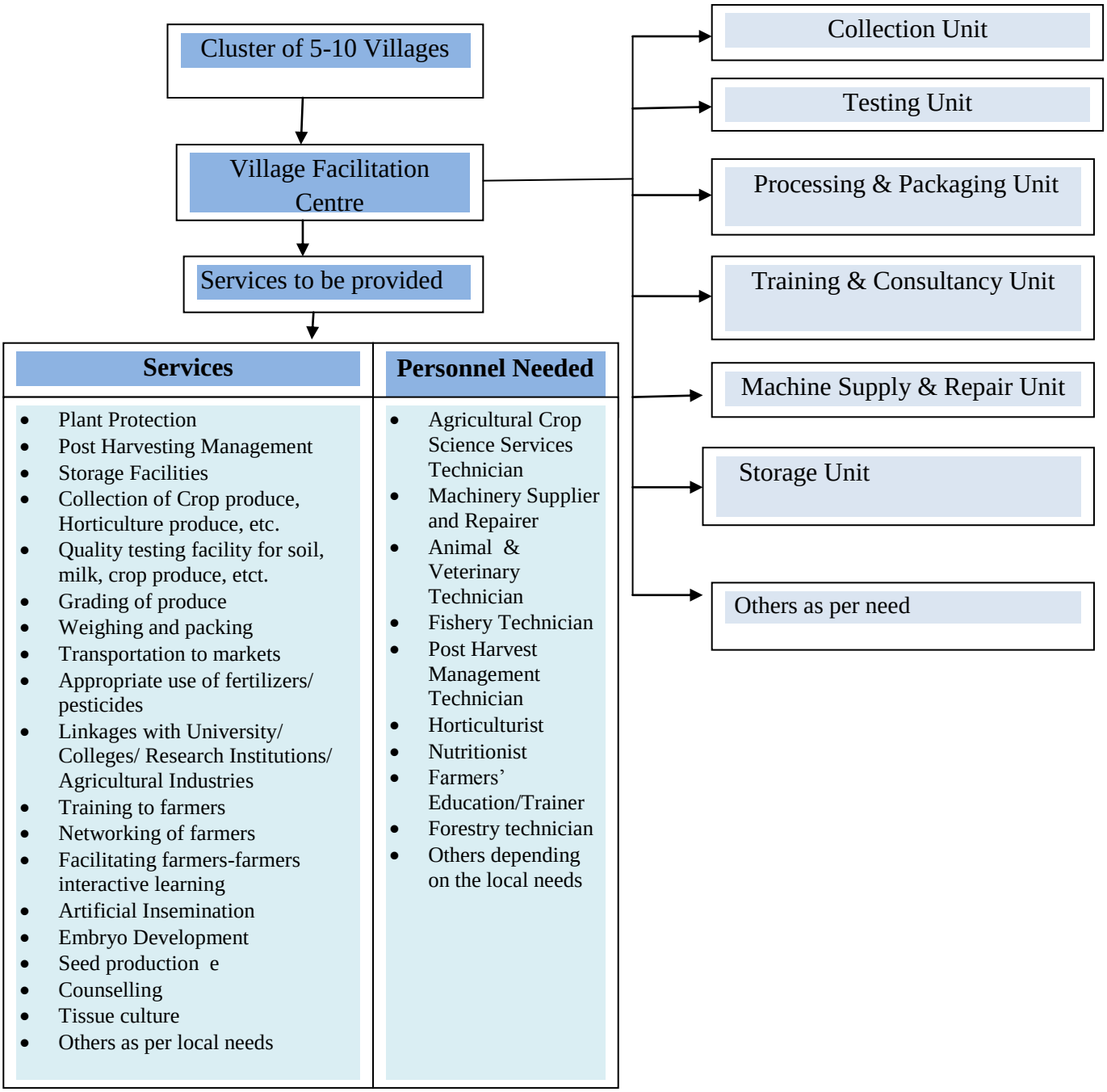
14.2.3 Village Service Centers/ Knowledge Centers

Prof. M.S.Swaminathan has suggested normative approach for forecasting the human capital requirements which appears to be appropriate for forecasting at micro level. There are about 6 lakhs villages. The experience shows that officers posted at block level are unable to provide services at village level. It is proposed that a Village Service Centre can be established for every 10-15 villages, if not in each revenue village. Village Service Centre should have one technical expert each in various sub-sectors of agriculture such as dairy, fishery, home science, veterinarian, agriculture personnel and so on supported by technicians/ para staff. The Village Service Centres not only to have a group of such skilled personnel, they should also be equipped with appropriate farm machinery so that the farmers could hire them as and when needed as each as every farmer cannot afford to buy machines individually. In such cases, there would be a need of machine maintenance personnel also.

There is ample scope for value addition in agriculture produce and persons in the local area can be trained in agriculture processing. They would also require training in entrepreneurship which has to include skill development in communication, financial management, project formulation as well as agricultural marketing. The agriculture processing course has to be area specific as different areas will have different agriculture produce.

At village level agricultural operations are not distinctly divided and a farming household engages in multiple activity such as crop production, dairy, fodder production, horticulture production, etc. Problems of farmers are also inter-related which require single window service close to their village. Small and marginal farmers as group can seek expert / technical counseling services through these centres. As agriculture is getting feminized, the centres can provide services specific to women. Keeping all these factors in focus some of the following core activities can be provided by Village Service Centres meeting the needs of farmers in a cluster of villages. Core services that could be provided at Service Centres are given in Fig-14.1

Fig-14.1: Suggested Framework for Village Service/ Knowledge Centre



The service centres can function like polyclinics with minimum set of core specialists and other support staff assisted by external experts on contract or regular basis as per local needs. They have to follow a pro-active approach to reach farmers. In view of the feminization of agriculture at least 50 per cent of skilled personnel should be females. These centres can also provide backward linkage to organized agribusiness that is growing at fast rate. These centres would network with other local organizations and also with organizations at district and higher levels in both public and private sectors.

14.2.3.1 Establishment of Village Service Centres

Establishment of these centres with in government systems is neither feasible nor viable. These centres can come up under **Public-Private Partnership (PPP)** mode with local bodies at block level taking an active role. Government would provide basic infrastructure like building, warehouse, equipment, etc. as in techno-parks with management to private sector or agri-preneurs. The existing infrastructure which is under-utilized can also be used for this purpose. Convergence of various government programmes for rural development as well as agencies involved is needed to develop the required infrastructure. Alternatively a service complex may be built up to house more than one service including financial services, etc. so that all facilities are available under one roof. This would again require need based skill development. One government organization may be designated as nodal agency for establishment of such centers under PPP mode. **A regular monitoring and evaluation system** should be put in place to keep track of the progress and also management support till the model matures.

14.3 Skills to be Developed

14.3.1 Major Skill Areas

The capacity building through finishing school is needed to catalyse many such enterprises. Some illustrative areas for skill development are listed in Table-14.2.

Table-14.2: Illustrative Areas for Skill Development

- Latest farm technology
- Post Harvest Management
- Nursery Management
- Soil Health Testing
- Livestock Production and Management
- Seed multiplication
- Quality Control
- Organic Farming
- Development and utilization of high yielding varieties
- Green House Technology
- Irrigation, Fertigation and Weedicide Technology
- Disease and Pests Control
- Processing
- Grading
- Testing of produce
- Packaging
- Bio-technology & Tissue Culture
- Marketing/e-marketing
- Market intelligence
- Development of small tools and equipments for farming as per local needs
- Soil and water conservation

- Use of Renewable Energy Sources.
- Drip irrigation
- Artificial Insemination
- Animal Health and Nutrition
- Machine repair
- Identification of Forest tree species and their improvement
- Management of Forest produce
- Fodder development
- Value addition at farm gate
- Good agricultural practices

In general, self-employment generating areas are application of advances in technology like genetically improved seeds, modern agricultural practices including micro-irrigation, plasticulture, nursery, organic and inorganic fertilizer production, post harvest technology, testing of agricultural produce, soil, water, fertilizer, waste and waste water analysis, bio-fertilizers, pesticide, veterinary services, livestock production, fishery production, agro ecotourism, environmental impact methods and analysis, renewable and non-renewable energy, bio-technology, marketing, etc. Knowledge in weather forecast, water management, satellite imagery, commercial information, market information, Govt. schemes, policy on agriculture and agri-business can be made available through agri-clinics, agri-business centres, bio-technology parks, food processing parks, veterinary pharmaceuticals, computer aided rural knowledge centres, testing labs, etc.

The skills can be developed through a variety of approaches like providing diploma level courses, vocational education and training and finishing school training. Skill development can also be had under 'Modular Skill Development Scheme' initiated by government of India.

14.3.2 Human Resources Supply Dynamics

Large number of executives in both public and private sector expressed need for below graduate level students for jobs within district, mostly in villages. In absence of such personnel ready to work in villages, private sector is employing other general science graduates and school drop outs and training them on the job for the specific work they need to do. In a way this is economic and working well too. However, many employers desired to have students trained in agri institutions as it would save their time in training. There are very few institutions of this nature. **Considering the number of rural youth, such institutions need to be established at medium size towns and block level across the country providing skills needed in their area. It would be an opportunity to develop chain of rural institutions close to grass roots for training rural youth.**

14.3.3 Potential for Human Capital Absorption in the Above

The above Centers should be established in a phased manner as it involves large investments, infrastructure development and coordination from various stakeholders. Estimates for human capital are based on the following considerations:

- Of the six lakh villages, the ideal requirement would be 1,00000 Village Services Centers (5-7 villages per center)
- Agri, veterinary, machine maintenance/repair technician, and nutritionist will be needed in all the centers
- At least 10,000 Village Centers should have fishery technicians. (The proportion of fishermen population to total population being 1/60).
- At least 10,000 Village Centers should have forestry technicians.(Green India Mission envisages one lakh Van Samrakshna Samities, It is proposed that at least 10 per cent would have forestry technicians
- The above would be accomplishing by 2020 in a phased manner – starting with about increment of 10 per cent per year.
- **Requirement of para staff needed for organized sectors given in respective chapters is not covered here. Dairy sector requirement is indicated in the sector report and hence not covered here.**

The estimated requirements of para-professionals for micro level organizations are given in Table-14.2.

Table-14.2: Need of Para Staff for Micro level in Agri and Allied Sectors-Projected up to 2020

Year	Agri	Vet.	Hort	Machine	Nutritionist	Fisheries	Forestry	Total
2010-11	10000	10000	10000	10000	10000	1000	1000	52000
2011-12	20000	20000	20000	20000	20000	2000	2000	104000
2012-13	30000	30000	30000	30000	30000	3000	3000	156000
2013-14	40000	40000	40000	40000	40000	4000	4000	208000
2014-15	50000	50000	50000	50000	50000	5000	5000	260000
2015-16	60000	60000	60000	60000	60000	6000	6000	312000
2016-17	70000	70000	70000	70000	70000	7000	7000	364000
2017-18	80000	80000	80000	80000	80000	8000	8000	416000
2018-19	90000	90000	90000	90000	90000	9000	9000	468000
2019-20	100000	100000	100000	100000	100000	10000	10000	520000

14.3.3 Para-staff needed in the Organized Sector

The sector wise reports indicate requirement of about 4,13,000 para staff (diploma holders) in 2010, which is likely to grow to 12,38,000 by 2020. Although the requirement of these two categories emanate from different perspectives, the capacity development of these two streams may be complementary. Thus, the capacity building efforts need to plan for developing para-staff stock of 4,66,000 in 2010, which would increase to about 17,58,000 by 2020.

The study envisages ratio of para staff to graduates to grow from 1:1 in 2010 to about 1:3 in 2020. This is desirable change as indicated by many professionals working in both the public and private sectors.

Considering the current stock of graduates in various disciplines of agriculture and allied sciences at about 4,75,000 in 2010 and expected to increase to 6,50,000 in 2020, this requirement is rather small.

14.3.4 Mechanism for Training

During the survey across the country, it was observed that students coming out of universities and colleges generally are not willing to serve in the villages, while skilled personnel are needed to cater to the needs at micro level. During Focus Group Discussions, executives from a variety of organizations desired that rural students / youth can be provided specific skill training for village level jobs dealing with farmers. In case such approach is accepted there would be a need to train people across the country in managing them. Such institutions need to orient their curriculum and programmes through interface with industries, NGOs, etc., in their area. **Need a more flexi-methodology to train the people at large as per their local needs.**

National Skill Development Corporation has initiated the development of human capital including in agriculture and allied sectors in their Modular Skill Development programme. Bulk of the training envisaged for micro level in agriculture and allied sectors can become part of this.

14.4 Conclusions

Micro-level organizations, which are by and large unorganized and mostly work at grass roots, need large number of trained persons at lower levels of operations. In conventional terms, the human resource at this level is popularly referred to as para-professionals. They can be trained in agriculture schools cum polytechnics, finishing schools imparting specific skills and vocational training organisations. Some already trained personnel would require certification.

Conservative estimate of human resource needed at the micro level is about 52,000 in 2010 and this is estimated to increase to 5,20,000 by 2020. In other words, the requirement is for development of about 50,000 such para-professionals every year during the next ten years for the micro level sector. Considering the organized sector also, the annual demand for para professionals would be about 1,00,000 per year during the period 2010-2020. Few programmes of this nature are already in place. For example, MAFSU produces annually about 3,500 para professionals in dairy and animal husbandry area in Maharashtra alone. Thus, it is possible and desirable to produce about 1,00,000 para-professionals annually.

Large number of government programmes aimed at agriculture and rural development need para professionals for service at village level. In the coming years, bulk of these programmes would be implemented through public-private partnerships and hence the trained persons would be employed by private partners in most cases. However, a host of public and private institutions need to undertake their identification as per local and regional needs and develop them. **This report recommends mandating every plan programme to identify area specific needs of trained personnel and include capacity building as part of such planned activities.**

Chapter-15

Supply Projections and Demand-Supply Gap

This chapter assesses the supply scenario and the demand-supply balance of agricultural human resources.

15.1 Methods of Estimating Available Supply

Assessment of the available supply of human capital of a particular category can be done in two ways. The first is to enumerate the persons with the qualifications in question through either a census or a sample survey. The second standard approach is to develop the supply estimates indirectly by cumulating the institutional outturn of the human resources over the years discounted for attrition due to deaths, and migration, etc.,

15.1.1 Data Availability and Quality

In India, the decennial population census does collect information about the number of graduates and post-graduates by qualifications, sex and age which include the agricultural (including dairy sciences) and veterinary sciences. The latest available data relate to 2001, those from the 2011 census having not come out yet. A major problem with the Indian census data about technical graduates is the level of underestimation. The 1991 census enumerated about 40,000 agricultural scientists and about 13,000 veterinary scientists. The 2001 census enumerated 1,00,000 agricultural scientists and 26,600 veterinary scientists. These are about half of the stock estimates for the year 2000 (209,410 agricultural scientists and 46,350 veterinary and dairy scientists) prepared by IAMR in their previous study. It would, therefore, be difficult to rely on the census data for assessing the level of supply of agricultural human capital. Moreover, 2001 data is outdated to get the current picture.

The other possible source is the five-yearly household sample surveys conducted by the National Sample Survey Organization (NSSO, 2011) on the labour force, employment and unemployment. The latest survey in this series relates to 2009-10, the base year for the current study. However, NSSO surveys adopt a 12 category classification of the labour force by educational levels, in which there is just one category covering all technical graduates – engineering, medical, agriculture, etc., which makes it impossible to get separate data for agricultural graduates.

15.1.2 Indirect method

In view of the above data problems, it has become necessary to estimate the base year (2009-10) supply of agricultural human capital in the country indirectly through cumulating of institutional outturns. Assuming that the average entry of agricultural graduates into the labour force is at about the age of 22 years and exit at the age of 60 years, the working span of agricultural graduates comes to 38 years. In the case of post-graduates and doctorates, the entry age may be taken as 24 and 27, respectively, implying a working span of 36 and 33 years, respectively. Since graduates form about two-thirds of the total outturn, it has been

assumed that the average active life span of agricultural scientists is 37 years. Annual attrition due to mortality, migration and non-participation in work is taken as 1 per cent.

To assess the base year stock for various categories of agricultural graduates, it is, in this approach, necessary to have data on the annual outturns of alumni classified **by various disciplines** for the period 1974 onwards to cover a span of 37 years by 2010. The first step in the process is, therefore, to build up this data set.

The most important source for historical data in this regard has been the data published by the Council of Scientific and Technical Personnel (CSIR) in their publication "Outturn of Scientific and Technical Manpower (1984-89) Vol.4–Agricultural Sciences (CSIR,1993) which provides data on the outturn of graduates, post-graduates and doctorates for two broad categories, viz., agricultural sciences (including horticulture) and veterinary and dairy sciences, from 1950 to 1989 (Annexure-15.1). This publication also provides colleges-wise (i.e., discipline-wise) outturn data for the period 1985-89.

Discipline-wise and level-wise outturn data for the period 1990-92 was taken from AGRIUNIS project (Rama Rao & Muralidhar, 1994) and this is given in Annexure-15.2.

Another source of data on the number of doctorates produced in these two streams from 1990 up to 2006 is the Research and Development Statistics (2007-08) published by the Department of Science and Technology (Annexure-15.3).

For the period 2001 onwards till 2010, data on intake and outturn for various disciplines have been collected under the present project from various agricultural universities and colleges. Though there are a few minor gaps in these data in respect of certain colleges and for some years, generally speaking, they provide a fairly accurate time series.

However, there are no such data for the period 1993 to 2000. It is observed that this period witnessed practically no growth in enrolment and consequently outturn in the case of agricultural sciences. Under the circumstances, the gaps in data have been filled by assuming low growth rates (0.7% for 1991-1996 and 2% for the period 1997-2000). Discipline-wise break-up obtained for the period 1988-92 has been used to obtain similar break-up for the years 1974 to 1987 and 1993 to 2000. For the later years, however, such break-up was directly available from the institutional survey conducted as a part of the project. The outturn data thus generated is given in the Table-15.1.

These data include not only graduates but post-graduates and doctorates as well who passed out in different years. However, the doctorates and post-graduates included in these figures must have passed out as graduates in some earlier years and hence already taken care of in the outturns of graduates. To adjust for this factor in assessing the total supply, the data for graduates and above were deflated by the average proportion of graduate outturn in the total outturn. This adjustment was done separately for each discipline using the 2001-10 data.

Table-15.1: Estimated Outturn of Graduates and Above in Agriculture and Allied Sciences (1970 – 2010)

Year	Agriculture	Horticulture	Forestry	Dairy Tech.	Veterinary	Agri.-engg.	Fishery	Agri-bio-tech	All
1970	6888	691	257	192	1162	832	186	-	10209
1971	5072	508	189	180	1089	613	137	-	7789
1972	5708	572	213	178	1074	690	154	-	8588
1973	4726	474	176	161	974	571	128	-	7210
1974	4826	484	180	185	1118	583	130	-	7506
1975	4253	426	159	168	1017	514	115	-	6652
1976	5019	503	187	207	1253	606	135	-	7911
1977	4628	464	172	215	1301	559	125	-	7464
1978	5256	527	196	202	1220	635	142	-	8178
1979	5535	555	206	173	1047	669	149	-	8335
1980	6251	627	233	250	1508	755	169	-	9792
1981	6307	632	235	254	1535	762	170	-	9896
1982	6439	646	240	254	1532	778	174	-	10061
1983	6347	636	237	247	1492	767	171	-	9897
1984	6532	655	243	221	1335	789	176	-	9952
1985	6609	663	246	229	1381	799	178	-	10105
1986	6708	673	250	252	1525	810	181	-	10400
1987	6745	676	251	282	1704	815	182	-	10656
1988	8803	305	157	79	2010	960	211	-	12525
1989	9147	683	273	149	2068	1081	218	-	13619
1990	9612	1056	346	229	2102	1245	313	-	14903
1991	9351	1112	399	310	1876	1215	265	-	14528
1992	9614	931	408	588	1691	1008	206	-	14446
1993	9711	974	367	328	1992	1171	258	-	14800
1994	9720	974	367	329	1994	1172	258	-	14815
1995	9730	975	368	329	1996	1173	258	-	14830
1996	9740	976	368	329	1998	1174	259	-	14844
1997	9934	996	376	336	2038	1198	264	-	15141
1998	10133	1016	383	343	2078	1222	269	-	15444
1999	10336	1036	391	350	2120	1246	275	-	15753
2000	10543	1057	399	357	2162	1271	280	-	16068
2001	9320	553	315	197	2205	626	397	32	13645
2002	9597	611	325	262	2250	667	460	21	14193
2003	9258	762	353	278	2253	762	410	101	14177
2004	9798	780	297	334	2321	806	426	108	14870
2005	11729	748	398	409	2875	854	454	157	17624
2006	12486	875	483	408	2714	1067	395	316	18744
2007	12994	870	527	420	2635	1072	371	373	19262
2008	13535	1198	586	439	2965	1293	371	519	20906
2009	13344	1330	553	471	2816	1355	399	631	20899
2010	15949	1465	716	310	2683	1507	433	734	23797

Sources: 1. For 1970 to 1989 Techncial Manpower Bulletin, Vol 4, Agricultural Sciences (1993), Council of Scientific and Industrial Research

2. For the years1990 to 2000, estimated by NAARM

3. For data from 2001 to 2010, institutional survey conducted by IAMR-NAARM

4. For data on doctorates for the period 1990 to 2000, Department of Science and Technology, Research and Development Statistics 2007-08, 2009.

15.2 Estimates of Supply in the Base Year 2009-10

Based on the data generated from various sources as mentioned above, estimates of stocks of graduates and above in agricultural and allied sciences have been built up by cumulating the discounted outturn data as indicated above. These are given in the Table-15.2.

Table-15.2: Estimates of Supply of Stock of Agricultural Graduates and Demand in the Base Year 2009-10

Discipline	Estimated Demand in 2009-10	Supply in 2009-10	Demand-supply gap	
			Number	As % of demand
Agriculture	292549	188708	103841	35.5
Horticulture	62583	14179	48404	77.3
Forestry	25458	5005	20453	80.3
Dairy Technology	17807	6062	11745	66.0
Veterinary Science	42166	40232	1934	4.6
Agricultural Engineering	18086	23207	(-) 5121	(-) 28.3
Fisheries Science	13781	5144	8637	62.7
Agri-Biotechnology	2988	1697	1291	43.2
All categories	475418	284234	191184	40.2

Thus, the total stock of agricultural graduates and above in 2009-10 has been estimated at about 284200, falling short of the assessed demand of 475400 by 40 per cent. The shortfall is across the board among all disciplines barring agricultural engineering.

15.3 Projected Supply till 2019-20

The estimates of supply have been projected till 2019-20 under varying sets of assumptions about the expansion of agricultural education. These assumptions are :

Scenario A: The average outturn levels of the last five years (2006-10) will be maintained unchanged till 2019-20.
Scenario B: The outturn levels will grow at the same rate as the growth observed during the last five years beginning with the average outturns during that period, given above.
Scenario C: The outturn will expand by 10 per cent per year till 2019-20, beginning with the average level of last five years in 2010-11.

The corresponding supply projections are shown in **Annexure-15.4.**

15.4 Demand-Supply Gap by 2019-20

The projected demand for various categories of human capital is compared in the following Table-15.3 with the likely supply situation under various scenarios described above to identify the demand-supply gaps.

Table-15.3: Estimates of Supply of Stock of Agricultural Graduates and Demand in the Base Year 2019-20

Discipline	Demand 2019-20	Supply under scenario			Demand-supply gap (% of demand)		
		A	B	C	A	B	C
1. Agriculture	364065	233307	264280	301384	35.9	27.4	17.2
2. Horticulture	95901	16901	26030	21699	82.4	72.9	77.4
3. Forestry	29044	6468	8148	8484	77.7	71.9	70.8
4. Dairy Technology	29920	7115	7269	9131	76.2	75.7	69.5
5.Veterinary Science	67756	48031	48433	61599	29.1	28.5	9.1
6. Agri-engineering	28486	26858	33859	34148	5.7	-18.9	-19.9
7. Fisheries Science	28407	6337	6705	8128	77.7	76.4	71.4
8. Agri-biotechnology	6208	4376	13383	6565	29.5	-115.6	-5.8
All categories	649787	349393	408107	451138	46.2	37.2	30.6

It may be observed that under all scenarios there is likely to be substantial gap between demand for and supply of human resources, except in agricultural engineering.

15.5 Conclusions

Compared to other streams of science and technology, the growth in agricultural education is relatively low (3 per cent) during the period 1970 -2000. In the past decade, the growth has accelerated to 5%, the result of which can be seen from the increased outturn of students in the last five years specially with the emergence of private sector participation in agriculture education. Considering the current developments and projected growth of various sectors of agriculture in the next decade, agricultural education is likely to experience above 5 per cent growth per annum. On this basis the scenario B presented is most likely. On this scenario there will be a gap of 37 per cent in demand- supply.

Chapter-16

System Dynamics Model

System dynamics modeling was used for forecasting and scenario generation of human capital requirement in agriculture and allied sectors and to evolve prospective human resource development strategies.

16.1 Supply-Demand Projections

The system dynamics model presented in the methodology chapter is used for carrying out supply-demand projections of agricultural human capital. Although human resources planning work usually involves consideration of both skilled and unskilled people, only skilled human resources in agriculture and allied sectors in India is considered in this study. Specifically, the study is carried out by considering only the passing out students from well-known colleges and universities in India in agriculture and allied sectors. The growth rate of the human resources requirements are modelled by considering the growth rates of the related industrial sectors.

Supply demand projections of human resources were carried out for individual sectors and all the sectors together. The results are presented below.

16.2 Supply-Demand Projections (all Sectors Combined)

16.2.1 Policy Scenarios

The following policy runs are considered:

1) Policy-1: with the intakes frozen at 2009-10 levels and at 4 per cent sector growth.
2) Policy-2: with 50 per cent increase in the intakes from 2009-10 and 4 percent sector growth.
3) Policy-3 : with 50 per cent increase in the intakes from 2009-10 and 3 percent sector growth.

Supply-demand projections are carried out for the overall agriculture sector with the following initial values.

Year	Stock in 2009-10				
	Diploma	UG	PG	PhD	Total UG & above
2009-10	3,90,461	3,17,837	84,482	38,632	4,42,716

The intakes in different programs are taken as given below:

The Intake in 2009-10			
Diploma	**UG**	**PG**	**PhD**
10,104	20,000	8,000	2,000

The overall target growth rate is initially considered to be 4 per cent for the overall demand of agriculture degree and diploma holders. However, the actual growth rates will be determined endogenously by the system dynamics model on the basis of considerations of attritions and supply-demand gaps.

16.2.1 Supply Projections of Overall Agriculture and allied Sectors

The intakes and out-turn ratios are important considerations in this regard. When Supply-Demand gap becomes negative, the attractiveness of the sector increases, and the out-turn ratio improves and so are the intakes. The out-turn ratios are considered to be varying from 60 per cent to 90 per cent on the basis of supply-demand gaps. When the supply is less than the demand, the out-turn ratios will be on the higher side. Table-16.1 shows the supply projections of overall agriculture sector for the base runs with 4 per cent growth rate with intakes frozen (policy-1), 4 per cent growth rate with 50 per cent increase in intakes (policy-2) and 3 per cent growth rate with 50 per cent increase in intakes (policy-3), respectively.

Table-16.1: Agriculture Manpower Stock Supply Projections for Different Policies

Scenario	Year	Diploma	UG	PG	PhD	Total
Base year	2009-10	390461	317837	84482	38632	831412
Policy-1	2019-20	377836	336873	101456	44799	860964
Policy-2	2019-20	401519	353634	113378	49559	918090
Policy-3	2019-20	400377	353198	112784	49323	915682

16.2.2 Demand Projections of Overall Agriculture & Allied Sectors

The demand projections are presented with the help of supply demand plots for degree holders and diploma holders for Policy-2 and Policy-3 given in Figs-16.1 to 16.4.

The results show that even with a 50 per cent increase in the intakes, the supply-demand gap is negative most of the times. The growth of the overall agriculture sector is also affected because of this – although the target growth rate is considered to be 4 per cent - the actual growth rate turns to be just above 2.5 per cent for the policy with 50 per cent increase in the intakes.

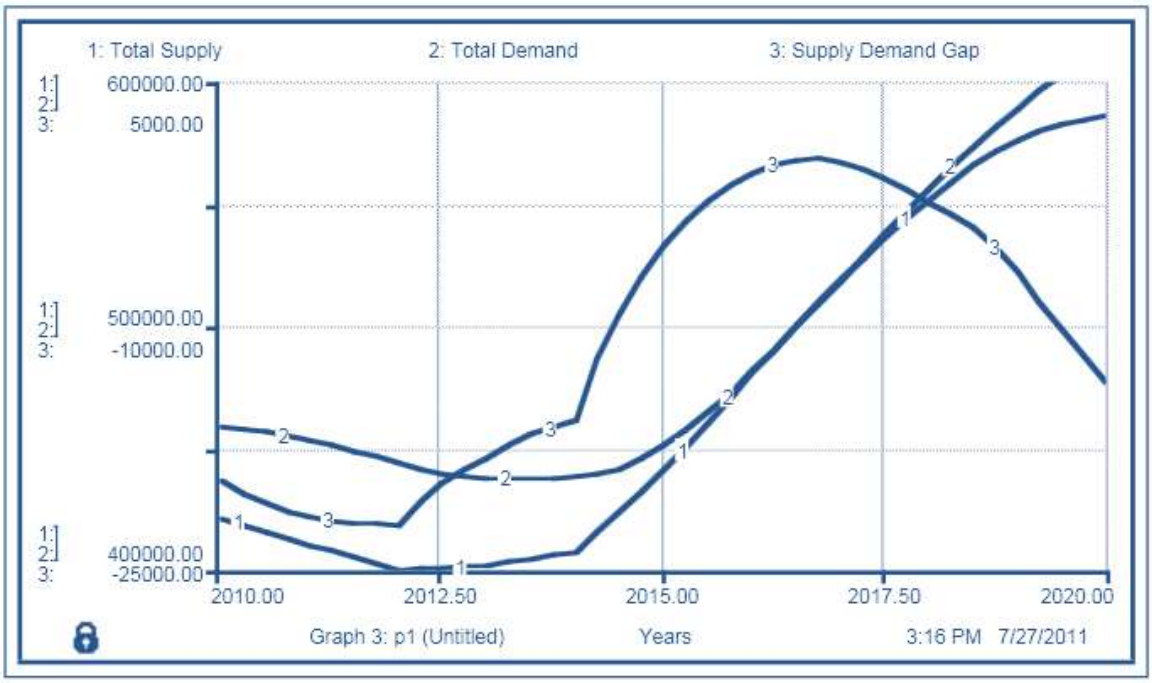


Fig-16.1: Overall Agriculture Supply-Demand Plot for Degree Holders for Policy-2 with 4 per cent Growth Rate and 50 per cent Increase in the Intakes

Fig-16.2: Overall Agriculture Supply-Demand Plot for Degree Holders for Policy-3 with 3 per cent Growth Rate and 50 per cent Increase in the Intakes

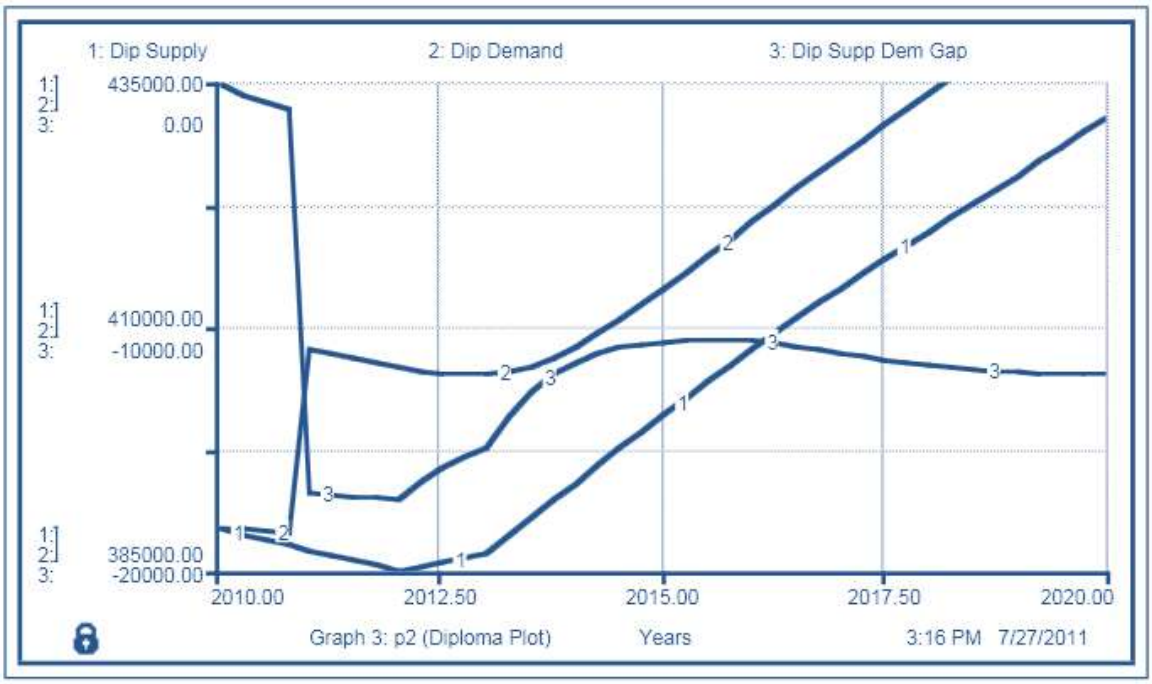


Fig-16.3: Overall Agriculture Supply-Demand Plot for Diploma Holders for Policy-2 with 4 per cent Growth Rate and 50 per cent Increase in the Intakes

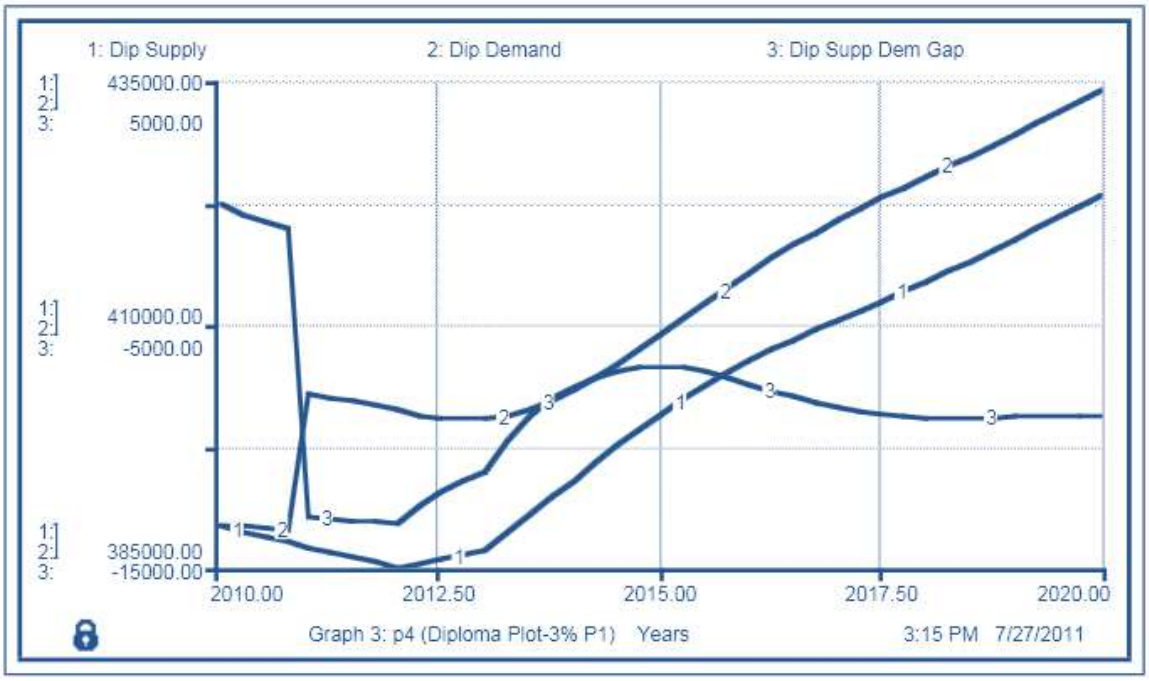


Fig-16.4: Overall Agriculture Supply-Demand Plot for Diploma Holders for Policy-3 with 3 per cent Growth Rate and 50 per cent Increase in the Intakes

16.3 Supply-Demand Projections (Sectorwise)

Supply demand projections for the following eight sectors were carried out for graduate level and above with the system dynamics modeling.

1) Crop Science
2) Horticulture
3) Veterinary
4) Fishery
5) Dairy
6) Agri-Biotechnology
7) Agri-Engineering
8) Forestry

Supply-demand projections are carried out for the various agriculture sectors with the initial values shown in Table-16.2.

Table-16.2: Sector-wise Initial Values of Stock for 2009-10

Sector	Stock in 2009-10				
	Diploma	UG	PG	PhD	Total UG & above
Crop Science	81807	190825	54216	21670	266711
Horticulture	138762	46548	8790	4217	59555
Veterinary	21862	26667	8635	5030	40332
Fisheries	125892	11870	2576	790	15236
Dairy	4685	14043	1833	1010	16886
Agri-Biotechnology	355	1045	810	880	2735
Agri Engineering	1838	10595	3455	1848	15898
Forestry	15260	16244	4167	3187	23598
All above	390461	317837	84482	38632	440951

16.3.1 Scenario Analysis

The projections for each of the eight sectors were made with three different policy options. The growth rate of each of these sectors was decided considering current trend and the feedback from the expert consultation. These sector growth rates for various policy options are given in Table-16.3. The simulation results for these scenarios for 2020 are summerised in Table-16.4.

Table-16.3: Growth Rates for Different Policy Scenarios

S.No	Sector	Growth Rates (%)		
		Policy- 1	Policy-2	Policy-3
1	Crop Science	3	3	2
2	Horticulture	4	4	3
3	Veterinary	5	5	4
4	Fishery	4	4	3
5	Dairy	4	4	3
6	Agri-biotechnology	6	6	5
6	Agri-engineering	3	3	2
8	Forestry	3	3	2

Table-16.4: Supply-Demand Gap in the year 2020 for Graduates and above

S.No	Sector	Supply-Demand Gap		
		Policy-1	Policy-2	Policy-3
1	Crop Science	-6531	-3893	-707
2	Horticulture	-2328	-1886	-1286
3	Veterinary	-1635	-1144	-679
4	Fishery	-567	-438	-272
5	Dairy	-652	-524	-355
6	Agri-Biotechnology	1874	2932	3375
7	Agri Engineering	4137	7756	9742
8	Forestry	-489	12	1439

The demand of human capital in agriculture, horticulture, veterinary, dairy and fishery sectors is more than the supply under the three policy scenarios. In these five sectors, the intake capacity needs to be increased considerably, i.e., above 50 per cent of the current level.

In forestry, the supply demand gap is small. In Agri-biotechnology and Agri-engineering, supply exceeds demand. However, the simulation carried out with 10 per cent increase in intake has shown a balanced demand –supply situation in these three sectors. Thus, in these three sectors, modest increase in the current intake capacity would be sufficient to meet the projected demand in 2020.

16.4 Conclusions

The results from the system dynamics model corroborate the overall trend of human resources supply-demand scenario envisaged from other forecasting techniques. In the assumed scenario, 50 per cent increase in intake of graduates would not be sufficient to meet the demand for low level of sector growth of 3 percent in agriculture, horticulture, veterinary, dairy and fishery sectors. Where as in Forestry, Agri-biotechnology and Agri-engineering, with 10 per cent increase in intake would be sufficient to meet the required demand in 2020. On the whole, special efforts, therefore, are necessary to sustain the growth in the agriculture sector with improvements in the intakes as well as in the out-turn ratios.

Chapter-17

Conclusions and Recommendations

The present project relates to forecasting of human capital needs in agricultural and allied sectors. The earlier chapters provided the results of forecasts made on the basis of growth pattern in each sector and sub-sectors in the light of various developmental programmes and the vision for each sector. A primary survey undertaken as a part of the project has provided the basic inputs needed to finalise the human capital needs according to various educational levels. The project looked at the human capital requirements not only in quantitative terms but on issues relating to quality as well. It also considered the institutional mechanisms for imparting education in agriculture and its allied sectors and addressed skill related issues in the context of changing labour market scenario as required in one of the objectives of the project.

Sector specific issues have been discussed in respective chapters in detail. This chapter would focus upon certain key results, conclusions and future roadmap.

17.1 Broad Results

The results in Fig-17.1(all disciplines put together) and 17.2 (discipline wise) show the sector-wise deployment of agricultural human resources in 2010. The shares of various segments by employment are : 33 per cent in government, 44 per cent in private, 10 per cent in financial, 4 per cent in research and academic and 9 per cent in others. The major shift in the past three decades is decline in the share of public sector in employment, which may be due to freezing employment in government sector as well expansion of opportunities in the private sector. This is in tune with the emergence of commercialisation as well as diversification.

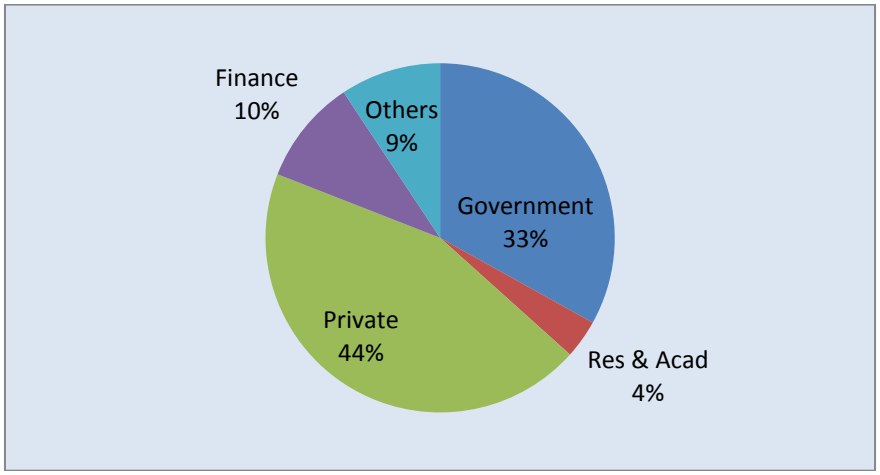


Fig.17.1: Pattern of Agriculture Human Resources Deployment

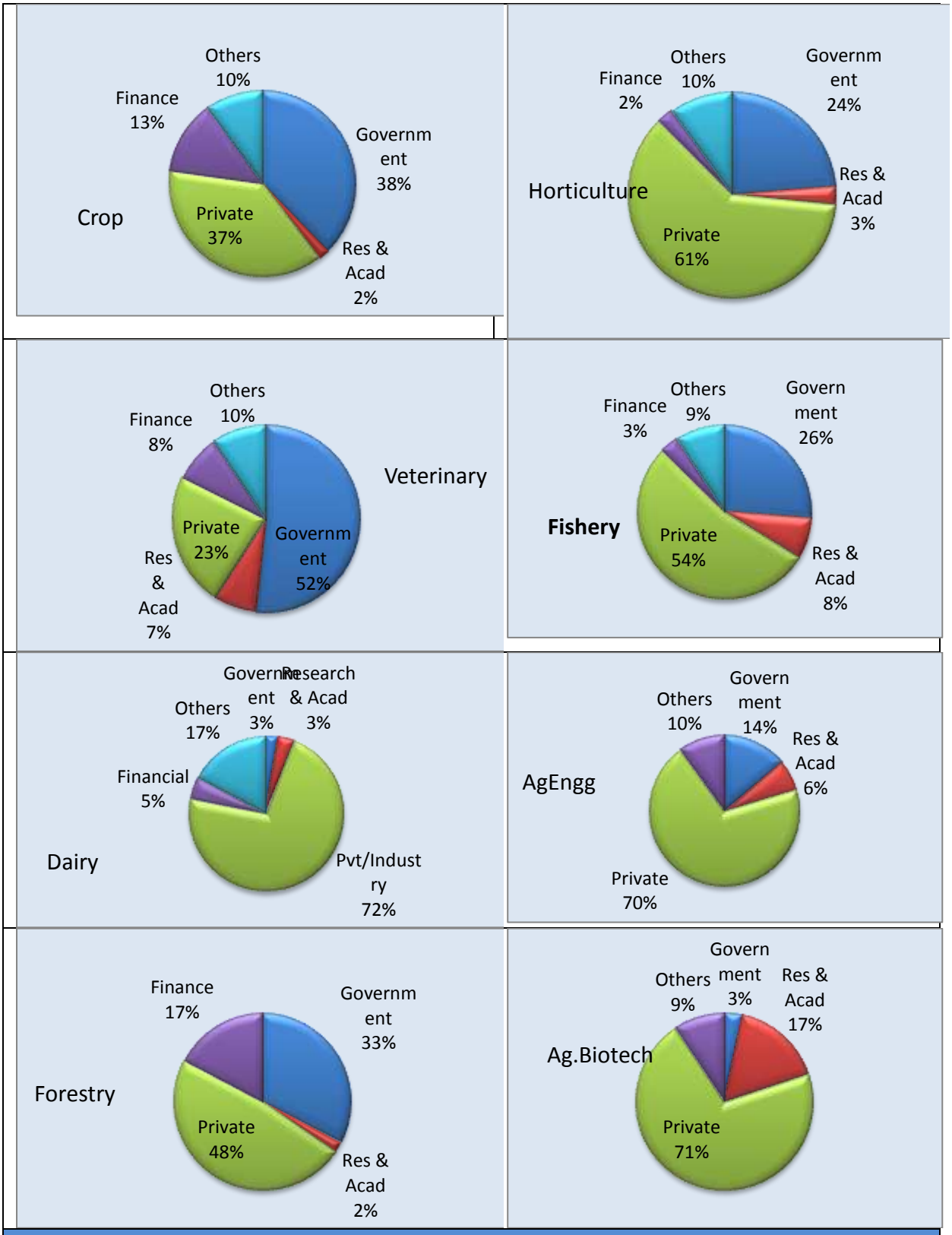


Fig. 17.2 Profile of Deployment of Agriculture Human Resources in Different Sectors

17.2 Annual Flow of Supply-Demand

With the demand projections made in the earlier chapters for various sub-sectors, the required annual outturn for the year 2020 in comparison to the same during 2010 is given in Table-17.1.

Table-17.1: Required Annual Outturn by Education Level in 2010 (Supply) & 2020 (Demand)

Discipline	UG		PG		PhD		UG & above	
	2010	2020	2010	2020	2010	2020	2010	2020
Crop Science	11852	18659	3514	5422	583	1203	15949	25284
Horticulture	1001	7295	409	993	55	330	1465	8618
Veterinary	1761	5332	797	1854	125	486	2683	7672
Fisheries	285	2096	109	418	30	100	424	2614
Dairy	255	2605	30	503	25	207	310	3315
Agricultural-Biotech	558	582	156	323	20	134	734	1039
Agricultural Engg	1218	2359	262	709	27	189	1507	3256
Forestry	386	1260	275	416	55	156	716	1832
Total	17316	40188	5553	10638	920	2805	23788	53630

At present the existing education system is producing about 24,000 graduates per year with crop sciences contributing 2/3rd of it. The projections indicate that by 2020 the annual outturn required would have to be about 54,000. Based on the current supply the demand supply gap would be 30,000 (Fig-17.3).

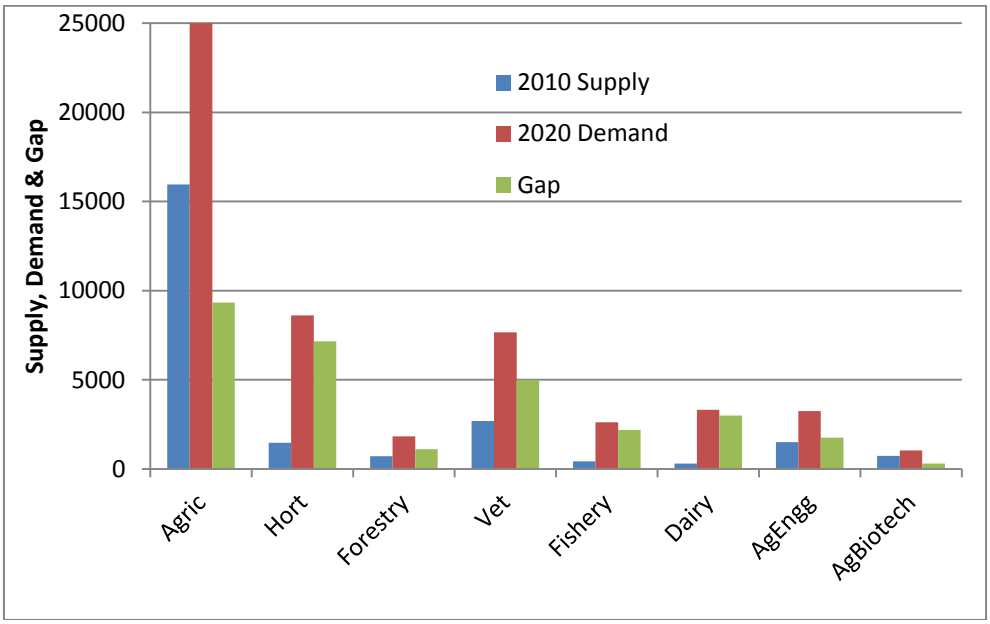


Fig.-17.3: Discipline-wise Net Additional Outturn Required by 2020

Discipline wise, the additional annual requirements of outturns are expected to be: Agriculture-9335; Horticulture 7153; Forestry 1116.; Dairy 3005; Veterinary & AH 4989; Fishery 2181; Agriculture Engineering 1749; and Agri. Biotechnology 305.

The average outturn during the last decade grew at the rate of five per cent per annum and in the coming decade it is projected to grow at above five per cent to meet the demands.

17.2.1 Degree-wise Requirement by 2020

The required annual increase in outturn by 2020 by education level and discipline is given in Table-17.2. The current level of graduate, postgraduate and PhD output need to be increased by 2.3, 1.9 and 3.0 times respectively.

Table-17.2: Required Annual Increase in Outturn of Graduates by 2020

Discipline	UG	PG	PhD	UG & above
Crop Science	6807	1908	620	9335
Horticulture	6294	584	275	7153
Forestry	874	140	101	1115
Veterinary &AH	3571	1057	361	4989
Fisheries	1811	309	70	2190
Dairy	2350	473	182	3005
Agri Engineering	1141	447	162	1750
Agri-Biotechnology	24	167	114	305
All above	22872	5085	1885	29842

17.2.2 Additional Colleges to be established

At the current rate of outturn is less than 65 per cent of the intake capacity. Though full capacity utilization is not possible, the system efficiency can be improved to produce another 15-20 per cent additional graduates from the existing system. The expansion may have to consider this factor.

The demand of professionals at PG and PhD level would be met through increase in number of sanctioned seats in existing colleges. At UG level, considering the current intake capacity and large gap in demand-supply, there is a need to establish about 150 new colleges. Discipline-wise new colleges needed are given in Table-17.3.

The new colleges would also require adequate infrastructure and qualified teachers to ensure quality of education. To meet the projected demand and required outturn growth and various issues pertaining to education quality and management important observations and conclusions are given below under various components.

Table-17.3: Additional Colleges Needed at UG Level

Discipline	Additional number of colleges needed
Crop Science	30
Horticulture	50
Veterinary & Animal Husbandry	25
Fisheries	15
Dairy	20
Agri-Engineering	5
Forestry	5
Total	150

17.3 Educational Planning

1. The results show that there are at present substantial gaps between demand and supply of human resources in agricultural and allied sciences even to the tune of 50 per cent or more. This is true across the board, though the shortfall is high in the case of rapidly growing horticulture, dairy and fisheries sectors and less serious in others. Dairy, fisheries and horticulture are the future engines of growth in the agricultural sector and are important from the point of view of food security of the nations. Their growth, in particular, should not be hampered by human resources unavailability snags.

2. The study also shows that the present educational facilities at their current levels of output will not be able to cope with the demand pressures likely to emerge in the next decade and substantial step up is required even to contain or slightly reduce the current and future demand-supply gap. No doubt, there has been some acceleration in the outturn of high level agricultural human resources in recent years, but it has been shown that even this belated accelerated growth would hardly make a dent on the seriousness of the problem. The situation demands much stronger initiatives. Perhaps an increase of 2 to 3 times in disciplines like horticulture, dairy and fisheries sciences.

3. The demand estimates presented in this report are on the presumption that all jobs requiring agriculture and its allied sciences would in fact be filled by agriculturally qualified personnel. This, in practice, is not always so, with people from general science streams and even unrelated fields accessing such jobs. Some initiatives may be required on the part of the government to ensure proper matching of skills and job requirements in government employment. It is also presumed that the XII Five Year

Plan will ensure pro-active measures to accelerate agriculture growth which would impact upon the future requirements of trained human capital in agriculture sector.

4. Apart from numbers, planning for agricultural education in the next decade has to look at the structure of the system. Till recently, the emphasis in the system has been more or less exclusively on the generation of graduates, post-graduates and doctorates and very little effort has been put in generation of intermediary skills at diploma level. Even though there have been some corrective steps on the part of some SAUs and colleges lately, a far greater effort is needed to promote diploma level education on the lines of engineering education. This is urgent in view of the expressed preference of the private sector, which is the future hope for increased absorption of agricultural human capital, for diploma level personnel to handle most of the routine jobs, leaving only management and research functions to the higher level human resources. A diploma in agriculture as an add-on to general education would also be helpful. The reported tendency on the part of the high level agricultural human capital engaged by private industry is to bide their time and move away from industry to secure and highly paid but scarce jobs in the government sector.

5. Initiatives for the future demand-driven growth in agricultural education at the diploma and undergraduate levels should be left to the private sector or should be taken in a PPP mode, subject to quality assurance systems being in place. Post-graduate and doctoral educations should continue to be the preserve of the public sector institutions.

6. An important aspect of educational planning is to ensure availability of faculty in adequate numbers and quality with institutional arrangements for systematic up-gradation of their knowledge and skills. It has been observed that about 40 per cent of the faculty positions in the agricultural universities have remained vacant for long periods of time raising questions about the quality of education. On the other hand, it has also been observed that at post-graduate level, the teacher-pupil ratio is extremely low in many disciplines, calling for a better organization of teaching system. It has been observed that at post graduate level the intake per course is very low as compared to other fields of technical and professional education. There is a need to consolidate the post graduate courses to conserve the resources for optimum utilisation. Compartmentalisation of research and teaching functions also adds to the problem and needs to be addressed.

7. Research is key to future agricultural growth and nation's food security system. It becomes more important today than ever in the context of emerging problems like limits on soil availability, degradation of available soil, declining responses to inputs, climate change and phenomenon like globalization. The research function is more likely to become directly production and productivity oriented and performed by the private sector as well. ICAR institutions and other public sector institutions in the central and state governments will continue to engage themselves in high level quality research. Here again, vacancies to the tune of 30 per cent in the positions of scientists does not auger well. Some of the indicative areas which can be sponsored by ICAR for researches are employment pattern among the alumni, migration, area specific skill needs, effective teaching strategies, sector specific and state specific in depth studies for human capital assessment, etc.

8. One of the critical factors in Indian agriculture dominated by small and marginal farmers is one of inadequate transfer of technology and consequently low productivity. Consultations as a part of the project pointed to the need for creating/strengthening local institutional mechanisms for providing day-to-day counselling and other escort services to the farmers at their doorstep. To handle a variety of day to day jobs of counselling and rendering routine assistance to the farmer, the 'bare foot technicians' need to be equipped with multiple skills – not only in regard to farm practices, simple and routine veterinary services, routine testing services, and various other rural occupations but also on aspects like agro-processing, marketing, escort services, etc. Such skills need to be developed among the rural youth themselves, preferably targeting school drop-outs, as youth from urban areas or with higher education shy away from working in rural areas.

9. These multi-skill development programmes can be dove-tailed with government's Skill Development Mission or an integrated course can be started through existing institutional systems. The para-staff can be trained in agriculture schools, finishing schools imparting specific skills and vocational training institutions. There is a need for certification of such programmes.

10. Large number of government programmes aimed at agriculture and rural development need trained human resources for services at village level. A number of government programmes aimed at rural industrialisation and farm mechanisation would attract youth to such programmes. **This report recommends mandating every plan programme to identify area specific needs of trained personnel and include capacity building as a part of such planned activities.**

11. An important development in agricultural education in recent years has been the increasing participation of girls, with their share of enrolment reaching 30 per cent overall and even over 50 per cent in some universities like TNAU. This is a phenomenon to be encouraged through creation of girls' hostels and other facilities specially in rural areas as the change calls for a gender sensitive education. Some finishing schools can be started either for girls alone or certain per cent mandated for girls. The development of soft skills and other entrepreneurship skill courses can be imparted to them so that they could be economically active.

12. Proper data base management is vital for educational planning. ICAR has no doubt taken useful steps in this direction by establishing data bases like NISAGENET and PERMISNET, but there are serious operational issues. NISAGENET is not up-dated regularly by the SAUs, while PERMISNET has no provision for maintaining data on a historical basis. Nor does it allow access to outside researchers. ICAR could consider throwing open limited aspects of the system that are read-only and those that do not reveal individual's details to general researchers. It is important that labour market signals for agricultural human resources are monitored on a regular basis to analyse the employment and unemployment situation among them that may unfold from time to time and work on corrective measures. SAUs may be encouraged to place their yearly placement details on their websites and also to conduct tracer studies from time to time. A Cell to conduct research in the labour market related issues of agricultural education may be established in the education division of ICAR for this purpose.

17.4 Skill Needs and Institutional Mechanisms

13. Survey indicates towards the need for skill up- gradation in the light of technological innovations as well as skill development in the emerging areas in the sector. An indicative list for skills to be developed has been provided in the report.

14. There is a wide spread concern for quality of agricultural education. In the absence of regulatory authority and inadequate staff and funding, most agriculture colleges are deteriorating in standards.

15. Quality of education is directly related to the employability. Consultations with industry and academicians as well as students suggested a large gap between the skills imparted in the institutions and skills required in the employment market. This calls for a re- look into the curriculum, teaching strategies and establishing forward and backward linkages. Although the Fourth Deans' Committee, mandated to revise agricultural curriculum, recommended a strong practical orientation to agricultural education, actual implementation is evident only at some places. There is a strong demand from all the stakeholders for skill-specific education with clarity of basics as well as hands-on technical expertise. In other words, there is a need to develop **functional skills** among the students in educational institutions almost in all the sectors of agriculture.

16. The issues relating to course syllabus, effective teaching strategies, and quality of teachers need serious thinking and policy interventions while considering expansion of agriculture education as well as meeting the labour market challenges.

17. Although the results of the study show that human resources supply in almost all the sectors of agriculture is less than the demand and therefore unemployment is low but as reported the agri-education is not considered as a professional course at par with other professional courses, especially at graduate level. **Pro-active policies are needed to give agriculture its proper dignity and place.** This would also facilitate in attracting youth to join the sector not as a compulsion but as a choice.

18. Another concern is of quality of teachers. Agriculture is undergoing rapid transformation with the advent of new technologies, commercialisation and globalisation and emergence of issues relating to climate and environment. Teachers have to keep pace with these developments and the resulting need to acquire new knowledge. While some organisations are imparting training in the emerging areas, there is no specific training policy for up- gradation of the skills of teachers. A plan of action has to be evolved so as to cover all the teachers under capacity development programme in a specific period of time.

19. At present there are very few institutions such as NAARM and HAU providing teacher training in agriculture. As there are about 25,000 faculty and scientists in the country, to cover all of them under training programmes in a five year cycle, there is a need for at least six institutes with the sole training responsibility with good faculty. International experts may be invited to impart advanced knowledge wherever needed.

20. Adequate institutional funding and infrastructure and effective management are some of the areas that directly made an impact on quality of education. Available budgetary resources are far from satisfactory to develop infrastructure or world class laboratories in the colleges and universities. 80 per cent budget is spent in meeting the establishment costs leaving little money for developing resources.

21. It is strongly recommended that extension services in the country should be strengthened on priority with adequate infrastructure facilities, staff and other resources to cater to the needs at micro level. Regular follow-ups of the programmes operated under extension services are also needed. Synergies in various organisations such as Extension services, NGOs, SHGs, farmers' associations etc. are extremely essential.

17.5 Other Issues

17.5.1 Financial Support

A number of private colleges are offering or are keen to offer PG education. They find it difficult to sustain due to lack for research infrastructure. At present, these colleges are not in a position to access the limited competitive grants available in the country. Graduate research through a special scheme can be initiated as is available in AICTE.

Results indicate that a number of private colleges are coming forward to impart agriculture education. There is a need for more serious dialogue on entry of private sector to maintain quality in agri-education. While initiatives by private sector are welcome as public sector alone cannot meet the increasing demand of the agri education sector, the public system should support these institutions to ensure quality in education. Financial support is extremely necessary to attract good and qualified teachers and establish quality research infrastructure. As agriculture education is not viable on commercial terms, teachers' selection and their salary should come from government so as to encourage private sector.

17.5.2 Agriculture at School Level

Agriculture education at lower level is no one's baby. Very few courses in agriculture subjects are taught in ITIs and Polytechnics and in schools. Agriculture education can be developed in a three tier system as is being done in engineering. Agriculture should also be introduced at school level as has been done in China and in some other countries so as to motivate students towards agriculture sector as many students are shying away from this sector. Madhya Pradesh has started the subject at school level and others may follow.

17.5.3 Urbanisation of Agri Education

Over the years, the enrolment of urban-based students has been on the rise in agriculture resulting into a continuous decline in share of rural students. The imbalance is due to the fact that urban students have better exposure and facilities and therefore have better competitive skills to corner the seats. There is a great reluctance from majority of trained human resources to work in rural areas as opportunities in rural areas are less attractive. They sometimes shift from this sector to other types of employment. There is a need to provide better opportunities to them

in the sector which can be given a serious thought for further probing. Some alternatives can be considered. One could be to reserve seats for rural students. Another option can be mechanisation and industrialisation of rural areas to attract qualified youth to work in rural areas. Yet another option can be to establish new colleges/ polytechnics in rural areas so that rural youth could join the agri. courses.

17.5.4 India as a Knowledge Centre

There is a general feeling that the country is not having high standard colleges of international standard except for few ICAR institutes and universities. While India is evolving as strong knowledge centre, it is time to establish few central universities with international quality standards providing education from UG to higher levels. The country can have minimum ten such universities, each providing education in growth areas of agriculture. The universities also need to have multidisciplinary focus to include agriculture with biological and social science disciplines and programmes. It is expected that such universities would provide high quality future human resource to teach and train at other institutions.

Agriculture has to meet the needs of the society at various levels. It has to serve the requirements of the industries as well as of farmers. It also has to keep pace with youth aspirations. It is the sole agent to ensure food security. Appropriate policy interventions for developing skills needed as per labour market indicators should be given a serious thought along with a revamp in educational expansion and its structure.

Bibliography

1. AFF, 2000. Study on Assessment of Manpower Needs and Development, A report prepared for CCS HAU, Hisar, Haryana by M/s A.F. Ferguson & Co., Delhi.
2. Agricultural Engineering (2002), in *The McGraw-Hill Encyclopedia of Science and Technology*. 9th ed. McGraw Hill: New York. ISBN 0079136656.
3. ASRB, 2011. Annual Reports for various years, Agricultural Scientists' Recruitment Board, Indian Council of Agricultural Research, New Delhi
4. Alam A (2006), *Future Requirements of Agricultural Machines for Mechanizing Agriculture*, Status of Farm Mechanization in India, pages 175-196. Taken from http://agricoop.nic.in/Farmper cent20Mech.per cent20PDF/05024-10.pdf
5. Anderson, E. G., Jr. 2001. The Nonstationary Staff-Planning Problem with Business Cycle and Learning Effects. Management Science. 47(6) , pp.817-832.
6. Anil Rai, S., D. Sharma, Prachi Misra Sahoo and P.K. Malhotra, 2008. Development of Livelihood Index for Different Agro-Climatic Zones of India, Agricultural Economics Research Review, Vol. 21 July-December 2008 pp. 173-182.
7. Anonymous, 2011. Animal Husbandry Statistics, Various years annual reports, Department of Animal Husbandry and Dairying, Ministry of Agriculture, GOI.
8. Basavaraj B. 2003, Supply-Demand Analysis of Professional Agricultural Manpower in Karnataka State, College of Agriculture, UAS, Dharwad.
9. Bartholomew, D. J. 1982. Stochastic models for social processes, Wiley. Chichester [England]; New York.
10. Bartholomew, D. J. and A. F. Forbes 1979. Statistical techniques for manpower planning, Wiley. Chichester [Eng.]; New York.
11. Bisht, B.S., Vizayakumar, K., and Sahu, K.C., (1996). Soybean Oil Processing Industry in India - Policy Perspectives, System Dynamics: An Int. J. of Policy modelling.
12. Bres, E. S., D. Burns, *et al.* 1980. A Goal Programming Model for Planning Officer Accessions. Management Science, 26 (8), pp773-783.
13. Challa, J., Joshi, P.K. and Tamboli, P., 2011, Revitalising Higher Aricultural Education in India, Economic & Political Weekly, Vol XLVI, Nos 26&27, pp326-329.
14. Chaturvedi, Sachin, 2002, Status and Development of Biotechnology in India: An Analytical Overview, RIS Discussion Paper No. 28/2002, Research and Information System for the Non-Aligned and Other Developing Countries.
15. CII & Yes Bank, 2008, Recommendation Paper on 'Developing Globally Competitive Fruit and Vegetable Value Chains in India', Confrontation of Indian Industry and Yes Bank.
16. CII & Yes Bank, 2010, 'Knowledge Report on the Indian Life Sciences Industry (Biotechnology), Confederation of Indian Industries, New Delhi.
17. CAA, 2008. Annual Reports of the Coastal Aquaculture Authority, Ministry of Agriculture, Government of India, Chennai.
18. Collart D. and Haurie A. 1980. On the control of care supply and demand in a urology department. European Journal of Operational Research 4, pp. 160–172.
19. CIAE, 2007, The Vision 2025 of CIAE, Central Institute of Agricultural Engineering, Bhopal.
20. CIFE, 2000. Report of the Brainstorming session on Human resources Requirements and HRD in Fisheries Sector, organized by CIFE, Mumbai.
21. CIFE, 2000, Manpower Requirements and Human Resource Development in Fisheries Sector, Education Division of Indian Council of Agricultural Research and Central Institute of Fisheries Education, Mumbai.
22. CIFE, 2010, Policy Guidelines & Framework for Fisheries and Aquaculture

Development in India, Central Institute of Fisheries Education, ICAR, Mumbai.
23. CSIR, 1993. Out turn of Scientific and Technical Manpower in India", HRD Group, CSIR, New Delhi, Vol. 1-4.
24. CSO, 2010. Annual Survey of Industries, Central Statistical Organisation, New Delhi
25. CSO, 2011. Annual Reports for various years, Central Statistical Organization, Government of India, New Delhi.
26. DAC-GOI (2007). Strategies for Employment Generation in Agriculture. Report of the National Policy for Farmers. http://agricoop.nic.in/NPF/npff2007.pdf
27. DAC, 2008. Agriculture Situation in India, various issues of the monthly publication of Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.
28. DAC, 2011. Agricultural Statistics for various years, DAC, Ministry of Agriculture and Cooperation, Govt of India, New Delhi.
29. DAC, 2011, Annual Reports for various years, Ministry of Agriculture and Cooperation, Government of India, New Delhi.
30. DARE, 2011. ICAR and DARE Annual Reports for various years
31. DBT, 2010. Annual Report 2008-09, Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
32. David Hills, 2004, "Agricultural engineering." in *The Engineering Handbook* (2nd ed). CRC Press. ISBN 0849315867. pp. 190-1 to -9.
33. Deane R.T. & Yett D.E. 1979. Nurse Market Policy Simulations Using an Econometric Model. Research in Health Economics 1, 255–300.
34. Denton F.T., Gafni A. and Spencer B.G. 1995. The SHARP way to plan health care services: a description of the system and some illustrative applications in nursing human resource planning. Socio Economic Planning Sciences 29, pp. 125–137.
35. DST. 2010. Research and Development Statistics 2007-08. Department of Science and Technology, New Delhi
36. Duraiswamy N.G., Welton R. and Reisman A. 1981. Using computer simulation to predict ICU staffing needs. Journal of Nursing Administration 11, pp. 39–44.
37. EXIM Bank, 2006. Floriculture: A Sector Study, Occasional Paper No. 112 of the Export- Import Bank of India.
38. FAI, 2010. Fertilizer statistics, Fertiliser Association of India, 2010.
39. Fulton, O., Gordon, G. and William, G., 1982. Higher Education and Manpower Planning. ILO, Geneva.
40. Gaimon, C. and Thompson G.L., 1984. A Distributed Parameter Cohort Personnel Planning Model that Uses Cross-Sectional Data. Management Science, 30(6), pp 750-764.
41. Gass, S. I., R. W. Collins, *et al.* 1988. The Army Manpower Long-Range Planning System. Operations Research, 36(1) 5-17.
42. GOI, 2007, 'XI Five Year Plan' Government of India
43. GOI, 2007, Report of the Working Group on Horticulture, Plantation Crops and Organic Farming for XI Plan, Planning Commission, Government of India.
44. GOI, 2009, FAIDA, Ministry of Food Processing Industries, Government of India
45. GOI, 2010. Ministry of Food Processing Industries, Government of India 'Vision Document-2015'.
46. GOI, 2011. Economic Survey for various years, Govt. of India, New Delhi.
47. Grinold, R. C. 1976. Manpower Planning with Uncertain Requirements. Operations Research. 24(3) pp. 387-399.
48. Hanssmann, F. and Hess, S. W. 1960. A Linear Programming Approach to Production and Employment Scheduling. Management Technology 1(1) pp. 46-51.

49. Holz, B. W. and Wroth, J. M. 1980. Improving Strength Forecasts: Support For Army Manpower Management. Interfaces 10(6) 37.
50. Holt, Modigliani C. C., F., *et al.* 1960. Planning production, inventories, and work force, Prentice-Hall. Englewood Cliffs, N.Y.
51. IAMR, 1979. Agricultural Manpower Planning, Training and Utilization, Country Profile Study - India. FAO, Rome.
52. IAMR, 1991. Estimation of Stock of Different Categories of Manpower up to 2001 AD. Institute of Applied manpower Research. New Delhi.
53. IAMR, 2001. Assessment of National Manpower Needs in Agriculture and Allied Sector. Institute of Applied Manpower Research (IAMR), New Delhi.
54. IAMR, 2008, National Technical Manpower Information System (NTMIS); Technical Manpower Review for various years, Institute of Applied Manpower Research, Delhi.
55. IASRI, 2010. Agricultural Research Data Book, Various Years, and PEMISNET II data (as on 23/4/2010), Indian Agricultural Statistics Research Institute & Indian Council of Agricultural Research, New Delhi.
56. ICAR, 1995. Report of Third Deans' Committee on Agricultural Education in India. ICAR, New Delhi.
57. ICAR, 1999. Report on Accreditation for Quality Assurance in Agricultural Education, ICAR, New Delhi.
58. ICAR, 2001. Report of Expert Committee on Agricultural Education Outside Agricultural University System. ICAR, New Delhi.
59. ICAR, 2003. Status of agriculture education in India, (Agenda Notes for Inter-Session Meeting of the Consultative Committee of the Ministry of Agriculture – 6th February, 2003, Mysore), Education Division, ICAR, New Delhi.
60. ICAR, 2005a. Status of agriculture education in India (from the data collected by ICAR to prepare the report on agricultural education for meeting of the Consultative Committee of the Ministry of Agriculture), Education Division, ICAR, New Delhi.
61. ICAR, 2005b. Report on modalities for starting certificate / diploma programmes, Committee constituted in the SAUs VCs conference held at Haffkine Institute for Research and Training, Mumbai during Feb 4-5, 2005, Education Division, ICAR, New Delhi.
62. ICAR, 2005c. Report of Fourth Deans' Committee on Agricultural Education in India. ICAR, New Delhi.
63. ISNAR.1982. A Manpower and Training Plan for the Agricultural Research System in Kenya, ISNAR, The Hague.
64. ISNAR.1989. Agriculture Research Indicator Series", ISNAR, The Netherlands.
65. Italia, 2010. Agricultural Education in India - Industry Profile 2010. The Italian Trade Commission, Kolkata. Taken from www.ice.gov.it/.../india/.../Agriculturalper cent20Mechanizationper cent20inper cent20India-per cent20Profileper cent202010.pdf
66. Jha, Brajesh, 'India's Dairy Sector in the Emerging Trade Order', Institute of Economic Growth, New Delhi
67. Jha Dayanatha, Kumar Sant and Joshi Lakshmi, 2007. 'Resources for Horticultural Research in India', National Centre for Agricultural Economics and Policy Research , New Delhi.
68. Joshi, P.K., 2005. http://www.isid.ac.in/~pu/dispapers/dp05-01.pdf
69. Kirti Singh, 1995. Agricultural Education in India in "Higher Education in India". Ed. Powar, K.B. and Panda S.K., Association of Indian Universities, New Delhi.
70. Krepl V, 2008. *Manpower Development in Agricultural Engineering in Selected Developing Countries*, Czech University of Life Sciences Prague, Czech Republic ITS CULS Prague, 160 21 Prague 6 Suchdol, Czech Republic.

71. Kulkarni, S D, 2010. Mechanisation of Agriculture - Indian Scenario, Central Institute of Agricultural Engineering (CIAE), Bhopal, India. Taken from *www.unapcaem.org/Activitiesper cent20Files/A09105thTC/.../in-doc.pdf*
72. Lee Hong Tau and Sheu Hua Chen. 2001. Fuzzy regression model with fuzzy input and output data for manpower forecasting. Fuzzy Sets and Systems,119, pp.205-213. http://ir.lib.ncut.edu.tw/bitstream/987654321/1685/1/per centC3per centA9per centE2per cent84per centA2per centC2per centB3per centC3per centA7per centC2per centA7per centE2per cent82per centACper centC3per centA8per centC2per cent8Fper centC2per centAFper cent20j10.pdf .
73. Mandal, P., Mohapatra, P.K.J., Jain, A., and Sangh, V.K.C., 1992. Analysis of scientific manpower flow scenarios for an R&D organization. J. of Sci. and Industrial Research, Vol. 51 pp. 685-692.
74. Mandal, P., 1993. A system dynamic model for food production. An Int. J. of Policy Modelling 6 (1): 5-25.
75. Mohapatra,P.K.J., Mandal,P., and Bora, M.C., 1994. Introduction to System Dynamics Modelling, University Press, Hyderabad.
76. Mohapatra, P.K.J., Mandal, P., and Saha, B.K., 1990. Modelling age and retirement in manpower planning. Int. J. Manpower 11 (6) : 27-31.
77. NAARM, 2011. Compiled Data on Students Intake and Out turn by Agricultural Universities for Various Years.
78. NCAP, 2002. Census of Agricultural Scientists (2001-02) (unpublished data), NCAP, New Delhi.
79. NCUI, 2009, Indian Cooperative Movement: A Statistical Profile, National Cooperative Union of India, New Delhi.
80. NDRI, 2010. Report of the National workshop on 'Issues and Roadmap for Dairy Education and Research in India', Organized by National Academy of Dairy Science & National Dairy Research Institute, Karnal.
81. NHB,2009, 'National Horticulture Board, Ministry of Agriculture and Cooperation, Indian Horticulture Database- 2009' Government of India.
82. NSS, 2003. NSS unit level data 59th Round on Statistics Assessment Survey of Farmers.
83. NKC, 2008. Vocational Education & Training, National Knowledge Commission, Annexure-1: Base line, Govt of India.
84. Pakki Reddy (Ed), 2005. Biotechnological Interventions for Dryland Agriculture: Opportunities & Consraints, BS Publications.
85. Pandey, M.M (2006), Present Status and Future Requirement of Farm Equipment for Crop Production, Status of Farm Mechanization in India, Ministry of Agriculture, GOI, Delhi. Taken from http://agricoop.nic.in/Farmper cent20Mech.per cent20PDF/05024-05.pdf , 69-113.
86. Penning F W T, Klass Metselaar, System approach for agricultural development,
87. Planning Commission, 2003, Report of the Committee on Development of Bio-Fuel, Government of India, New Delhi.
88. Planning Commission, 2006. Report of the Working Group for the XI Five Year Plan (2007-12) on Crop Husbandry, Agricultural Inputs, Demand and Supply Projections.., Planning Commission, Government of India, New Delhi.
89. Planning Commission, 2006. Report of the working group for the XI Five Year Plan-2007-12 on Fertilizer Industry, Planning Commission, Government of India, New Delhi.
90. Planning Commission, 2007. Report of the working group on Horticulture for the formulation of 10th Five Year Plan, Planning Commission, Govt. of India, New Delhi.

91. Planning Commission, 2007, Report of the working group for the XI Five year Plan 2007-12 on Forestry, Planning Commission, Government of India, New Delhi.
92. Planning Commission, 2007. Steering Committee on Agriculture and Allied Sectors for formulation of the XI Five Year Plan (2007-2012), April.
93. Planning Commission, 2008. XI Five Year Plan, Vol.III., Planning Commission, Government of India, New Delhi.
94. Planning Commission, 2011. Mid-Term Appraisal of the XI Five Year Plan, Planning Commission, Government of India, New Delhi.
95. http://planningcommission.nic.in/plans/mta/XI_mta/chapterwise/chap6_edu.pdf
96. Psacharopoulos, G., Hinchliffe, K., Dougherty, C. and Hollister. R. (1983). Manpower issues in Educational Investment. World Bank Staff Working Papers Number 624, The World Bank.
97. Psacharopoulos, G.. (1990). Why Educational Policies can fail: An overview of Selected African Experiences. World Bank Discussion Paper Number 82, The World Bank.
98. Psacharopoulos George. An Input-Output Model for the Assessment of Labor Skill Requirements. Higher Education. 2(4), 1973, pp. 461-474. http://www.jstor.org/stable/3445668.
99. Raghavendra B. G. 1991. A Bivariate Model for Markov Manpower Planning Systems. The Journal of the Operational Research Society. 42(7), pp. 565-570.
100. Rama Rao, D. and Muralidhar, U. 1994. AGRIUNIS Report. NAARM, Hyderabad, India.
101. Rama Rao, D. and Kalla, J.C., 1995. Performance of Students in NET in Agriculture", Seminar on "Performance of Students in National Eligibility Test", Osmania University, Hyderabad, August 18-19.
102. Rama Rao, D., Muralidhar, U. and Jagdessh C. Kalla, 1996. Profile of Scientific Staff in Agricultural Universities in India. European Jounral of Agricultural Education and Extension, 3(2), 119-129.
103. Ramarao, D., R. V. Kumari and E. Haribabu. 2000. Agricultural education in India: a sociological perspective. Outlook, 29: 177-184.
104. Rama Rao, D., Vizayakumar, K., and Narsinghani, S., 2000. Design and analysis of demand and supply for edible oil in India, Proceedings of the ninth National Conference on System Dynamics, December 26-29, Hyderabad, pp 40-54.
105. Rowat, R., 1980 & 1983. Trained Manpower for Agriculture and Rural Development. FAO Publication Number 10, FAO, Rome.
106. Sacheti, A.K and Salooja, M. K., 2000, Skilled Manpower in Agriculture – Prospects and Modalities for Development, Pandit Sunderlal Sharma Central Institute of Vocational Education, Bhopal.
107. Sastry NSR and S Ramalinga Raju, 2006. Para-veterinary Training Programs in Andhra Pradesh - Programmes, Curricula & Evaluation, A joint study by Swiss Agency for Development and Cooperation and Government of Andhra Pradesh, Hyderabad.
108. Sasidhar, P.V.K., 2009, Poultry Science Education and Human Resource Planning for Poultry Sector, Central Avian Research Institute, Izatnagar.
109. Singh, G., 2000."Agricultural Engineering Education in India". *Journal of Scientific Research and Development*. Vol. II. October 6.
110. Sirikanokwilai Nichakorn, Suwit Wibulpolprasert and Paichit Pengpaiboon. 1998. Modified population-to-physician ratio method to project future physician requirement in Thailand. Human Resources for Health Development Journal (HRDJ). 2(3), pp. 197-209. http://www.moph.go.th/ops/hrdj/HRDJ5/HRDJ2.3/NICHA13.PDF .
111. Shivanagaraju, C., Mahanty, B., Vizayakumar, K., and Mohapatra, P.K.J., 1998. Beta-distributed age in manpower planning models, Applied mathematical Modelling, Vol. 22, pp. 23-37.

112. Škulj Damjan, Vasja Vehovar and Darko Štamfelj. 2008. The Modelling of Manpower by Markov Chains – A Case Study of the Slovenian Armed Forces. Informatica. 32, pp. 289–291. http://www.informatica.si/PDF/32-3/07_Theper cent20Modellingper cent20ofper cent20Manpowerper cent20byper cent20Markovper cent20Chains.pdf.
113. Song F. and Rathwell T. 1994. Stochastic simulation and sensitivity analysis: Estimating future demand for health resources in China. World Health Statistics Quarterly 47, pp. 149–156.
114. Susiganeshkumar E. and R. Elangovan. 2010. Prediction of Manpower Wastage in Tamil Nadu Software Industry Using Cox's Regression Approach. International Transactions in Mathematical Sciences and Computer. 3(1), pp. 27-44. http://www.aacsjournals.com/download/paperfreepdf/004itmsc31.pdf
115. TCS, 2000. Study of Manpower Needs of the Agriculture Sector in Tamil Nadu. Government of Tamil Nadu. Tata Consultancy Services, Chennai.
116. Tessaring Manfred. 1998. The future of work and skills Visions, trends and forecasts. Vocational education and training – the European research field Background report. 1, pp. 270-316.
117. TOI, 2010. The Times of India, September 25,2010, New Delhi.
118. Trivedi V., Moscovice I., Bass R. and Brooks J. 1987. A semi-Markov model for primary health care manpower supply prediction.Management Science 33,pp.149–160.
119. VCI, 2011. Annual Reports for various years, Veterinary Council of India, New Delhi.
120. Visalakshi, S., 2001. Manpower requirements in biotechnology and strategies to achieve them - international and Indian experiences, International Journal of Biotechnology 2001 - Vol. 3, No.1/2 pp. 199-216.
121. Vizayakumar.K., 1990. A study on some aspects of environmental impact analysis. Ph D Thesis, Department of Industrial Engineering and Management, Indian Institute of Technology, Kharagpur.
122. Willems Ed. 1996. Manpower Forecasting and Modelling Replacement Demand: An Overview. Research Centre for Education and the Labour Market. ROA-W-1996/4E, http://edocs.ub.unimaas.nl/loader/file.asp?id=528 .
123. World Bank, 2006. Skill development in India. The vocational education and training system. Human Development Unit, South Asian Region, The World Bank.
124. www.icar.org.in
125. www.agriclinics.net
126. www.commodityindia.com
127. www.tradeindia.com
128. www.theindiandairyindustry.com
129. http://nfdb.ap.nic.in
130. www.oie.int/eng/info/en_infold.htm
131. www.baif.org
132. www.indiastat.com

Annexures