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REPORT OF THE WORKING GROUP ON AGRICULTURAL RESEARCH AND EDUCATION FOR THE FORMULATION OF EIGHTH FIVE-YEAR PLAN

(1990-1995)

PLANNING COMMISSION
GOVERNMENT OF INDIA
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PREFACE

1. The Planning Commission had constituted a Working Group on Agricultural Research and Education for the formulation of the Eighth Five-Year Plan vide its letter No. M-12043/3/87-Agri. (IV) of 30 September 1988. The Group had its first meeting on 23 and 24 November 1988 and another meeting on the 4 and 5 May 1989. The Group was informed of the major recommendations of the ICAR Review Committee under the Chairmanship of Dr G.V.K. Rao. These recommendations have been kept in view while considering the Eighth Plan priorities in agricultural research and education. It was decided to constitute seven sub-groups to look into specific areas such as new frontiers, remedying imbalances among regions and commodities, research and training oriented towards economically handicapped sections, conserving environmental assets, strengthening inter-institutional and inter-disciplinary linkages, human resource development and financial resources. The sub-groups met several times and their reports were considered at the meeting held on 4 and 5 May 1989. Based on the conclusions at this meeting, a draft report was prepared and circulated among Vice-Chancellors of Agricultural Universities, Directors of ICAR Institutes and Senior Scientists of ICAR headquarters. Meetings were held with them on 9 and 10 July. The final meeting of the Working Group was held on 11 July when this report was finalised.

2. The Working Group considers that the nineties will constitute a critical decade in our agricultural history. We will have to produce in the coming decade as much additional quantities of rice and wheat as we had produced during the past two decades. Large increases are needed in the production of pulses, oilseeds, fodder, foodgrains, fuel wood, fruits, vegetables, milk, meat and eggs, and a wide range of industrial and plantation crops. Such increases will have to come not withstanding our diminishing land resources and the expanding biotic and abiotic stresses. Also, the economic viability and ecological sustainability of advances in terrestrial and aquatic productivity will have to be ensured. The Working Group went into all aspects of improving the sustainability, stability, productivity and profitability of major farming systems in the country.

3. *Our analysis shows that there is no future for our agriculture unless it becomes knowledge-intensive and is oriented towards the generation of more income and skilled jobs.* Our rural population is predominantly young and it will be difficult to attract or retain youth in agriculture unless agriculture becomes both intellectually stimulating and economically rewarding. Also, special efforts are needed to ensure that new technologies reach the unreached and that women participate actively in technology development, dissemination and adoption.

4. Jawaharlal Nehru, whose birth centenary falls this year, often reminded us that in view of our fast growing population, we have to run twice as fast to remain where we are. This is particularly true in the matter of improving agricultural production through both productivity improvement and

higher intensity of farming. Fortunately, we are blessed with rich biological diversity in plants, farm animals and fishes. We also have frontier technologies such as biotechnology, information technology, space technology and management technology, new opportunities for enhancing the economic and social value of traditional technologies. The Working Group has suggested for this purpose the establishment of *Genetic Enhancement Centres (for transferring valuable genes across sexual barriers) and Technology Blending Centres.* Genetic engineering has greatly enhanced the value of our rich genetic estate. During the nineties we should harness the best in modern science to serve small farmers. Over 90 million out of 100 million operational holdings in the country belong to the small and marginal farmers categories. A small farm is ideal for knowledge-intensive agriculture. A small farmer suffers from numerous handicaps arising from the cost-risk-return structure of farming. Hence, during the Eighth Plan period there has to be a greater integration of social sciences and social engineering with physical and biological sciences. Social scientists should play a proactive rather than a reactive role in the determination of research strategies and priorities.

5. We are fortunate in having a fairly widespread infrastructure for agricultural research and education consisting of a national grid of agricultural universities, deemed universities, central institutes, national bureaus, national research centres and all India co-ordinated projects covering all aspects of crop husbandry, animal husbandry, fisheries and agro-forestry. Unfortunately, we are not able to derive full benefit from this infrastructure due to sub-critical funding and inadequate experimental facilities. Most of the available resources go to meet staff salaries and the per capita resource back up to scientists is sub-optimal.

6. New methods of organisation of research are needed during the next decade. In selected areas, such as pest and water management, a mission mode of looking into the totality of problems will have to be introduced with clearly articulated objectives and time targets. It will be necessary to develop strategic research linkage centres to provide the necessary interface between strategic research and applied research.

7. The ICAR will have to develop a consumer-contractor relationship with other science departments and private industry and in the process generate additional resources for supporting its research and extension education programmes. Unlike other science departments/councils, the ICAR has the responsibility of UGC to support Agricultural Education in the country. Over 66% of the Seventh Plan allocation had been utilised for supporting the programmes on education, research and extension in the State Agricultural Universities (SAUs). The allocation of resources in the Seventh Plan to the agricultural research and education sector has been much smaller both in proportion to the other science departments as well as in relation to previous plans.

8. There is need for a massive investment in agricultural research and education for upgrading laboratory equipment, pilot plants, farm and laboratory facilities as well as in manpower training specially in frontier areas. There was a large resource available under Indo-US co-operation in sixties which had helped the establishment of the SAUs. This support has not been available in the seventies and eighties. It is necessary that sufficient financial resources are provided for training young scientists in advanced laboratories and institutions.

A number of institutions/centres were started in the later part of Sixth and Seventh Plans. Due to serious shortage of financial resource, major infrastructure facilities for these institutions are yet to be developed. Funds for completing the unfinished tasks of the Seventh Plan should be a priority charge on Eighth Plan funds.

9.1 **Agricultural Universities.** No further expansion is necessary in terms of creating new universities but every effort should be made to strengthen the existing State Agricultural Universities in frontier areas of science and enhance their capacity for greater relevance and excellence in their educational programmes. The SAUs should be encouraged to develop strong and meaningful linkages with rural universities and womens' universities. They should also undertake the responsibility of providing technical guidance to the National Wasteland Development Board and Jawahar Rozgar Yojna. In addition, they should organise a wide range of short term non-degree training programmes in agriculture and rural development. Suitable members (women and men) of *gram panchayats* should be trained in scientific land and water management in order to ensure that high productivity does not erode ecological sustainability. SAUs should also give special attention to the generation of more income and opportunities for skilled employment in villages. A Central University of Agriculture sanctioned for the N.E. region during the Seventh Plan should be made fully operational during the Eighth Plan.

9.2 **ICAR Institutes.** No new institute is proposed to be established. But a few national centres such as National Research Centre for Technologies for Farm Women and a National Research Centre for Agricultural Exports should be established. The vacant positions in existing institutes can be suitably redeployed to undertake priority areas of research. The capacity of ICAR institutes to undertake mission-oriented strategic research has to be strengthened. For this purpose, the Working Group recommends a one time grant of Rs 200 crores in order to equip in an appropriate manner the National Research Institutes and Centres to achieve the desirable blend of traditional and frontier technologies. A major effort should be made to strengthen the capacity for comunication and training including the preparation of software for the media and educational resources for schools and colleges.

9.3 **National Bureaus.** The Bureaus of Plant, Animal and Fish Genetic Resources should be considerably strengthened in order to conserve for posterity the fruits of thousands of years of natural evolution and human selection. Conservation of biological diversity and sustainable management of land and water should be accorded very high priority. A bio-fertilizer germplasm centre should be established in order to conserve useful micro-organisms, capable of biological nitrogen fixation. Beneficial insects which are of value in biological control of pests, should also be conserved.

10. To sumup, the major thrusts in agricultural research and training programmes during the Eighth Plan period will be to enhance in an ecologically sustainable manner, the productivity, stability and profitability of major farming systems in the country. A massive effort should be made to strengthen existing mechanisms for technology transfer through the Lab-to-Land Programme, National Demonstrations, Operational Research Projects and Krishi Vigyan Kendras. The dimension of off-farm employment should be added to Krishi Vigyan Kendras through collaboration with

the

CSIR in the case of rural industry and the Ministry of Environment and Forests in the case of Agro-forestry and social forestry. In addition a Rural Systems Research Programme should be initiated during the Eighth Plan period for linking the primary, secondary and tertiary sectors of the rural economy in a mutually reinforcing manner.

11. The farm sector has to provide jobs for over 70% of our population. The dimensions of the scientific challenge facing the country are vast. Fortunately, we have the scientific manpower and essential infrastructure to tackle the new challenges. However, present per capita output of scientists is low in view of a grossly inadequate resource back-up . Serious brain drain cannot be avoided if we are not able to provide young agricultural scientists with the facilities they need to deliver results. Therefore, the Working Group urges the Planning Commission to step up very considerably the allocation for farm research and education during the Eighth Plan period. At the same time, we urge ICAR to implement the structural changes suggested by the Dr G.V.K. Rao Committee and by us as soon as possible, without waiting for the commencement of the Eighth Plan. Without linking authority and accountability in a mutually reinforcing manner at all levels, it will be difficult to impart the needed extent of dynamism in research and educational efforts.

We wish to record our deep sense of gratitude to Dr N.S. Randhawa, Director-General of ICAR for his very active participation in our work and for providing the help of his colleagues in ICAR.

Dr R.M. Acharya, Deputy Director-General of ICAR who served as Member-Secretary of the Working Group gave very substantial support to the work of the Group and played a key role in the preparation of this report. The Working Group is indebted to him for this help.

We are also grateful to Dr S.S. Khanna, Adviser (Agriculture), Planning Commission, for all the help and the guidance we received from him.

(M.S. SWAMINATHAN)
Chairman
Working Group on
Agricultural Research and
Education

INTRODUCTION

In pursuance of the decision taken at the meeting of the Steering Group on Agriculture and Allied Sectors held on 15 July 1988, the Planning Commission constituted a working group for the formation of the Eighth Plan — vide Order No. M-12043/3/87-Agri. (IV), dated September 30, 1988 in the area of Agricultural Research and Education. The composition of the Working Group is given in Annexure I. The terms of reference of the Working Group were:

(i) To make a critical review of the achievements in the field of agricultural research and education during the Seventh plan period and make proposals for implementation in the Eighth Five-Year Plan:

(ii) To recommend strategy and approach of research, education and training for agricultural development with reference to target groups, specific areas and infrastructure development. This may take care of the problems of hill areas, tribal areas, North-Eastern region, etc.

(iii) To suggest measures for ensuring effective co-ordination in the field of agricultural research in the State sector;

(iv) To examine further scope of linkages between research activities and agricultural development programmes;

(v) Critically examine the existing staff strength in Central Research Institutes and the non-plan (Committed) expenditure involved. Proposals for incremental staff required for various Central Research Institutes are to be carefully examined;

(vi) To review the working of NARP aimed at rectifying the regional imbalance in agricultural research and suggest suitable improvement in its functioning;

(vii) Higher yields of different agricultural crops are reported to have been obtained under irrigated conditions and with the adoption of package of practices at demonstration farms and experimental stations at the ICAR. The Working Group may examine the scope of their multiplication at farmers' fields through various measures aiming at transfer of technology, improved delivery system for input supply, etc.; and

(viii) To examine further scope of research possibilities in the fields of rainfed farming and dryland farming and make suitable proposals for implementation under the Eighth Plan.

At its first meeting held on 23 and 24 November 1988, the Working Group constituted seven sub-working groups in the following areas with membership indicated in Annexure II.

1. Frontier technologies
2. Remedying imbalances in progress among regions and commodities
3. Research and training needs of economically handicapped sections of the community, equity considerations and research on delivery systems

4. Conservation of environmental assets, improvement in productivity and linking it with profitability and equity
5. Agricultural research and education and strengthening inter-institutional and inter-disciplinary linkages including international collaboration
6. Human resources development
7. Financial management and programme implementation

The Working Group had its final meeting during 9-11 July 1989 in which the draft circulated in advance was discussed with Directors and senior oficers of ICAR, Vice-Chancellors of State Agricultural Universities and members of Working Group. The sub-groups met several times and their reports were circulated among all members and were discussed in the final meeting of the Working Group. The Committee had the benefit of active participation and advice of Dr N.S. Randhawa, Director-General, ICAR and Secretary, DARE and all senior officers at the Headquarters.

The observations, conclusions and recommendations of the Working Group are presented in this Report. *The activities and programmes recommended should be implemented in accordance with the 15 major agro-ecological zones identified by the Planning Commission.*

CONTENTS

CHAPTER 1

PERSPECTIVE: IMPARTING A NEW DYNAMISM TO AGRICULTURAL RESEARCH AND EDUCATION

The nineties will constitute a critical decade in our agricultural history. We will have to add to total production in the coming decade as much quantities of rice and wheat as we produced during the last two decades.

Table 1 shows the production of major agricultural commodities in 1950-51 & 1989-90. Large increases are also needed in the production of pulses, oilseeds, fodder, foodgrains, fuel wood, fruits, vegetables, milk, meat and eggs and a wide range of industrial and plantation crops. Such increases in production will have to come despite our diminishing land resources and the expanding biotic and abiotic stresses. Also the economic viability and ecological sustainability of advances in terrestrial and aquatic productivity will have to be ensured. Above all, the farm sector will have to provide more opportunities for skilled jobs, if we are to overcome the growing famine of jobs. *The major food security challenge now is economic access to food arising from inadequate purchasing power.* Agricultural research has to be geared to improve the productivity, profitability, stability and sustainability of major farming systems in the country involving crop husbandry, animal husbandry, fisheries and forestry. An agroecological orientation will be necessary for land and water use planning in order to derive maximum benefit from the prevailing conditions. Finally, advances in productivity must be coupled with equity and social justice.

Our analysis shows that there is no future for our agriculture unless it becomes knowledge-intensive and is oriented towards the generation of more income and skilled jobs. *Our rural population is predominantly young and it will be difficult to attract or retain youth in agriculture unless agriculture becomes both intellectually stimulating and economically rewarding.* Also special efforts are needed to ensure that new technologies reach the unreached and that women participate actively in technology development and its adoption.

MAJOR GOALS OF AGRICULTURAL RESEARCH AND EDUCATION

The principal goals identified by the Working Group are as follows:

1. To enhance productivity, profitability, stability and sustainability of major farming systems involving various blends of crop husbandry, animal husbandry, fisheries and forestry.
2. To increase the share of agriculture in national income as well as export earnings.
3. To make education a powerful instrument for development and spread of ecologically sound, economically viable and knowledge-intensive agricultural technologies.

4. To improve:
   (a) The quality of life of economically and socially disadvantaged sections of the rural population through better growth linkages among the primary, secondary and tertiary sectors of economic growth and between on-farm and off-farm employment.
   (b) The productivity of ecologically handicapped regions of the country.
   (c) The nutritional standards of human population.
5. To remedy imbalances in the improvement of different agricultural commodities and regions.

The group recommends that for determining future research strategies and thrusts, the country may be divided into seven major operational zones on the basis of the nature of the scientific challenges involved:

(a) Green Revolution Areas

To sustain and expand production; this will involve maintenance research on the one hand and forward edge research on the other.

(b) Green but no Green Revolution Areas

These cover the entire eastern India where water and nutrient management and not water is the principal constraint.

(c) Montane Eco-systems

The unique ecological assets of the Himalayas, Western and Eastern Ghats and Vindhyas should be managed in a sustainable manner. Montane eco-systems deserve added attention since damage upstream can cause great damage downstream. For example, the future of Indo-Gangetic agriculture depends very much on the ecological health of the Himalayas.

(d) Semi-arid Areas

The strategies so far developed for increasing and stabilising yields under diverse soil, precipitation, evapo-transpiration and groundwater conditions and topo-sequence and other variables need to be tested and demonstrated on a large scale. Social engineering aspects relating to saving and sharing water need attention.

(e) Arid Areas

The hot and cold deserts of the country provide good opportunities for animal husbandry, horticulture, seed production and agro-industries. The cold desert also provides an opportunity for establishing *ex-situ* gene banks under permafrost conditions.

(f) Coastal eco-systems

The 8,000 km coastal stretch provides great opportunities for integrated crop-animal

husbandry-fish production systems and for establishing export-oriented agricultural and horticulture enterprises. High-tech aquaculture deserves special attention. For developing coastal area agriculture, it would be useful to consider 20 km of land surface and 20 km of sea surface in an integrated manner.

(g) Island Eco-system

The rich island ecosystem both on our east and west coasts provides unusual opportunities for integrated production systems, for off-shore quarantine facilities and for eco-tourism.

The research strategies and priorities in each of these Science and Technology Zones should be developed on the basis of the fifteen agro-ecological zones delineated by the Planning Commission (Annexure III). For achieving the above goals, it is essential that work on all aspects of soil and water conservation, collection, conservation, evaluation and utilisation of plant, animal and fish genetic resources and monsoon monitoring and management, is strengthened considerably during 1990-1995. Also, the frontier areas of science and technology should be brought to the service of small farmers.

Technology Alert and Assessment

For this purpose, it is necessary to set up a Technology Alert and Assessment Centre at the ICAR headquarters for monitoring global trends in agricultural sciences, education and extension. Developments such as the growing trend towards privatisation of agricultural research in developed countries and intellectual property rights should be analysed and interpreted for national action. Similarly, developments in designing environmentally safe or green technologies should be studied. We have a large agricultural research and education infrastructure in terms of State Agricultural Universities (SAUs), Deemed Universities, Central Research Institutes, National Bureaux, National Research Centres, Project Directorates, All-India Co-ordinated Research Projects and a number of professional societies concentrating on all aspects of crop science, animal science, fisheries and forestry. A National Academy of Agricultural Sciences has also recently been formed. The National Agricultural Research Project initiated with a World Bank loan has helped SAUs to strengthen their regional research capability. The Group looked into this existing infrastructure with respect to geographical spread, adequacy of existing co-ordinating mechanisms, both inter- and intra-institutional, mechanisms for promoting inter-disciplinary research, major gaps in institutional structure, development and utilisation of human resources and duplication in research and education effort.

We are unable to derive full benefit from our agricultural research and education infrastructure because of subcritical funding and inadequate experimental facilities. Most of the available resources are currently expended on staff salaries and the per capita resource back up to scientists remains suboptimal.

There are various mechanisms for evaluation and monitoring of research projects both internal and external; such as in Central Institutes' Staff Research Councils and Management Boards/

Committees/Project co-ordinators and annual workshops for All India Co-ordinated Research Projects (AICRPs), external reviews through QRT for the institutes and mid-term appraisal committee for the AICRPs. The scientists at the headquarters have an important role in planning, evaluation and monitoring of research projects both at the institutes and under AICRPs as well as the *ad-hoc* projects funded out of A.P. Cess funds, U.S.-India funds, under bilateral cooperation and those funded by other agencies within the country and outside. The externally aided and bilateral co-operative projects have built-in mechanisms for periodical reviews through reports, six monthly and annual review meetings involving both the Indian and external members. *In addition to these mechanisms for internal and external review, there is a need for occasional stripe reviews covering a major sector.* Such a stripe review should cover all the work being done on a commodity or a factor of production or a major farming system under different institutional structures. For example, a stripe review on animal nutrition will cover all sources of nutrition, pastures, fodder grasses and legumes, non-conventional feeds, etc. We also recommend that *Management Reviews* be carried out concurrently with scientific reviews.

The output of a scientific organisation is the product of interaction between the competence and dedication of the scientists employed by the organisation and the management efficiency of those administering research. The role of management in the areas of strategy formulation, service and monitoring is critical.

The Group felt that there is a need for reviewing the linkages between research and development. The existing mechanisms for technology dissemination, viz. Operational Research Projects, National Demonstrations, Lab-to-Land programmes, KVKs/TTCs serve to provide first-line demonstration and feedback to the research system. They further allow testing of the proven-technologies with respect to their economic and social acceptability. The relationship between State Agricultural Universities and the State Departments related to agriculture, animal husbandry, fisheries and agro-forestry needs strengthening. At the central level, effective mechanisms of interaction need to be fostered between ICAR and Departments of Agriculture and Co-operation, Department of Rural Development, Indian Council of Forestry Research and Education, CAPART and other National Science Organisations such as DBT, ICMR, CSIR, DST, NDDB and Social Science Organisations such as ICSSR. Effective institutional mechanisms should be developed for strengthening the feedback relationship among them. Joint panels between ICAR and some of these agencies exist but they do not seem to be very effective. Similarly there is a research and extension co-ordination committee involving ICAR and DOA and C. The consultative process needs to be strengthened further.

Such interactions are extremely important to avoid duplication of research and development efforts and for developing co-operative programmes. Interaction with credit institutions such as NABARD and private and public sector industries such as National Seeds Corporation, State Agro-Industrial Corporations need to be developed or further strengthened. Every year a *National Agricultural Research Week should be organised by ICAR for top-level interaction among research strategists and scientists, development and extension agencies, credit institutions, ministers and policy makers and private and public sector industries and representatives of mass media.*

The Group feels that there is a need for review of existing facilities for human resource development, identifying major gaps by regions and disciplines and taking steps for upgradation of skills through national and international training, and through mechanisms for promoting continuing education and development. Mechanisms for integrating research, education and extension at the scientist level need strengthening. The National Agricultural Research Project (NARP) was initiated with an IDA loan to develop location – specific research and training competence in the State Agricultural Universities. It is in the middle of the second phase of implementation. This project should be utilised during the Seventh Plan period for remedying imbalances in scientific progress among different regions and commodities. The NARP should also become a major instrument for strengthening all aspects of research and training which are related to making advances in biological productivity for ecological sustenance.

There is need for strengthening research on delivery systems such as inputs (seeds and genetic material), implements, credit, knowledge and skill transfer and identifying economically viable technologies for self-employment. There is also need for integrating of agricultural and rural development with agricultural research and education and for initiating a *Rural Systems Research (RSR)* programme designed to identify opportunities for increased on-farm and off-farm employment

We recommend that every Agricultural University be entrusted with the following responsibilities by the concerned State and Central Government Departments with reference to one district.

(a) Planning for the improvement/restoration of biological potential of wastelands under the National Wasteland Development Programme based on sound principles of restoration ecology.
(b) Training Rural Youth for Self-employment (TRYSEM), based on a careful identification of economically viable opportunities for self-employment.
(c) Nehru Rozgar Yojana.

There is need for a careful review of international co-operation within the SAARC region, bilateral collaboration with individual countries, multilateral organisations such as UNDP, FAO, CGIAR institutes and collaboration with private and public sector industries.

There is need for improving agricultural production by raising productivity and higher intensity farming. Fortunately, we are blessed with rich biological diversity in plants, farm animals and fishes. New frontier technologies such as biotechnology, information technology, space technology and management technology offer new opportunities for enhancing the economic and ecological strength of traditional technologies. The Working Group suggests the establishment of *Genetic Enhancement Centres* for transferring valuable genes across sexual barriers both in plants and animals, *Strategic Research Linkage Centres* providing interface between strategic research and applied research and *Technology Blending Centres* to combine frontier and traditional technologies in synergetic manner. We strongly urge that the proposed:

(a) *Genetic Enhancement Centres;*
(b) *Strategic Research Linkage Centres; and*
(c) *Technology Blending Centres;*

be developed with the help of existing ICAR institutions and SAUs but should be given complete functional autonomy. The programmes should, however, be jointly developed by the users and concerned scientists. Teams of outstanding young scientists will have to be assembled at each Centre, to give meaning and content to this recommendation. If such instruments are not created during the Eighth Plan, we may be bypassed by the revolution now taking place in agricultural sciences.

Over 90 million of the 100 million operational land holdings in the country belong to small and marginal farmer categories. A small farm is ideal for knowledge-intensive agriculture. However, a small farm family suffers from numerous handicaps arising from the cost-risk-return structure of farming. *The production potential of a small farm can be realized only by helping small farmers overcome their handicaps.* There is scope for greater integration of social sciences and social engineering with physical and biological sciences.

New methods of organisation of research are needed during the next decade in priority areas. A mission mode method of looking into the totality of a problem will have to be introduced in selected areas with clearly articulated objectives and time targets. ICAR should initiate during the Eighth Plan period a few ecological pest management missions in order to achieve a substantial control of a few major pests, pathogens and weeds within a span of five years. Appropriate collaboration with the Commonwealth Institute of Biological Control could be developed to achieve the objectives within the specified time frame.

ICAR will have to develop consumer-contractor relationship with other science departments and private industry and in the process generate additional resources for supporting its research and extension education programmes. Unlike other science departments/councils, ICAR has the responsibility of UGC to promote and support agricultural education in the country. *Over 66% of the Seventh Plan allocation had been utilised for supporting the programmes on education, research and extension education in SAUs. The allocation of resources in the Seventh Plan to the agricultural research and education sector has been much smaller both in proportion to the other science departments as well as in relation to previous Plan periods. We consider this unfortunate since as stated earlier there is no economic future for small farm agriculture unless it becomes knowledge-intensive and efficient in management.*

There is need for a massive investment in agricultural research and education for upgrading laboratory equipment, pilot plants, farm and laboratory facilities as well as in manpower training, specially in frontier areas. There was a large resource available under Indo-US co-operation in the sixties which facilitated the establishment of the SAUs. This support has not been available in the seventies and eighties. It is necessary that sufficient financial resources are provided for manpower training in advanced laboratories and institutions abroad.

Since several institutions/centres were started in the later part of the Sixth and in the Seventh

Plan, the infrastructure facilities essential for these institutions to function at an optimum level could not be developed due to resource constraints. These institutions should be made fully operational during 1990-95 and should receive priority in resource allocation.

It may not be necessary to establish any new university but efforts should be made to strengthen the existing SAUs in frontier areas of science and enhance their capacity for greater relevance and excellence in their educational programmes. The SAUs should be encouraged to develop strong and meaningful linkages with Rural Universities and Women's Universities. They should also undertake the responsibility of providing technical guidance to agencies like National Wasteland Development Board and Jawahar Rozgar Yojana. The SAUs can promote the restoration of degraded lands through the use of tree species, particularly nitrogen-fixing tree species and soil binders. In addition, they can organise frequent non-degree training programmes in agricultural and rural development and train rural youth to provide relevant services to farming families. SAUs should also give special attention to the generation of more income and opportunities for skilled employment in villages. The Central University of Agriculture sanctioned for the North-Eastern Region during Seventh Plan should be made fully operational during the Eighth Plan.

The Eighth Plan period should be a period of consolidation and selective strengthening. *It should mark the beginning of a new era in agriculture where the best tools of biotechnology, space technology, information technology, and management technology are pressed into service for small farm agriculture and small-scale aquaculture.*

ICAR Review Committee Recommendations

The Working Group was informed of the recommendations made by the ICAR Review Committee especially with regard to delineation of responsibility as between the ICAR Research Institutes and SAUs, the need for integrating AICRPs on improvement of various crops/commodities/species of livestock with the institutes working on them and transfer of regional research stations of the ICAR institutes to the SAUs. The ICAR Review Committee had recommended that the ICAR institutes should concentrate primarily on basic and strategic research and research on problems of national importance. The regional problems should be tackled by ICAR only where they cannot be handled by the existing research infrastructure with the SAUs or where such infrastructure cannot be created in the near future.

The activities and responsibilities of the sub-stations of ICAR institutes in the light of the transfer of regional research responsibilities to the SAUs have earlier been reviewed by the Arakeri Committee. The continuance of the regional/sub-stations of the ICAR institutes should be reviewed in the light of the recommendations made by the committee and action taken before the beginning of the Eighth Plan, so that appropriate financial provision can be made in the concerned SAU budget from April 1989.

The Review Committee had also recommended integration of AICRPs on improvement of commodity/species with commodity/species institutes. The directors of the institutes were to be recognised as national leaders for co-ordinating the resident and co-operative research. They should

be assisted by joint directors for Co-operative Research who should be the co-ordinators exercising complete control over the budget and programme of the projects. The Working Group considered the recommendation and reiterates that such AICRPs be integrated with commodity/species institutes/ Project Directorates/NRCs.

Some AICRPs in operation do not fall strictly in the category of co-ordinated projects, not being multi-disciplinary, multi-locational, with defined targets and being time-bound. In such a case it may be desirable to develop a single disciplinary or inter-disciplinary multi-centre strategic research project with several locations based on specific needs of the areas to be served. Such network projects for strategic research would allow effective sharing of information and help to direct efforts to solve a specific problem. One of the centres may be located preferably and developed as lead centre and given the responsibility of co-ordination in the crop/species/commodity/discipline institute of SAUs.

With respect to the regional/sub-stations we offer the following guidelines:

1. The centre should be related to core programme(s) of the Institute e.g. off-season nursery, hot spot for disease and pest screening, exotic germplasm centre, genetic enhancement centre, etc.
2. It should be essential in the interest of remedying regional imbalances or representing an important ecosystem. Wherever feasible, centres of different ICAR institutes should be located together to share common facilities, as has been done by CSIR.

ICAR institutes should redeploy their resources towards strategic research areas. It will be necessary to equip them suitably to achieve the desirable blend of traditional technologies and frontier technologies. A major effort should also be made to strengthen the capacity for communication and training including the preparation of software for the media and educational resources for schools and colleges.

Conservation of biological diversity and sustainable management of land and water need to be accorded very high priority. This will not only involve plant, animal and fish genetic resources but also bio-fertilizer germplasm and germplasm of other useful micro-organisms. *ICAR should launch a major effort to halt the biological impoverishment of Indian agriculture*. For this purpose, high priority should be accorded to the conservation of both ecological and socio-economic key species.

The major thrust in agricultural research and training during the Eighth Plan period will be to enhance the productivity, sustainability and profitability of major farming systems in the country in an ecologically sustainable manner. A massive effort will have to be made to strengthen existing mechanisms for technology transfer. The dimension of non-farm employment will be added to the KVKs through collaboration with CSIR and KVIC in the case of rural industry and the Ministry of Environment and Forests in the case of agro-forestry and social-forestry. *Partnership both at the national and international levels will be a major goal of ICAR, since the complex field problems confronting our farmers today can be solved only through greater efforts in inter-institutional and inter-disciplinary collaboration.*

Support to the National Academy of Agricultural Sciences and Professional Societies and Journals

The health of a scientific enterprise can be measured by the state of professional organisations and journals existing in each area of science: Interaction among peers and a peer review of scientific papers are both facilitated by the existence of well organised science academies and societies. ICAR should extend substantial support to such organisations.

Priority for Research and Education Programme — Utilising Regional Committees

The working of regional committees should be streamlined in the light of the recommendations of ICAR Review Committee. The participation of the State Development Departments in addition to ICAR institutes and SAUs in the region should be ensured since it is basic to development of research and manpower training priorities. This will also allow proper sharing of research, training and extension education responsibilities between ICAR institutes and SAUs. Consideration should be given to bringing out extension literature jointly by the ICAR institutes and SAUs. It would be useful to constitute compact Research Strategy Committees for each of the 15 agro-climatic zones.

Table 1

Production of major agricultural commodities

Item		Unit	Year	
			1950-51	1988-89 (as on 7.7.89)
i)	Total foodgrains	million tonnes	50.8	172.18
ii)	Rice	million tonnes	20.8	70.46
iii)	Wheat	million tonnes	6.48	54.14
iv)	Maize	million tonnes	1.73	8.75
v)	Coarse cereals	million tonnes	15.38	32.65
vi)	Pulses	million tonnes	8.41	14.92
vii)	Oilseeds	million tonnes	5.61	17.79
viii)	Sugarcane	million tonnes	57.05	197.30
ix)	Cotton	million bales	3.04	8.69
x)	Jute and mesta	million bales	3.30	7.76
xi)	Fish	million tonnes	0.75	3.52
xii)	Wool	million kilograms	27.5	42.22
xiii)	Eggs	billion numbers	1,832	18,238
xiv)	Milk	million tonnes	17.2	48.70

CHAPTER 2

SEVENTH PLAN ACCOMPLISHMENTS : A REVIEW

The major objectives of the Seventh Plan were to provide a thrust to the following areas:

1. Conservation of genetic resources for improving production.
2. Increased production of oilseeds.
3. Increased productivity of horticultural crops.
4. Developing integrated farming systems.
5. Improvement in dry-farming technology.
6. Increased production of fodder, fuel, agro-forestry and also energy management.
7. Application of biotechnology for increased plant and animal productivity.

The major accomplishments during the Seventh Plan in different sectors of agricultural research, extension and extension education are reviewed here.

CROP SCIENCES

(a) Plant Genetic Resource Conservation

India is one of the eight important gene centres in the world. Greater emphasis was, therefore, laid during 1985-86 - 1988-89 and 1,10,411 accessions of various agricultural, silvicultural and other crops of importance were obtained from over 60 countries of the world. One hundred and seventy-three indigenous explorations were undertaken and 36,347 valuable accessions were collected and conserved. As many as 2,85,134 samples were cleared from quarantine and post-quarantine angle. A national gene bank with well-equipped long and medium term storage facilities was commissioned. This is now fully functional. More than one lakh accessions have already been stored during the last four years. Efforts are on to establish an effective network system for taking care of our rich genetic resources.

(b) Improving Crop Productivity

As a result of concerted efforts during the first four years of the Seventh Plan, performance in crop sciences had been quite impressive. In cereals (120), oilseeds (65), pulses (48) and commercial crops (28), a number of high-yielding varieties/hybrids possessing inbuilt resistance/tolerance to various biotic and abiotic constraints were identified/released.

Superfast growing and early maturing rice varieties possessing a fair degree of tolerance to moisture stress ('Sattari', 'Hira', 'Kalyani 2' and 'Annada') and high-yielding varieties for rainfed medium low lands ('Panidhan', 'Sabitri', 'Gayatri', 'Tulasi') have shown distinct possibility of revolutionising rice cultivation under uplands and medium low lands in traditional rice growing areas. The productivity barriers have been broken and ongoing efforts on-farm research have been intensified.

Disease resistant varieties in wheat suitable for late sown conditions ('HD 2285', 'HD 2270' and 'HI 977') and for rainfed early sown hill conditions ('VL 616') have opened ways for sustained productivity. Strategies adopted for development of rust-resistant varieties separately for each of the agroclimatic zones and their cultivation have helped to control rust almost completely for the last several years in the country.

Recently released maize hybrids and composites have paved the way for realising enhanced production in hill ('Sartaj', 'Navjot','Mansar', 'VL Makka 41' and 'VL Makka 88'), tribal and *rabi* maize growing conditions in different cropping systems ('Deccan 103', 'Ganga 11', 'Deccan 1', 'Dhawal').

Eight multiple disease resistant sorghum hybrids and varieties ('CSV 10', 'CSV 11', 'CSV 12', 'CSH 10', 'CSH 11', 'SPH 201', 'GJ 37' and 'CSH 12R') with high grain and fodder yields have been released. For striga sick areas, 'SAR 1' possessing high degree of resistance has also been released.

Pearlmillet early maturing hybrids in the offing ('HHB 67') and varieties ('MP 201' and 'MP 204') are expected to go a long way in enhancing gains in different multiple cropping systems and limited moisture availability situations. Downy mildew tolerant hybrids ('MH 169', 'MH 143') and variety 'MP 155' would provide a mosaic pattern in a contemplated sustainable production system.

Small millet promising varieties would arrest cropping shift and capitalise gains particularly in finger millet where as much as 50 q/ha yield has been recorded in national demonstrations. In other small millets too, the highest yield recorded in experimental fields has been to the tune of 42.47 q/ha. The first white seeded finger millet variety 'OUAT 2' (having protein content of 12 per cent) and salt tolerant variety 'TRI 1' for salt-affected soil conditions have been released.

In cotton where India had the distinction of evolving first hybrid cotton in the world, a breakthough has again been achieved by the development of interspecific hybrid in Desi cotton. A number of recently released/identified hybrids ['CICR HH 1' (40's counts), 'Savita' (60's counts) and 'H 224' (80's counts)] are in great demand and dependence on just a few hybrids has been overcome. A short duration variety – 'Vikas' – released during 1988 has been found suitable for *zaid* conditions in the northern region of the country. The white fly resistant variety – 'Kanchana' – has been released to combat high incidence of this pest in the coastal districts of Andhra Pradesh.

In groundnut, with the release of multiple foliar disease-resistant and drought-tolerant variety

'Girnar 1', the long felt instability in production in rainfed areas would be minimised.

New castor hybrid 'GCH 4', possessing inbuilt resistance to wilt, has started revolutionising castor cultivation in both irrigated as well as rainfed areas.

Sunflower hybrid 'MSFH 17' has recorded over 16 per cent higher seed and 23 per cent higher oil yields per hectare over the best hybrids available. Although the crop went into commercial cultivation over a decade back, with the recent release and notification of 7 hybrids sufficient choice has now become available in the sunflower belts. The crop has penetrated in the non-traditional irrigated areas in spring season, viz. Punjab and U.P. in a big way.

For the first time, 2 double purpose linseed varieties ('Gaurav' and 'Jeewan') having fibre- and seed-yielding abilities at par with the best flax and seed types have been released and notified. With this, a long felt dream of the thirties is now fulfilled. The first powdery mildew resistant variety - 'Jawahar 23' and first multiple resistant (wilt, rust and powdery mildew) variety 'Kiran'– are in great demand in the Central and Peninsular regions of the country.

In safflower, 'Malvia Kusum 305' released and notified, is acknowledged for its proven resistance to salinity/sodicity. It is expected to cover large areas in the Indo-Gangetic plains.

Early maturing and YMV resistant high yielding varieties of mungbean have brought additional area under summer cultivation in the north. In U.P. alone, summer cultivation of mungbean has crossed one million hectares. Further, early maturing varieties of mungbean ('PPM 54', 'DDM 1', 'Pusa 105', 'Pant Mung 1' and 'Pant Mung 3') and urdbean ('LBG 17' and 'UG 218') are becoming increasingly popular in rice fallows in the Peninsular India.

Development and popularisation of ascochyta resistant varieties of chickpea ('Gaurav', 'Pusa 267' and 'GMG 146') and sterility mosaic resistant varieties of pigeonpea ('Bahar' and 'DA 11') have made their dent in bringing the much needed stability of production in these crops. Early maturing varieties of pigeonpea ('Pusa 84', 'Manak' and 'ICPL 151') will bring non-traditional areas under it in the north-western plain zone. Some of the potential hybrids at the final stage of multilocation testing have shown the way for the exploitation of heterosis in pigeonpea for the first time.

During *rabi* season in north eastern plains, realisation of rajmash yield to the tune of 3 tonnes/ha with the newly evolved varieties, namely, 'PDR 14' has established grounds for the popularisation of the crop in the plains.

Newly evolved powdery mildew resistant *dwarf* and *leafless* genotypes of field pea have responded very well to the added doses of fertilizer and irrigation with enhanced yield. Hence, a breakthrough is round the corner in a crop where area under cultivation was continuously decreasing.

In forages, 'Bundel 1' a promising variety of Dinanath grass was released and notified in

1987 for cultivation in the entire country with a yield potential of 60-70 tonnes/ha in 140-150 days. Further, 'Bundel 2' is identified for release. Oats variety 'Bundel Jai' ('JHOI 822') and Napier bajra hybrid culture 7 and 10 have been identified for release with 175 to 180 tonnes/ha yield potential. Berseem variety 'BL 2' is capable of yielding 100 tonnes/ha up to the end of May as against limited harvests up to March in other varieties.

Simple, stable and easily identifiable morphological characters have been identified in maize during seedling and grand period of growth for identification of inbreds during field inspection. Appropriate isolation distances for seed production of various categories of seeds in a number of crops and regions/seasons have been standardised and production technologies have been worked out. It is established that genetic purity of cotton hybrid seeds can be ascertained by polyacrylamide gel electrophoresis of soluble seed protein as well as of enzyme esterases.

During the four years of the Seventh Plan, there has been distinct increase in the production of breeder seed of oilseeds (19,575 quintals), pulses (10,900 quintals), cereals (18,830 quintals) and coarse cereals (917 quintals). It is hoped that this would go a long way in fulfilling the quality seed requirement of improved varieties and hybrids in the country.

A number of crop combinations and highly rewarding cropping systems in different regions and agro-climatic conditions using newly evolved varieties and hybrids have been worked out and demonstrated. Crops like pigeonpea, soybean, sunflower, rapeseed-mustard, urdbean, mungbean, rajmash, etc. have shown considerable promise in the non-conventional areas/seasons.

Easily adaptable and economically viable integrated pest management strategies have been developed for the control of major pests in rice, cotton, pulses, oilseeds, sugarcane etc. In biological control of crop pests a large measure of success had been achieved in the conservation of biologically useful organisms through either selective use of pesticides or their avoidance. Control of Pyrilla and top borer of sugarcane, mealy bug of coffee, lepidopterous pests affecting cotton, tobacco, coconut and sugarcane cultivation could be profitably extended as for instance spring sunflower and groundnut in Uttar Pradesh and Punjab, mustard in Maharashtra, Karnataka and Andhra Pradesh, safflower in south-eastern Rajasthan, soybean in southern parts.

These and the development of matching technologies with emphasis on low cost inputs have opened a whole range of new avenues for stepping up area, production and productivity of annual oilseed crops and improve incomes from drylands. Contrary to the widespread belief, data generated in recent years showed that productivity levels of oilseed crops from drylands could be pushed up by 40 per cent or more just by provision of one protective irrigation at critical stages of crop growth. Infact, under conditions of minimal irrigation some of the oilseed crops like rapeseed-mustard, safflower, groundnut turned out to be more remunerative than those requiring liberal and too frequent irrigation water. Equally worth mentioning is the development of a number of simple, less expensive post harvesting methods for improving viability of oilseeds as for example shade drying of *rabi*/summer groundnut.

Even with the available crop varieties and technologies results of on-farm trials revealed

existence of vast untapped yield reservoir possible under a wide range of agroecological and crop growing situations. Preliminary indications available from researches so far undertaken in Seventh Plan also highlight enormous potentials of hybrid vigour in safflower and mustard, possibilities for reducing production costs of hybrids through refinements in seed production technologies (as in the case of castor) and scope for exploitation of bioagents for the control of major insect pests such as castor semi-looper.

During the current plan, the production of basic and breeder's seed of various high yielding varieties and hybrids have been stepped up considerably over 1984-85. As compared to 2,112 quintals, seed production in the fourth year touched as much as 10,614 quintals which represents an increase of over 400 per cent. The availability of a host of new crop genotypes, efficient cropping systems, production etc. are a few examples where success has been achieved through the release of bio-control agents. Spectacular success has been achieved in biological control of two aquatic weeds, namely water hyacinth in Karnataka and Kerala and water fern in Kerala.

Waiting periods for recommended pesticides on major crops have been determined and pesticide residues in agricultural products are being monitored in the market.

The Italian honey-bee *Apis mollifera* has been successfully established in Punjab, Haryana, Himachal Pradesh and Bihar. An eight-fold increase in honey production has been realised.

(c) Increased Production of Oilseeds

As a result of concerted efforts of TMO, the aggregate production of annual oilseeds, which has been stagnating around 11-12 million tonnes is estimated to have reached an all time record of 17.5 million tonnes in 1988-89 against the target 15.5 million tonnes leading to a sizeable reduction in the country's import bill. What is more, the country could successfully, maintain vegetable oilseed supplies in 1987-88 close to the previous peak withnessed in 1983-84 in spite of the worst drought conditions. The above achievements on oilseeds front adequately demonstrated the tremendous strength and resilience, the country has built in recent years to achieve self-reliance on vegetable oil front.

HORTICULTURAL CROPS

A. FRUITS

The work on different fruit crops is being carried out at IIHR, Bangalore, CIHNP, Lucknow, NRC Citrus and three AICRPs on Tropical, Sub-tropical and Arid fruits.

1. New Varieties

Among tropical and sub-tropical fruits a dwarf mango hybrid 'Manjeera', a cross between 'Rumani' and 'Neelam' was released from the AICRP Sub-tropical fruits centre, Rangareddi (AP).

In grapes 7 seedless and four seeded promising hybrids with high yield and T.S.S. have been developed at IIHR, Bangalore, and released for multilocation testing. In papaya, a new variety 'Co-6' was released from Coimbatore centre of AICRP of Tropical fruits. Besides, one interspecific cross showed resistance to papaya mosaic. Two Kagzi lime hybrids developed at Rahuri (Maharashtra centre) have shown resistance to canker.

Under the AICRP on Arid fruits, two varieties of ber resistant to powdery mildew have been identified. In pomegranate clonal selections, viz. 'Jalore Seedless', 'G 137', and 'Jyoti' were identified, while in datepalm clonal materials of 15 varieties were imported from abroad for evaluation.

In temperate fruits, two scab resistant apple varieties introduced from abroad have been found suitable for commercial cultivation in H.P. Apart from this six apple Solan hybrids have been released for multilocation testing by centre. In almonds two promising selections showing delayed flowering to escape spring frost with higher shelling percentage have been identified by Srinagar centre.

2. Production Technology

In banana, population density, cropping system and nutritional requirements for 'Robusta', 'Nendran' and 'Cavendish Dwarf' have been standardised at Coimbatore. In grape, pruning time and fertilizer requirements were standardised for south Indian conditions at IIHR, Bangalore, while for north Indian conditions, methods were standardized at Ludhiana centre to rejuvenate old unproductive vines.

3. Crop Protection

Rhizome weevil damage in banana was reduced at Tamil Nadu Agricultural University (TNAU) centre at Coimbatore with the application of phosphamidon 2% and quinalphos 1%. Sunnhemp was found to be effective intercrop for reducing banana nematode population. Neem cake was found to be effective for control of nematodes in papaya.

B. VEGETABLES

The work on vegetable crops was carried out at IIHR, IARI and AICRP on Vegetables covering 22 different crops:

1. New Varieties

Forty-one varieties of 10 vegetable crops were developed at IIHR and five centres of AICRP, of which 10 varieties have been released by the Central Variety Release Committee. Two of these varieties are F_1 hybrids and five are resistant to diseases and insect pests. Outstanding achievements include development of brinjal 'Pusa Bhairav', resistant to *Phomopsis* blight and fruit rot caused by *Phomopsis vaxans* by IARI, New Delhi, cauliflower variety '6-1-2-1', resistant to black rot by Katrain centre in H.P., a tropical carrot variety 'Pusa Meghali' by IARI, New Delhi centre,

kharif onion variety 'Agrifound Dark Red' by AADF centre, powdery mildew resistant garden pea variety 'PM 2' by Pantnagar centre,'F-1' muskmelon, Punjab Hybrid by Ludhiana centre and watermelon 'Arka Jyoti' and a photo-insensitive dwarf variety of Dolichos bean by IIHR and yellow vein mosaic resistant 'Okra Selection 2' by NBPGR centre.

2. Production Technology

Twenty-eight agronomical recommendations have been made for different agro-climatic situations. Important recommendations on spacing cum fertilizer requirements for optimal crop production in important vegetable crops have been standardized. Significantly high return from sequential cropping of okra + beans – capsicum + onion – muskmelon + radish have been obtained. Important recommendations on irrigation, weed control and spacing in some vegetables have also been made.

3. Crop Protection

Forty-eight control measures required for protection of vegetable crops from insect pests and diseases have been recommended. These include control of jassids and aphids in brinjal, jassids, aphids and fruit borer of okra, mites, pod borer and powdery mildew of chillies, septoria leaf spot, *Heliothis armigera* and late blight of tomato, powdery mildew of peas and disease complex of beans, etc.

C. POTATO

Work on potato is being carried out at the CPRI, Shimla, and under AICRP on Potato.

1. New Varieties

Two potato varieties, viz. 'Kufri Swarna' resistant to cyst nematode for Nilgiri hills and 'Kufri Megha' resistant to late blight for North-Eastern hills were released by CPRI. Two hybrids viz. 'SE/1-1307' ('Kufri Kanchan') red tubered and wart and late blight resistant for Darjeeling hills and 'JH 222' ('Kufri Jawahar') late blight resistant for North-Western plains have been recommended for release by CPRI. Four True Potato Seed (TPS) lines and their production technology have been developed for commercial potato crop at Deesa (Gujarat), Modipuram (UP) and Jalandhar (Punjab) centres of AICRP.

2. Production Technology

Sprout cuttings and micro-propagation methods for rapid multiplication of seed was standardized at CPRI. Methods for efficient use of fertilizers through soil and foliar application were developed/standardized at different centres of AICRP. Potato grader and automatic potato planter were designed and developed by Jalandhar centre.

3.Brown Rot Control

Seed treatment with boric-acid for control of tuber and soil borne diseases and culture practices

for the control of brown rot have been developed at Shillong centre.

D. TUBER CROPS

Work on six tuber crops is being carried out at CTCRI, Trivandrum, and under AICRP on Tuber Crops.

1. New Varieties

During Seventh Plan, seven varieties of tuber crops including one in cassava, two in sweet-potato , one in colocasia, one in amorphophallus and two in white yam were released by CTCRI. A dwarf variety of white yam *Dioscorea rotundata* was developed by CTCRI to reduce heavy staking cost.

2. Production Technology

Two tier cropping system with one shallow bulking and one deep bulking variety of sweet-potato planted in alternate rows, has been recommended to get 30 to 40% increase in total production per unit area at Dholi centre of AICRP, and Bhubaneswar Centre of CTCRI. Intercrops for cassava were identified by CTCRI. Agro-techniques for nutritional requirements, spacing, planting and seed size have been standarised both by CTCRI and at the coordinated project centres. Use of cycocel for sweet-potato was recommended for getting higher yields by Jorhat Centre. Flowering could be induced in Xanthosoma and colocasia by hormone treatment.

E. MUSHROOM

The work on mushroom is being carried out at the NRC Mushroom and under the AICRP on Mushrooms.

1. Crop Production

More than 250 fleshy fungi have been collected and evaluated by NRC Mushroom at Solan. Of these 29 are edible. Commercial cultivation of oyster (*Pleurotus* spp.) and tropical species of white button (*Agaricus bitorquis)*mushrooms has been popularised by IIHR resulting in more production in tropical areas of the country.

Wheat straw has been found to be suitable for the cultivation of oyster and black wood (*Auricularia* spp.) mushroom in addition to various other agro-wastes. Chemical sterilization of substrates gave higher and consistent yields and has replaced cumbersome hot water treatment practiced earlier. Addition of dried leaf matter (neem, castor, eucalyptus) and compost gave higher yield of white button mushroom through the control of competitor moulds in pasteurized compost. Higher yields of white button mushroom have been achieved by refining the technology already in use.

2. Crop Protection

Arthrobotrys anchonia was successfully used as a biocontrol agent against mushroom nematodes.

F. FLORICULTURE

Work on different flowers is being carried out at IIHR and under the AICRP on Floriculture.

1. New Varieties

Forty-six rose varieties were developed of which 12 were identified to be promising. A new rose root-stock, namely, *Rosa indica* var. *odorata* has been identified to be suitable for northern plains. Twenty-nine gladiolus varieties were also developed of which 5, namely, 'Mayur', 'Pusa Suhagin', 'Poonam', 'Sapna', and 'Nazrana' were identified as promising. Chrysanthemum varieties suited to different seasons and purposes have been developed to enable growing chrysanthemum round the year in addition to several dwarf varieties suitable for pot-culture. In orchids two promising hybrids, one each in Dendrobium and Vanda have been developed at IIHR. Three carnation varieties suitable for growing under Indian conditions have been identified.

2. Production Technology

Production technology of standard carnations under Indian conditions has been standarised. Media and nutritional requirement for both epiphytic and terrestrial orchids has also been standarised.

3. Crop Protection

Control measures for powdery mildew and black spot diseases of rose by sprays of sulphex 0.2% and Karathane 0.5% for powdery mildew and Captan 0.2% and Dithane M-45 0.2% for black spot. Fusarium wilt and corm-rot (in storage) of gladiolus were recommended to be controlled by Emisan 0.2%, Bavistin 0.2% and Captan 0.5%. For control of septoria leaf spot disease of chrysanthemum, sprays of Bavistin 0.1% and Difolatan 0.3% were effective.

G. MEDICINAL AND AROMATIC PLANTS

Research on these crops is being carried out under the AICRP on Medicinal and Aromatic plants.

1. New Varieties

In opium poppy a new variety 'Trishna' ('IC 42') was recommended by Mandsur centre for release, and four promising lines, viz. 'IC 19', 'NOP 4', 'UO 177-1' and 'UO 177-2' have been recommended by Faizabad and Udaipur centers for large scale cultivation.

In Isabgol, 'Selection 10' and ball mutant were identified as higher yielders by Anand Centre.

Three promising selections of vetiver, viz. 'NV 66403', 'NC 66404' and '66416' have been identified for high yield and aroma at Vellanikkara Centre under AICRP.

2. Production Technology

Use of Rhizobium culture in palmarosa, henbane and opium poppy has been found to improve nitrogen economy. Spraying of Kaolink twice during growth phase reduced irrigation and improved herbage and total tropane alkaloids in henbane.

3. Disease Management

Macrophomina phaseolina has been identified to cause root rot in opium poppy at Mandsur (MP). Seed treatment with Apron 35 at 10 g/kg or Dithane M-45 (4.5 g/kg seed) together with two sprayings of Ridomil (0.1%) at 20 and 45 days after sowing are recommended to provide 85% protection against primary infection of downy mildew in opium poppy.

H. PLANTATION CROPS

Plantation crops research is being carried out by CPCRI, NRC Spices and NRC Cashew and three coordinated projects, one each on palms, cashew and spices.

1. New Varieties

In coconut seven hybrids and varieties were released both at the State and Central level of which two are from the CPCRI and five from coordinated project centres. In cashew five hybrids/cultivars developed at Bapatla, Vengurla and Vridhachalam centres have been recommended for release in Kerala, Maharashtra and A.P. 'Roma' from Pottangi (Orissa) and 'Swarana' from NRC Spices in turmeric, 'Suprabha' from Pottangi (Orissa) in ginger, 'GAU I Gujarat Fennel I' from Jagudam (Gujarat) have been released for large scale cultivation.

2. Production Technology

Techniques for rapid multiplication of pepper developed at NRC Spices and soft wood grafting in cashew developed at NRC Cashew have also been standardised. These techniques are being adopted by the development department for multiplication of elite planting material.

High production technology for getting yields of 800 kg cardamom per hectare have been developed at NRC Spices centre at Appangale. Similar techniques have also been developed at NRC Spices Calicut to double the pepper yield.

3. Root Wilt Disease Management

An Integrated management practice for root wilt affected palms has been developed at the

Regional Station at Kayankulam. The root wilt diseased palms in the early stages of infection were found to give economic yield with summer irrigation, balanced fertilizer application including application of farm yard manure and prophylactic plant protection measures. Constant association of MLOs in the tissues of root wilt disease affected coconut palms has been noticed and MLO wilt disease affected coconut palms have been noticed and MLO etiology has been established in this disease through transmission trials using insect vector lace bug.

4. Quick Wilt Disease Management

The work on post-harvest technology of horticultural crops is being carried out at several Institutes, namely, IIHR, CIHNP, NRC Citrus, CPRI, IARI and CPCRI and under the AICRP on PHT of Horticultural Crops.

Pre-harvest sprays of calcium chloride (0.6%), Topsin-M and Bavistin (1,000 ppm each) delayed senescence, reduced incidence of diseases, improved storage life and marketability of mango and guava fruits. Harvesting indices for 'Alphonso' mango have been standardised at Dapoli (Maharashtra) centre to reduce incidence of spongy tissue.

The zero-energy cool chamber developed by IARI and evaporative cool store developed by CPRI for perishable crops have been found effective under dryland agro-climatic conditions. CFB boxes with partitions for packaging and transportation of mango were designed and successfully tested by IARI and Dapoli Centre of Konkan Krishi Vidyapeeth.

A small scale palm oil extraction mill has been indigenously designed, fabricated and erected at CPCRI Research Centre, Palode (Kerala), paving the way for cultivation of oilpalm by a small holder.

A multi-purpose drier using agricultural wastes as fuel has been developed by CPCRI for drying copra, cardamom and arecanut. New devices such as copra moisture meter, cassava chip making machine were developed by CPCRI and CTCRI respectively.

The technology for production of alcohol from cassava developed by CTCRI has been patented. Nearly 1,000 small scale factories have come up in Tamil Nadu for starch and sago production based on cassava starch.

J. TISSUE CULTURE

Work on tissue culture is being carried out at IIHR, IARI, CPRI, CTCRI, CPCRI and NRC Spices.

Tissue culture techniques have been developed for micropropagation of papaya (IARI), datepalm (Hisar), banana (IIHR), potato (CPRI), ginger, turmeric, small cardamom (NRC Spices), oilpalm (CPCRI) and a few medicinal and ornamental crops (IIHR). *In-vitro* conservation of

To achieve timeliness in crop harvesting, a tractor-operated harvester developed at CIAE has been commercialised in Bhopal. The ground diggers developed at TNAU and CIAE are found superior to existing designs. The tractor front mounted Vertical-conveyor-reaper-windrower commercialised in 82-83 continues to capture new territories in use and manufacture. Besides rice-wheat it has been found useful for oilseed crops like mustard, safflower, sesamum, etc. In addition self propelled, power tiller-operated and animal-drawn engine operated designs of Vertical conveyor reaper windrowers are now available. Power threshers were adopted for oilseed crops, as well as new designs that are more versatile and of larger capacities have been developed.

For spraying tall crops a self-propelled high clearance hydraulic sprayer with 6/8 m wide boom and tractor-mounted ULV sprayer were developed and field evaluated with encouraging results.

During the Seventh Plan period the Agricultural Implements and Machinery Review Release Committee released 22 improved implement designs for popularisation. About 3,000 prototypes were distributed through industrial liaison to facilitate manufacture, demand generation/extensive evaluation, etc. The Agro-Industries Corporation of Gujarat, M.P., Maharashtra, Orissa, W.B., Rajashthan, A.P., Karnataka, T.N., U.P., Bihar and Assam have taken up manufacture and distribution of improved implements developed.

(ii) Post-harvest Engineering and Technology

R & D was directed to post-harvest conservation of produce, their qualitative improvement through primary processing to obtain value added produce and diversification of use of fibre crops, lac as well as agricultural wastes/ byproducts. Technically superior, economically viable low-cost appropriate techniques, processes and equipment were developed, evaluated and made operational. A pedal-operated grain cleaner costing Rs 2,500 does the cleaning at a cost of Rs 6-10 per tonne at the rate of 350-500 kg/ha; two grain pearlers of 20 and 120 kg/ha costing Rs 1,800 and Rs 4,200 respectively and manual and power-operated castor shellers of 40 kg and 158 kg/ha capacities respectively, have been developed and industrially liaised. In order to impart value-adding capacity at rural level and reduce the drudgery of traditional method, a package of pulse milling method/technology was developed and tried in comparison with the traditional method for pigeonpea. The package developed improved dal recovery by 4% and reduced the processing period to three days. The drudgery was also minimised. Though costs of processing went up by 20% but even this increased cost of processing makes possible a lower retail price.

To minimise rotting of onion, improved storage structures of one tonne capacity for indoor and outdoor use costing about Rs 2,000 were developed. The results of 3 months rainy season storage resulted in a loss of only 15%.

In order to utilize soybean, a rich source of protein and fat in Indian diet, technology for production of full fat soyflour at rural level was developed and evaluated in field conditions. Up to 10% fortification of wheat flour with soyflour has been found acceptable. Efforts are underway to propagate such technologies through establishment of Model Agro-processing Centres in rural areas through village co-operatives. Equipment for production of soy-*paneer*, soy-flakes and other indigenous soy-products have also been developed.

Technologies have been developed and industrially adopted to produce bottled sugarcane juice, production of briquetted fuel from coir pith, and pyrolysed fuel briquettes from waste crop residues.

Fungal culture to improve the jute fibre quality developed earlier was taken up for large scale manufacture. For diversifying the uses of jute fibre, caplon blanket technology was commercially adopted. Small scale units have taken up the manufacture of laminated jute stick particle boards. A light fabric for postal bags has been developed. To produce value added products at rural level, mini jute spinning machinery has been developed. Various other jute based products like carpets, sound insulation fabrics, paper pulp, etc. have also been developed.

A flame retardancy treatment technique for cotton fabrics was developed such that the skin is not affected. Calibration cottons, hitherto imported, have been substituted with indigenous products, saving foreign exchange. Processes were developed for producing speciality paper, micro-crystalline cellulose, packaging boxes and other products from cotton and its byproducts.

Lac-based formulation like varnish having high thermal resistance and good anti-tracking properties, primer paints having anti-corrosion nature, modified lac wax, rabulac adhesive, etc. were developed. Briquettes made out of lac waste and coir pith as well as other agricultural wastes were developed.

Besides the above, a number of other techniques/ processes/equipment for cleaning, grading drying, storage, milling, packaging and other post-production operation have been developed under various programmes.

(iii) Agricultural Energy and Power

Energy audits have been carrid out on major crops, crop rotations and village eco-system. Energy requirement has been found to vary from a low of 2,000 MJ/ha of rainfed rice in West Bengal or Madhya Pradesh to as high as 70,000 MJ/ha for groundwater irrigated rice in Coimbatore. Designs have been developed for low-cost dryers, solar water heaters, solar cookers, solar stills, biogas plants, wood and crop residue gasifier aerogenerator, etc. Two designs have been recommended to DNES for popularisation. Operational research has been carried out on integrated energy and nutrient supply systems.

Growing modernisation of agriculture and rural transport have limited draft animal use in many cases to seedbed preparation and sowing. To rationalise use of draft animals and improve their economic competitiveness, systematic research was initiated during this period establishing draftability, work-rest cycles of selected species/breeds of draft animals and development of matching implements that increase system efficiency and improve animal use through stationary mode operations. Crossbred bullocks have been found to be useful as draft animals. With improved harness and work-rest cycle, work output can be easily increased by 15-20%.

(iv) Soil and Water Engineering

Rationale have been developed for design, construction and renovation of dug wells, water lifting, conveyance as well as agricultural drainage techniques and gadgets. R & D efforts have yielded results of wide applicability like protection of tubewells from corrosion and incrustation, energy efficient improved foot and reflex valves, engine safety device against dry-running, and low-lift high-discharge propeller pumps for irrigation and drainage applications. Asphalt-coated fibre wound over stoneware pipes, served the purpose of strainers for tubewells with relatively longer life. Vertical drainage system at costs comparable to conventional horizonal drainage for situations with high water-table has been developed. In Kuttanad region of Kerala sub-surface burnt clay drainage system costing about Rs 9,000/ha was found to increase the yield of rice by 1.93 tonnes/ha.

(v) Instrumentation and Hardware for Modernising Agriculture

Active participation in the activities of National Committee on Plastic in Agriculture led to the concept of Plasticulture Development Centres, initiatives in surface-covered cultivation, push to drips and plastic sprinkler system. Participation in Department of Electronics (DOE) initiative on Agri-Electronics led to formulation and launching of DOE funded Promotion of Agri-Electronics Project. Its implementation was entrusted to ICAR. Six electronic gadgets are being field demonstrated for use at farm and rural level for handling, marketing and processing activities. To minimise experimental error in field experiments and reduce dependence on labour, precision field plot machinery was imported and tested for adoption and a few machines were developed indigenously for example manual line marker, precision tractor mounted drill, precision pneumatic planter, single ear and experimental plot thresher. For systematic study on draftability loading car, data logger were developed and field evaluated. The loading car is in demand by several institutions.

ANIMAL SCIENCES

1. ANIMAL BREEDING

(a) Cattle

Under the Project Directorate on Cattle, crossbreeds generated earlier at the various Units were evaluated for growth, production and reproduction. At the Military Dairy Farm, Meerut interbreeding of crossbred, required for stabilisation of exotic inheritance, around 50% did not result in any large decline in milk production. The milk production in Friesian half-breds and 3/4th was recorded as around 4,500-5,000 kg. At NDRI, Karnal, it was found that Karan Swiss cows had better economic efficiency than Murrah buffaloes.

(b) Buffalo

In Buffalo improvement programme under the AICRP on buffaloes at*PAU* the daughters

of proven bulls produced 2058 to 3860 kg milk in 305 days, the maximum being 4005 kg.

(c) Sheep

In sheep production, the annual greasy fleece yield was recorded as 2.26 kg in Chokla, 2.64 kg in Nali synthetics and 2.51 kg in Chokla synthetics which exceeded the fixed targets of 2.5 kg at *CSWRI*. A high producing breed of fine wool sheep, 'Bharat Merino' has been evolved based on 3/4 bred Merino and Rambouillet crosses. Under the mutton component of AICRP on Sheep at MPKV, Rahuri, Dorset halfbred weighed 17.7 kg at 90 days and 30.3 kg at 180 days and gave better performance over indigenous and merino halfbreds under intensive feed lot experiments.

(d) Goats

Under the AICRP on Goat for milk component, the Kerala Agricultural University, Mannuthy, evolved genetic combinations of native 'Malabari' with 'Saanen' and Alpine improver sire breeds. The crosses gave 95% more milk yield than the native 'Malabari'. 'Saanen' x 'Malabari' cross was found superior to 'Alpine' x 'Malabari' producing 170 kg of milk in a lactation period of 150 days. At Western Regional Station,*CIRG*, Jhakrana was found to be a potential dairy breed with an average yield of 148.7 kg in 254 days. At BAU, Ranchi, Black Bengal crosses which could attain an average body wieght of 14.7 kg at 6 months of age under intensive feeding were successfully evolved. The crossbreds were 53.6% superior in growth and 10% superior in feed efficiency contemporary purebred Black Bengal kids.

(e) Poultry

Two new high-yielding layer strain crosses — one at Kerala Agricultural University Unit and the other at JNKVV, Jabalpur, are under advanced stage of testing and are to be released soon for commercial exploitation.

(f) Rabbits

High-yielding strains of broiler and wool rabbits have been evolved and germplasm made available for commercial exploitation.

(g) Other Species

At NRCs on Equine, Camel and Yak, research work on improvement of draft and at NRC on Mithun, research work on improvement of Mithun for meat has been initiated. Methods of measuring draft capacity are being standardised.

The progress of research programmes in the Institutes, Project Directorates and AICRPs has been monitored through appointment of QRTs, Mid-Term Appraisal Committees and the annual

Workshops held from time to time. The following changes have been proposed.

(i) Project on nutritional and adaptation studies under the Project Directorate on Cattle will be phased out.
(ii) The AICRPs on Buffalo, Sheep, Goat and Pigs will be phased out and research on genetic aspects of their improvement will be taken up through network projects either involving institutional herds/herds and flocks of the farmers. Two indigenous cattle breeds, viz. Tharparkar and Gir will be included in AICRP on Improvement of Indigenous breeds.

2. ANIMAL NUTRITION

Deficiency of feeds and fodders is a major constraint in the production of our livestock and poultry. Studies have indicated that the nutrient needs of animals maintained in tropical environments are different. Tropical forages grown in India in different agro-climatic regions widely differ in chemical composition and nuritional value. Nutritional needs of our livestock have been determined according to their requirements in different physiological states.

In order to mitigate the shortage of feeds, considerable work has been done on utilization of unconventional feed resources. In AICRP on 'Determination and Availability of Feed Resources', new byproducts identified as feed resources are coconut pith, *kokam* cake, decaffeinated tea waste, uromol, *mahua* seed cake, sunflower straw, *kosum* cake, cocoa pods, maize cobs and *nahar* seed meal. Technologies have been developed for improvement of feeds. Wheat *bhusa* treated with urea (4 kg urea dissolved in 65 litres of water and sprayed on 100 kg *bhusa*) and stored improves its digestibility by 40-45% and voluntary feed intake is increased by 86-100%. Steam treatment (7 kg/cm^2 for 30 minutes) of sugarcane bagasse increases voluntary feed intake and digestibility (approximately 56% each). Studies have been conducted on utilization of animal organic wastes, poultry litter and slaughter wastes as feed for livestock and poultry.

At the IVRI, Izatnagar, water-washed *neem* seed kernel-cake was found to be an excellent protein supplement (having about 40% crude protein).

In the Indo-Dutch Project at NDRI, Karnal, a two-stage fungal treatment of straw has been developed with *Coprinus* species with advantage.

At CIRG, Makhdoom *Caparis zeylanica, Balanites aegyptiaca (hingota), Salvadora persica (kharjal)* and many other shrubs and tree leaves have been found useful for goat feeds.

At CSWRI a package of practices was developed for meat lamb production by grazing on *Cenchrus ciliaris* pasture and supplemented with concentrate mixture.

At NDRI, Karnal, chalk powder, marble, lime and filter-press mud waste were found to be good calcium supplements for animals.

Incriminating substances in feed are a great problem in India. Studies at NDRI, Karnal, have indicated that aflatoxins could be tolerated only at the dose levels of 260 ppb in neonatal calves and 147 ppb in neonatal kids. At CARI, Izatnagar, the broiler chicks were found to tolerate dietary aflatoxins up to 0.4 ppm level only.

3. ANIMAL PHYSIOLOGY

In animal physiology, studies have been conducted mainly to improve the production by enhancing reproductive performance of animals. At IVRI, Izatnagar, buffalo semen was stored at 5°C in natural (concentrate) form with excellent viability for 8-9 months when plasma was removed and sperm pack was mixed with tris-buffer without yolk. The procedure connected with embryo transfer was standardized. At the CIRG, Makhdoom, TCYG and EYCG diluents were found to be suitable for freezing buck semen. Inter-breed embryo transfer was successful in goats. A healthy kid was born from single blastomere. At *GBPUAT*, Pantnagar, lactating buffaloes showed signs of heat within 48 hr when 25 mg of progesterone was injected for 7 days followed by 3,000 I.U. of *PMSG* on the eighth day.

At NDRI, Karnal, superovulation was induced in cattle with the *FSH* hormone and embryos were successfully transferred in cattle and buffaloes. Pregnancies were established through non-surgical transfer among cross-bred animal and ten calves were produced.

At *PAU*, Ludhiana, embryo transfer was successful in buffaloes. One of the recipients received two embryos and gave birth to twin calves, one male and another female.

At CARI, Izatnagar, research was conducted on hydrolytic enzymes in semen. This will greatly promote artificial insemination in chicken for better fertility and production. Various housing equipments for quails have been developed.

4. ANIMAL HEALTH

(a) New diagnostics and Vaccine

Three immunobiologicals, viz. tissue culture sheep pox vaccine, NSI adjuvant goat pox vaccine and Tuberculin (PPD) were successfully tested at the users doorsteps on a large number of animals by the Indian Veterinary Research Institute.

For large-scale production of monovalent and polyvalent Foot-and-Mouth Disease virus vaccines fermentor technology using BHK-21 cell suspension system has been successfully developed.

The inactivated oil adjuvant vaccine against Egg Drop Syndrome (EDS-76) and Infectious Bursal Diseases (IBD) in poultry were produced and they were found to induce protective level of antibodies four weeks post vaccination without any immunosuppressive effect.

Recombinant *CDNA from FMDV* type O, A_{22} and Asia-I were prepared, purified and inserts were characterized.

Monoclonal antibodies were produced against FMDV type A5, A10, A22 and Asia-I. Positive clones were characterized, purified, subcloned and cryopreserved.

Plasmids have been isolated from *Clostridium perfringens* type 'D' and curing has been done to determine the toxin production.

Five immunogenic proteins of rinderpest virus were identified by Western blotting.

(b) Drug and surgical interventions

The indigenous drug 'Arjuna' proved to be effective in the management of haemodynamic disorders and hypercholesterolaemia as evidenced in the preliminary studies.

Studies on orthopaedic surgery on osteo-inductive and healing process of different types of bone grafts in bovine fracture revealed that autogenous grafts are accepted with no sign of new bone formation.

Cases of fluorosis in bovines were recorded for the first time in India.

The prevalence of lungworm infestation in swine associated with the outbreak of swine fever were recorded from Andaman & Nicobar Islands.

(c) Equine diseases

The equine influenza outbreak in 1987 was successfully contained through surveillance and controlling movement of horses. Equine influenza A/Equi-2 virus was isolated and characterized by the N.R.C. Equines.

Equine Infectious Anaemia (EIA) and Equine Coital Exanthema were detected and identified for the first time in India.

A killed vaccine developed from an isolate of *Salmonella abortus equi* has been found to be safe in mares. The methodology for large-scale production and use in the field has been passed to Vaccine Institute, Haryana State Government.

Extensive, sustained and continuous efforts made on surveillance, monitoring and testing of glanders have limited the occurrence of the disease in Haryana State.

(d) Disease problems in the N.E. region

The Causal agent of False Black Quarter disease in Manipur was identified as *Clostridium*

perfringens type 'A' and the vaccine evolved from the local strain proved to be effective in controlling the disease at the ICAR, NGA Research Complex.

(e) Epidemiological and Virological Studies on Foot-and-Mouth Disease

Detailed investigations of outbreaks in selected areas of study revealed that there was substantial loss of milk yield during and after the outbreaks and marked reproductive disorders in recovered cows and heifers under the AICRP on *FMD*.

A clear shift in the prevalence from type 'A' to type 'O' was observed throughout the Southern states.

Asia 1 and A22 are the types which show increased activity in the western and northern states.

Subtype A5 was recognized after a lapse of 3-4 years and its identity was duly confirmed by the world reference laboratory at Pirbright, U.K.

ELISA assay revealed precise type differentiation of *FMD* virus.

(f) Intracellular Blood Protista

(a) The cell culture vaccine has been developed and tested for infectivity and immunogenicity. Large-scale production of vaccine has been taken up for protecting the animals under field conditions under AICRP on Intracellular Blood Protista.
(b) A simple reliable and efficient test—Dot Elisa has been developed to detect infection.
(c) A new drug Buparvaquone along with supportive therapy was found to be effective in the treatment of clinical cases of theileriosis in cattle.
(d) Vector responsible for transmission of the disease in different parts of the country have been identified and control measures have been formulated.

(g) Animal Disease Surveillance and Monitoring

(a) Details of households, identified animals, meteorological data, disease profile in selected areas of study were collected and compiled.
(b) Outbreaks of FMD, Haemorrhagic Septicaemia in cattle and buffaloes, sheep pox and goat pox were recorded and investigated in selected areas of study.
(c) Subclinical mastitis, particularly among buffalo population and internal parasitism were also recorded and investigated in selected areas of study.

A computer model for disease surveillance and monitoring in the organized sheep farms has been developed.

5. ANIMAL PRODUCTION TECHNOLOGY

(a) Dairy Technology

In the area of dairy technology, an infant formula having 12 per cent milk proteins was successfully developed at NDRI by suitably modifying bovine milk. A purely vegetarian processed cheese was successfully prepared using fungal rennet. A synthetic ghee flavour was standardised for simulating ghee flavour in butter oil. A ghee making plant was designed on the principle of hydrodynamics and heat transfer in horizontal thin scraped surface heat exchanger. This plant has a capacity to handle 500-600 kg per hour of creamery butter. A technique has been standardised to preserve raw buffalo milk upto 24 hours at 32°C, employing LP-System. A two-fold increase in shelflife in paneer was attained by use of *acidophilus* as coagulating agent as compared to citric or lactic acid.

(b) Meat Technology

In meat technology a meat protein concentrate was developed at *TNAU*, Madras which contained 88 per cent crude protein and 0.49 per cent fat with keeping quality of 6 days at room temperature. Partial bypass to duodenum in pigs, calves and goats by surgical technique helped to produce lean meat, particularly useful to people having tendency towards high blood pressure. A method for the preparation of gelatine from buffalo and goat bones was standardised at *IVRI*. Meat and edible byproducts from spent hens have been beneficially utilised by processing them together into various products like patties, nuggets and kabbas. Starving poultry birds prior to killing, use of cones for bleeding, singeing and extended draining period considerably reduced the microbial load of dressed chicken.

C. Animal Fibre Technology

The technology to produce yarns of better uniformity was developed, using Mohair/Merino/Viscose blends. Ramie half blend finished fabrics were produced at *CSWRI* which were found to be very useful. A worsted yarn from a 50:50 blend of fine wool and silk waste was successfully woven into an apparel fabric which could be used for high quality shirting. Rabbit hair blended with polyester (50:50) can be corded in worsted system, spun on Charkha and woven into lightweight shawls on the handloom. The fabric has higher durability, super whiteness, softness and warmth.

FISHERIES

(a) Fresh Water Aquaculture

The potential of aquaculture has become realistically evident with the development of high fish production technologies by Central Inland Fisheries Research Institute through scientific applications to the traditional carp culture system. Fish seed production through administration of

the pituitary hormones has revolutionised culture fisheries in the country. The composite fish culture technologies ensuring the production of 3-5 tonnes/ha/hr in non-drainable ponds and production of over 10 tonnes/ha/hr in ponds with limited water exchange facilities has been widely adopted at the national level through FFDA's to improve upon the production of 50 kg/ha/hr by traditional methods. The Government of India has already established 200 *FFDA's* covering a water area of about 2 lakh hectares with an average production of about 1,500 kg/ha/hr. So far 38 commercial seed farms of 10-20 hectares have been established under the World Bank and national programmes for raising adequate number of fish seeds. Their requirement has grown considerably on account of the expanded fishery activities in the country. The seed production technology developed by *CIFA* leading to 95% survival has benefited many enterpreneur-farmers who took up this activity in a big way in West Bengal and Andhra Pradesh. The technology developed for enhancing production from reservoirs is being fruitfully utilized by the Government of India which has directed the State Governments to select two medium size reservoirs for management on scientific lines.

(b) Riverine & Coastal Water Pollution

The pollutionin major rivers and coastal water bodies of the country is being monitored through screening of pesticides and heavy metals to evaluate fish toxicity and evolve measures for its control.

(c) Cold Water Fisheries

The efforts of the NRC *CWF*are bearing fruit in popularising trout farming in the country. Private enterpreneurs are taking up trout farming on a commercial scale.

(d) Fish Genetic Resource Evaluation & Conservation

The *NBFGR* has brought out a manual on fish genetic resources of the country with the description of genetic resources of species of economic value inhabiting freshwater, brackishwater and marine environment to serve as a baseline information for future conservation efforts. Information on endagered, threatened and rare freshwater species which need immediate attention has been gathered by the Bureau. An important achievement in applied field of gonodal sex manipulation, is artificial injection of permanent reversal of the sexual phenotype without change of genotype.

(e) Marine Fisheries

In the marine sector, vessel-based investigations by the *CMFRI* have led to resource assessment of established fisheries in the *EEZ*and location of fresh potentials for enhancing fish production through exetended exploitation of these resources through increased deep sea fishing fleet. Marine culture technologies developed for fin fish and shell fish are proving additional productive potentials for enhanced fish production from coastal and brackishwater areas.

The *CMFRI* has cautioned the industry against overfishing of shrimp and the urgent need

to conserve the valuable shrimp resources. The industry is following the advice. The resource assessment surveys in Lakshadweep and Andaman and Nicobar Islands have greatly helped the Islands Development Authority in drawing up developmental programmes for these islands.

The pearl oyster culture perfected by the *CMFRI* has prompted the Fisheries Development Corporations of Tamil Nadu and Gujarat to venture into commercial pearl culture.

The brackishwater Institute has given a boost to the establishment of prawn hatcheries in the State sector, with financial assistance from *MPEDA*.

(f) Fisheries Technologies

The *CIFT* has modified and designed various categories of trawl nets for improved fishing efficiency for the benefit of small and large fishing sectors, these have attracted the industry's keen interest for adoption. A leading private manufacturer has taken up commercial production of combination wire rope by steel & plastic as designed by CIFT. Post-harvest technology developed have led to improvement of shelf life of products. The production of chitosan from shell waste, absorbable surgical sutures, and prawn and fish flavours has been commercialised.

AGRICULTURAL EDUCATION

During the Seventh Plan major emphasis was given to (a) consolidation of educational programmes already developed; (b) development of on-going programmes of the state agricultural universities; (c) establishment of new faculties in selected agricultural universities; (d) development of agricultural faculties of central universities; (e) strengthening of educational programmes in forestry, home science, agricultural engineering and veterinary science; (f) establishment of centres of advanced studies; and (g) improvement of internal training to veterinary graduates.

The above objective were achieved through 16 schemes which can be grouped into following three categories:

(a) Infrastructural development
(b) Promotion of quality in education
(c) Manpower development

The progress made in each of these schemes is summarised as under:

(a) Schemes on Infrastructural Development

During the period four new State Agricultural Universities were established viz. (i) Dr. Y.S. Parmar University of Horticulture & Forestry, Solan; (ii) Indira Gandhi Krishi Vishwavidyalaya, Raipur; (iii) University of Agricultural Sciences, Dharwar; and (iv) Rajasthan Agricultural University, Bikaner. The first three universities were established by bifurcating the existing agricultural

universities in the States of Himachal Pradesh, Madhya Pradesh and Karnataka. The fourth agricultural university was established in Rajasthan after a great deal of duscussion and persuasion with the State Government of Rajasthan which established a separate agricultural university in the State by bifurcating the then University of Udaipur. The number of constituent colleges was increased to 156 from 108 during the beginning of the Plan. The major growth took place in the field of forestry, veterinary science, home science and agricultural engineering. The number of constitutent colleges and approximate admission capacity is given in Table 1

Table 1

Number of colleges, disciplines and their admission capacity under various programmes at state agricultural university

Sl. No.	Discipline	No.of colleges	Admission capacity	
			Under Graduate	Post-Graduate
1.	Agriculture	50	5450	2500*
2.	Veterinary Science & Animal Husbandry	20	1800	450
3.	Agricultural Eng.	16	560	200
4.	Home Science	17	710	115
5.	Fisheries Science	7	150	55
6.	Dairy Technology	7	165	200
7.	Agricultural Marketing Banking & Cooperation	3	80	--
8.	Forestry	15	240	12
9.	Horticulture	9	240	--
10.	Sericulture	1	30	--
11.	Food Science & Technology	50	6	
	Total	146	9475	3538

The admission capacity in the field of veterinary science has increased from 1,600 to 1,800. Simlarly, admission capacity has been increased considerably in the case of home science. But in other disciplines, though the number of institutions has marginally increased, the admission capacity almost remained the same. It is estimated that the present institutions are capable of producing adequate manpower in various fields of specialisation. A slight shortage has been noticed in veterinary science in certain States. While in some other States 2-3 batches of students are awaiting employment.

Efforts are in progress to establish a Central Agricultural University for the North-East States. Two ICAR institutes viz. NDRI at Karnal and CIFE at Bombay have been accorded the status of 'deemed to be university'. During the period, the Council provided developmental assistance to the tune of Rs. 36 crores to the State Agricultural Universities and central assistance to the three agricultural faculties of central universities viz. Vishwa Bharati; BHU, Varanasi; and North-East Hill University and 9 affiliated colleges of the general universities. Main emphasis was given to optimising infrastructural facilities in terms of classrooms, laboratories, equipment, staff and students amenities.

(b) Quality Improvement Programmes

The major schemes under this head were (a) Establishment of centres of advanced studies; (b) Book production scheme; (c) Internal competence scheme; (d) Scheme of Professor of Eminence.

Under the Scheme of establishment of centres of advanced studies funded by UNDP, five centres viz. Centre for Energy Management at PAU; Post-Harvest Technology at *GBPUAT*; Plant Virology at IARI; Agricultural Statistics and computer Application at IASRI; Agricultural Communication at GBPUAT established during the VI Plan were continued during the period. Eleven new centres viz. (1) Agricultural Education and Research Management and *NAARM*. Hyderabad; (2) Plant Biotechnology at IARI, New Delhi; (3) Animal Biotechnology at NDRI, Karnal; (4) Immuno Biotechnology at IVRI, Izatnagar; (5) Irrigation Management at *CSSRI*, Karnal; (6) Land Resource Management at *NBBS & LUP*, Nagpur; (7) Soil Fertility and Plant Nutrition at PAU, Ludhiana; (8) Agricultural Meteorology at *MPAU*, Pune; (9) Agroforestry at *CSWCR & TI*, Dehradun in collaboration with Dr. YSPUH & F at Nauni (Solan); (10) Seed Technology at *HAU*, Hisar; and (11) Inland Fisheries at *CIFA*, Kausalyagang started functioning with effect from 1 September 1986. These centres are expected to continue during the Eighth Plan also. Midterm assessment was done on the progress of these schemes during the period while exploring and trying out new technologies considered relevant to the Indian situation. UNDP/FAO intervention has been sought to stregthen various new specialised areas to assist the country to face challenges of the future and equip itself with latest technologies and train its manpower with the ultimate aim of maximising production and productivity in the agricultural sector as a whole. A new UNDP assisted Scheme for the development of Home Science Education and Research was started in 1986 with 5 centres in the State Agricultural Universities, viz. *APAU*, Hyderabad; *MAU*, Parbhani; *GBPUAT*, Pantnagar; *PAU*, Ludhiana; and *HAU*, Hisar with emphasis on foods and nutrition and child development. All the UNDP assisted centres had the benefit of consultancy equipment and fellowship. Postgraduate programmes on Masters and doctoral levels were continued in the respective discipline in addition to training and research in specific areas.

The Scheme for the award of Professor of Eminence and National Fellow was revived and modified as ICAR Professors.

No new selections were made during the period on the basis of the observations made by the ICAR Review Committee. It is proposed to modify the Scheme during Eighth Plan. A large number of Summer Institutes/Short Courses were organised under the Scheme Summer Institute

with a view to up-dating the knowledge of scientists/teachers on emerging scientific areas. A Scheme for promotion of writing of text books in various disciplines of agriculture and allied sciences has been initiated. A proposal for establishment of more centres of Advanced Studies during Eighth Plan has been initated.

(c) Manpower Development

To promote the development of trained manpower in agriculture and allied sciences, the Council has been operating various schemes of scholarships/fellowships.

(i) Merit-cum-Means Scholarship

Merit-cum-Means Scholarships were initiated during the Third Plan in line with the national scholarship scheme of the Ministry of Education. Seven and a half per cent ($7\frac{1}{2}\%$) of the total students admitted in various degree programmes in agricultural universities and selected colleges were covered under the scheme. The rate of the scholarship was revised to Rs 170/- from Rs 125/-per month.

(ii) Post Matric Scholarship for SC/ST students

This scheme means to provide financial assistance to SC/ST students in Bachelor's degree programme was continued during the Plan period. This scholarship provides a monthly grant of Rs 300/- per month and contingent grant of Rs 750/- per year.

(iii) Junior Fellowship

The Council continued to award 350 junior fellowships every year for study at Master's Degree level in 38 disciplines of agriculture and allied sciences. The rate of fellowship was revised from Rs 800/- per month to Rs 1,200/- per month with effect from 1 April 1988 and contingent grant was raised from Rs 2,000/- per year to Rs 3,000/- per year.

(iv) Senior Fellowship

One hundred and fifty senior fellowships were awarded every year for study/research in various fields of specialisation. The rate of fellowship was revised from Rs 1,000–Rs 1,200 per month to Rs 1,800–2,100 per month. The rate of contingent grant is Rs 5,000/- per year. Fifty fellowships have been reserved for teachers/scientists of SAUs and ICAR Institutes.

(v) Post-doctoral Fellowship

The post-doctoral fellowship Scheme was also continued during the period. The proposal to revise the rate of this Fellowship is under consideration.

In addition, 20 per cent of the fellowships, both junior and senior are reserved for SC/ST students. Provision has also been made to award 15 teachers fellowships to the State Agricultural Universities at the rate of Rs 750/- per month for higher studies at Ph.D level under the Scheme "Establishment and Development of Agricultural Universities". Recently it has been decided that the ICAR senior fellowship should be used as a tool for reducing inbreeding. With this view, it has been decided that henceforth the Council's senior fellowship will be available only to those candidates who take admission for Ph.D in an institution other than the one from which they have obtained the Masters Degree.

(vi) Internship/Apprenticeship Scheme

The Council assisted all the State Agricultural Universities to provide internship allowance to the veterinary graduates for a period of 6 months at the rate of Rs 400/- per month. There have been continued representations from almost all the institutions that the rate of internship allowance should be raised to at least Rs 800/- per month: this has been accepted and recommended by Vice-Chancellors Conference also. Requests for providing financial assistance for the implementation of the work experience Scheme for agricultural graduates and in-plant training to students of Engineering and Dairy Technology and Food Technology Programmes have also been under consideration for a long time.

EXTENSION EDUCATION

The first-line extension education effort of ICAR aims at (i) promptly disseminating the latest agricultural technologies to (a) farmers as well as (b) extension agencies; (ii) testing and verifying the latest technologies in the socio-economic conditions of the farmers; (iii) analysing the constraints of adoption process and giving first-hand scientific feed-back to farm scientists; (iv) evolving models of transfer of technology as well as farming practices appropriate to local conditions; and (v) promoting research in transfer of technology. Since 1965, the ICAR extension system has been playing a decisive role as a strong catalytic mechanism for accelerating agricultural production.

Through national Demonstrations Projects spread over 48 districts, efforts are being made to demonstrate the production potentiality of major cereal crops in the field conditions. Over 100 demonstrations are conducted annually under this programme for educating farmers as well as state extension workers. There are 3 types of Operational Research Projects (152 Centres) namely: (i) Operational Research Project for Watershed Development; (ii) Operational Research Projects devoted to specific farm problems; and (iii) Operational Research Project devoted to specific target groups. Under the Operational Research Project on watershed, efforts are being made to develop total resources of the watershed villages comprising Crops, Live-stock Production, Fisheries, Agro-forestry, Horticulture, etc. Operational Research Projects in problem areas like: Integrated Pest Management of Rice or Cotton, production from Crop and Livestock combination, etc., and demonstrating appropriate technologies to Scheduled Caste/Scheduled Tribe communities and

evolving suitable cropping sequences are also being activated. The project on Krishi Vigyan Kendras (KVKs) is devoted to vocational training of the farmers, farm women, young farmers, school dropouts and field level extension functionaries. Specialised Trainers' Training Centres (TTCs) basically associated with the ICAR Research Institutes are catering to the training needs of the trainers of KVKs both in terms of technology as well as teaching. The Lab-to-Land Programme is a target-oriented effort for demonstrating no-cost and low-cost technologies to the small and marginal farmers and agricultural labourers.

Since 1986, in the demonstration and training programmes, priority has been given to production of oilseeds and pulses and promoting rice production in the eastern parts of India. Dryland farming is also finding an important place in the scheme of our extension efforts.

About 5000 demonstrations have been annually organised under the National Demonstrations Projects in 48 districts. These demonstrations are expected to conform to targetted yields of 9-11 tonnes/ha in 2 to 3 crop sequences respectively. These demonstrations have shown wide gaps in yields of cereals, pulses and oilseed crops between the potentials of improved varieties and the yields realized on the farmers' field. The yield gap shown in such demonstrations during 1986-87 is presented in Table 2.

Table 2

Yields (q/ha) of cereals, pulses and oilseeds in National Demonstrations compared with the average national yields (1986-87)

Crop	National Average	Av. yield of N.D.	Highest yield in N.D.	Percentage increase in Av. yield in N.D.over national average	Ratio of mean yield and State Average
Rice (Irrigated)	22.05	47.49	89.32	115.4	2.15
Wheat (Irrigated)	19.16	35.08	52.60	83.08	1.83
Maize	12.81	29.16	45.00	127.00	2.27
Sorghum	5.75	32.70	70.50	486.6	5.68
Pearlmillet	4.00	17.05	45.00	326.25	4.26
Groundnut	8.41	19.81	32.25	135.55	2.35
Mustard	7.00	8.91	19.25	27.28	1.27
Mungbean	3.45	6.82	13.00	97.68	1.97
Sesamum	2.06	3.46	16.00	67.96	1.68

The successful crop rotations found in N.D. programme were paddy-paddy-paddy, paddy-wheat-moong, paddy-paddy, paddy-wheat and groundnut-wheat.

The 46 Operational Research Projects on Watershed launched in 46 sites in 16 States in 1983-84 with the support of the Department of Agriculture, Rural Development and the ICAR, continued to contribute in total resources development of the watershed villages. The work in the watersheds in respect of land treatment, introduction of improved package of practices, harvesting of rain water, afforestation of pasture development and improving the overall productivity in the areas have been more or less achieved in 30 watersheds; in the remaining watersheds considerable progress has been registered in the above areas of activities. In addition, the impact of Operational Research Projects on Watersheds on the moderation of drought during 1987 was assessed. The results indicated that the watershed areas withstood adverse condition much better than the outside area. The crop failure was only 20-35 per cent in watershed areas whereas outside the watersheds, the failure was 50-70 per cent.

Operational Research Projects (ORPs) in respect of specific problem areas or production sectors have also contributed considerably in terms of educating the farmers and extension workers about the extension approach as well as management practices in raising productivity by scientific farming. For instance, the ORPs on cross-breeding of cattle and upgrading of buffaloes have shown that through artificial insemination the local cattle have produced 2,611 crossbred calves in the project area during 1977-88. The project area has now become a marketing centre for crossbred animals in north-west India. Nearly 718 of the total income from the sale of crossbred animals went to the weaker sections. In all, 1,415 artificial inseminations were done in buffaloes and 1,963 buffaloes were diagnosed for pregnancy during 1987-88. The milk producers were also benefited from an organized marketing channel in the adopted villages. Transfer of new technology of crop production was also done through 791 field demonstrations on different cereals, fodders, pulses, oilseeds and vegetables, mostly conducted on marginal and small holdings. The transfer of technology of milk and crop production has brought about significant improvement in animal and crop productivity in the project villages.

Nearly 40,000 small and marginal farmers and agricultural labourers benefited annually under the Lab-to-Land Programme by way of learning the new methods of cultivation of the improved varieties, raising their production by 50-200 per cent.

The two target-oriented projects exclusively devoted to Scheduled Castes and Scheduled Tribes attempted to demonstrate appropriate technology in their socio-economic condition and also tried to promote the most economical crop combinations and sequences. Enterprises allied to agriculture or rural-based industries were also promoted because the limited land with them could not provide them economic viability. Under 26 ORP Centres for tribals, 16,000 farm families derived benefit through the training and demonstration of agricultural technologies. Due to their increased production and income 600 families could get rid of their debts; the average annual income of the family increased from about Rs 1,000/- in 1982 to Rs 3,500 in 1988. Likewise, the scheduled caste and backward families benefited from 19 centres spread in 16 States. These centres covered

over 10,000 farm families under their programmes. The annual income of these families has gone upto Rs 5,500 against the base level of Rs 1,500 in 1982. For small and marginal farmers and agricultural labourers, specially belonging to under-privileged groups like Scheduled Caste and Scheduled Tribe, diversification in agriculture has been promoted including more than one enterprise per family so that the combined enterprises could provide them economic viability and bring them above the poverty line. The enterprises like sericulture, bee-keeping, poultry, duckery, rabbit farming, and goatry have been welcomed by such poor-resource farmers.

Over 90 Krishi Vigyan Kendras (KVKs) have been organising more than 6,000 short and long-duration vocational training courses for the farmers annually benefiting nearly two lakh farmers and farm women. For instance, in 1988, the KVKs organised 7,304 training courses and trained 197,612 farmers, farm women, rural youth and school dropouts. Eight Trainers' Training Centres (TTCs) organised 163 training courses during the year for the trainers of the KVKs and field level extension functionaries of the State Departments of Agriculture benefiting 2,819 trainees. The KVKs are emerging as the most potential and viable vocational training institutions in their respective districts.

NATIONAL AGRICULTURAL RESEARCH PROJECT (NARP)

The NARP which was launched by ICAR in January 1979 with a support of soft loan from the World Bank is in the middle of second phase. It has helped in strengthening permanently the capability of SAUs to conduct location-specific, production oriented and need based research in 120 agroclimatic zones identified in 17 states in areas of its jurisdiction The Project has provided SAUs with resources to develop the much needed infrastructure and manpower facilities.

Phase II of NARP was initiated from April 1986 at a total cost of Rs 133.11 crores. The target and uptodate achievement of the subproject sanctioned are as given below:

	Target	Achieved
Research (zones)	120	117
Supplementary	91	72
Special	6	4
Administrative	5	5

The emphasis on research during phase-I was on foodgrains, cereals, pulses and oilseeds under rainfed conditions. During phase II new areas of research such as irrigated farming, animal-drawn implements, horticulture, including post-harvest technology, commercial crops, agro-forestry and animal nutrition were covered. The major impact of NARP during the Seventh Plan was on (i) Shift of applied research from main campus of SAUs to specific agro-climatic zones. The zonal concept and research gaps in the identified zones of the various States have been realised by the SAUs and research programmes initiated to solve the location-specific problems in agricultural production; (ii) Infrastructure built up at zonal levels; considerable research support has been provided to all the SAUs to increase zonal research capability permanently and a total of 196 research stations

have been established/strengthened in phase II of NARP; (iii) Research-extension linkage: Linkage between research and extension at the zonal level has been well established and technology transfer in the rural areas has been promoted by the NARP centres.

AGRICULTURAL ECONOMICS, MARKETING AND STATISTICS

Argicultural Economics and Marketing

There is no plan or non-plan project/programme funded during the Seventh Plan period. However, a large number of research projects of national/regional importance has been financed from A.P. Cess funds of the Council. Some of these projects completed during the Seventh Plan are:-

(a) Socio-economic impact of the 1987 drought in Rajasthan and Gujarat.
(b) A critical study of overdues on loans—a case study of two districts of U.P.
(c) Economic and social impact of Lab-to-Land programme.
(d) Growth and imbalances in Indian agriculture with special reference to rice production in southern states of Tamil Nadu and Andhra Pradesh.
(e) Technology, growth and welfare in agriculture—a case study in West Bengal.
(f) Impact of livestock productivity on rural economy in arid areas of western Rajasthan.
(g) A study of betel leaf marketing in Midnapore district of West Bengal.
(h) Conjunctive use of groundwater and surface water for optimal irrigation management and cropping pattern in river basin projects under different rainfall conditions.
(i) Management of impact of agricultural output in the market for manufacturers.
(j) Methodology for simultaneous determination of input and output prices.

These studies have brought to surface some of the important issues and policy implications which would be useful planners and policy-makers alike. These studies have identified the constraints in the adoption of high-yielding technology and suggested policies required to remove or relax these constraints. Some of these constraints identified are lack of infrastructure and institutions including irrigation, credit, marketing and land reforms which have been found to be the most binding constraints in the adoption of modern agricultural practices. Furthermore, the socio-economic impact including income distributional effects of agricultural development and high-yielding technology have been quantificd and analysed. In addition to research in agricultural economic financed from the A.P. Cess funds of the Council, the department/division/units of Agricultural Economics in various ICAR institutes, particularly the national institutes like IARI, IVRI, and NDRI have conducted several agricultural economic studies of national and regional importance. Besides, teaching programmes leading to M.Sc. and Ph.D. degrees in Agricultural Economics are going on at IARI, NDRI and IVRI.

Agricultural Statistics and Computer Applications

Research in agricultural statistics and computer applications in agriculture is largely confined to IASRI, New Delhi, which is the premier Institute in the ICAR system to conduct both basic and

applied research in agricultural statistics as also to undertake development of computer software and library programmes. The Institute has made notable contributions in development of methodology in various areas of statistics and genetics, forecasting of crop yields estimation of livestock products, estimation of marine fish catch, resources and catch of inland fish and other allied fields. Efficient designs for plants and animal husbandry with limited material have also been developed. An important achievement was the development of methodology for estimation of crop yield involving multiple harvest which would improve the estimation of crops like cotton, fruits and vegetables, etc.

Computer software has been developed for analysis of data of research projects in agriculture and animal husbandry and these have been made available to research workers in different ICAR institutes and Agricultural Universities. The Institute has also provided guidance and assistance in setting up of computer centres and units in different ICAR institutes. The Institute also conducts regular training courses including M.Sc. and Ph.D. programme in agricultural statistics and M.Sc. programme in computer application in agriculture. A number of training programmes have been conducted to train agricultural scientists in the use of computer for analysis of research data.

Research in agricultural statistics has also been undertaken by scientists working in different ICAR institutes, National Centres and Co-ordinated Projects. A national-level conference of statisticians of the ICAR institutes and Agricultural Universities is also organised once in three years to discuss current problems and formulation of research programmes in agricultural statistics and computer applications.

CHAPTER 3

EMERGING CHALLENGES IN AGRICULTURAL RESEARCH AND EDUCATION

The following areas of agricultural research, education and extension need to be strengthened.

(A) RESEARCH

1. With increasing population, per capita availability of land is decreasing at a fast rate. It has therefore, become, absolutely essential that available land resources are used in a most profitable and sustained manner. For this purpose a detailed inventory of soil resources as well as guidelines for achieving minimum productivity and optimum soil health care should be prepared.
2. Intensive agriculture in the irrigated areas has put a heavy strain on the ability of the soil to sustain high productivity. Imbalance in water use has created waterlogging and salinity problems. There is an urgent need to devise an optimum on-farm water utilization schedule and drainage strategies so that production can be sustained without further deterioration of land. At the same time, procedures should be developed for sustainable management of groundwater resources.
3. A number of physical and biological activities have resulted in degradation of vast areas of land. The degradation process has assumed serious proportions in Peninsular India and Himalayan region. Immediate attention is needed to contain this process and develop technologies to reverse it and rehabilitate degraded land to its productive use.
4. Global climatic changes are drawing the attention of scientists all over the world. Though the impact of such changes is not precisely known the greenhouse effect will change the thermal regime, precipitation pattern and soil/water balance relationship in major cereal growing areas. The postulated climate change may cause a significant shift in agro-ecological zones and further result in flooding of the coastal areas. All these call for a closer-watch and identification of anticipatory research areas.
5. There is need for intensifying research on improved efficiency of fertiliser, water and other factors of production. Cost reduction without yield reduction should be a major line of research.
6. Conservation of basic agricultural assets such as land, water and biological diversity should receive greater attention.
7. In green revolution areas, research on raising the ceiling of yield of crops like wheat and rice should receive high priority. At the same time, in such areas maintenance research to conserve the gains already made should be given considerable allocation. Although this

kind of research may not appear glamorous, it is vital for safeguarding food security of the nation.

8. Rainfed farming research should be carefully reviewed to find out why it is not having the desired impact on production at the field level.
9. Research on alternative methods of pest control to those relying heavily on chemical peticides, breeding for resistance, biological control and integrated pest management should be carried out.
10. Diversification of agriculture through appropriate land use to maximise farm incomes in view of progressive decline in land holdings, emerging problems in intensive agriculture areas and ecologically fragile zones need attention.
11. Genetic improvement in livestock is limited by non-availability of systems for performance recording required for developing superior germplasm. Application of multi-ovulation embryo technology, semen freezing technologies and linking institutional herds/flocks involving farmers,herds/flocks in genetic selection programmes will help in reducing this limitation.
12. Excessive biotic pressure from livestock needs controlling. This will require full information on existing feed resources and their utilisation and improving efficiency of utilisation so that the number of livestock and their level of production can be matched with the available feed resource.
13. Considering the size of the livestock population and the prevailing diseases, it will not be possible for controlling them through prophylaxis alone. Development of proper disease surveillance and monitoring systems with a possibility of forecasting need attention, so that strategic control and eradication measures could be developed.
14. Biotechnological research support to nutrition, reproduction, growth, genetic engineering, immunology and disease control aspects for upgradation for aquaculture as an industry has become essential.
15. Development of sea-farming technology should be an important component in the fisheries sector requiring survey and assessment of suitable areas, development and standardisation of breeding of marine fishes, shells, sea cucumber and cultivation of seaweed. Research programmes in post-harvest technology would pertain to development of products from unconventional fish species.
16. There is often a mismatch between production and post-harvest technology. When post-harvest technology is poor, both producers and consumers do not derive full benefit from production. This is particularly true in perishable commodities like vegetables, fruits, flowers, milk, meat and fish. There is urgent need for strengthening post-harvest research and extension. Research in post-harvest technology should include standardisation of techniques for preparing value-added products from the available agricultural biomass.
17. The participation of women in technology development and adoption should receive high priority.The emphasis should be on reducing drudgery and enhancing opportunities for skilled employment.
18. The whole area of social sciences including agricultural economics, food policy, agrarian reform and market intelligence (national and global) is currently very weak. There is, therefore, need for strengthening social science research both in existing institutions as

well as by setting up of *National Centre for Agricultural Economics and Policy Research.* The Centre will also help in studying economic and social impact of new agricultural technologies and constraints in their adoption. Social scientists should be involved in *all programmes in a pro-active rather than in a reactive responsibility.* This implies the involvement of social scientists in all aspects of research strategies, including priority setting.

19. Assured and remunerative marketing opportunities determine farmers' decisions on investment in agriculture. Both home trade and international trade need greater attention from the point of research and extension. In view of the opportunity available for producing a wide range of agricultural commodities including the health foods of the future for export, it is important that ICAR sets up a *National Research Centre for Agricultural Exports.* This centre should identify R&D priorities and feed them into the research system, taking into account quality requirements, consumer preferences, cost considerations and stability of supply of the products which have export potential.

(B) EDUCATION

1. There is acute shortage of trained manpower in social sciences, veterinary sciences, agricultural engineering, post-harvest technology, fisheries and forestry.
2. The frontier areas of science such as biotechnology, computer science, space technology and management technology require more detailed planning from the point of view of human resource development.
3. The quality of graduates in various disciplines of agricultural sciences is going down and there is an urgent need for Agricultural Universities to give attention to upgrading the quality and standards. The teaching and training responsibilities of scientists should also receive greater recognition.
4. There is need to provide for continuous retraining of teachers and researchers. This should form an integral part of scientific career planning.
5. Each ICAR institute and Agricultural University should develop a Five-Year Plan for staff upgradation. For this purpose, the critical gaps in existing internal competence should be identified and steps taken to fill these gaps.
6. Imparting of new skills to rural women should receive priority. Agricultural Universities should help in identifying economically viable skilled jobs for women so that programmes like TRYSEM can become more effective.
7. There is a need to review critically the major thrust of Home Science education. Home Science colleges should concentrate on the productive aspects of the role of women. There is also need to find a new name for Home Science colleges in order to do justice to the spearhead role several of them are playing to help women to acquire new skills.
8. In the new education policy rural universities are being set up. The first Education Commission chaired by Dr S. Radhakrishnan had considered agricultural universities as rural universities. *In order to avoid duplication and achieve the purpose of helping rural men and women in a meaningful manner, Agricultural Universities and Rural Universities should clearly identify their respective roles.* They should work in a complementary

manner rather than duplicating the scarce financial and technical resources. Since land and water based occupations provide much of the employment in villages, it will be necessary for Rural Universities, as described in the New Education Policy, to have strong linkages with Agricultural Universities. *In many cases, Agricultural Universities can take on any additional responsibility needed for them to fulfil the role of Rural Universities.* Our emphasis must be on maximising the benefits to the rural population from the existing infrastructure.

(C) EXTENSION EDUCATION

1. Research on knowledge and skill transfer mechanisms including a critical study of T&V needs to be undertaken in all Agricultural Universities.
2. The gap between research know-how and its field application gets wider with increase in risk. The cost-risk-return structure of major farming systems needs study in each agro-ecological zone.
3. Too many varieties are being recommended at the State level. An independent screening mechanism appears necessary. While varietal diversity is important, we must ensure that farmers are not confused by too many releases made without rigorous testing.
4. Mobilisation of mass media particularly radio and TV is extremely important to disseminate knowledge and awareness. Government should consider establishing TV channels for use in every Agricultural University. ICAR should enable selected Agricultural Universities and Central Institutes to develop *Media Resources Centres*. Organisations like FARM (Forum for Agro Rural Media) should be strengthened through recurring grants.
5. Krishi Vigyan Kendras will have to be established in all districts. The cost should be shared between the State Government and ICAR. Also duplication with other similar devices for training should be avoided. Krishi Vigyan Kendras should carry out training through work experience on learning by doing and should also organise mobile training programmes, particularly for women. Wherever appropriate, Krishi Vigyan Kendras should be developed into Krishi-cum-Udyog-cum-Van Vigyan Kendras.

mentioned earlier, ICAR in co-operation with DBT should establish during the Eighth Plan period 5 regional genetic enhancement centres. These centres will undertake pre-breeding research and develop material containing novel genes for a wide range of biotic and abiotic stresses. Such material will be made available to practical plant and animal breeders.

Use of DNA finger printing in genetic identification of plant and animal materials, establishment of familial relationship, selection of specific genes associated with specific disease problems, adaptation to environmental stress on production should receive major emphasis.

Basic Research

Mission-oriented basic research holds the key for providing solutions to the existing and emerging problems. The following areas need immediate attention:

i) Modelling salt-water transport in soil-plant-atmospheres system.
ii) Physics of erosion.
iii) Understanding basic process involved in nutrient transformation and transport in soil-plant system.
iv) Clay mineral transformation and association in various processes in soil.
v) Environmental pollution and behaviour of heavy metals in biological systems.
vi) Photosynthetic efficiency and nitrogen fixation mechanisms.
vii) Solute transport through membrane and membrane permeability to understand salt stress tolerance in crops.
viii) Modelling of plant architecture and development of efficient ideotypes of various crop plants to suit different cropping requirements.
ix) Establishment of the biochemical basis of resistance to various biotic and abiotic stresses, quality traits and other traits of economic significance.
x) Basic understanding of genetic architecture of various plants for further genetic improvement.
xi) Basic research in animal genetics especially, immuno, bio-chemical and molecular genetics, genome analysis and identifying genes related to specific economic characteristics.
xii) Immunology.
xiii) Rumen microbiology, genetic and non-genetic manipulations for enhancing utilisation of low-quality roughages.
xiv) Energy and protein metabolism.
xv) Endocrinology, work, growth, lactation and reproduction physiology.
xvi) High-tech aquaculture system for carps, air-breathing fishes and prawn involving feed formulation, disease control, high-quality seed and control of pond environment, use of plastic houses in horticulture.
xvii) Studies on photosynthesis for increasing photosynthetic efficiency.
xviii) Osmo-regulation and water transport in plants for improving arid zone agriculture production.

xix) Nitrogen fixation through transfer of nitrogen fixing to plants/soil microbes not capable of nitrogen fixation.

xx) DNA transfer for developing transgenic plants, animal e.g. cysteine-rich feed for sheep for improving wool production and development of new species through somatic cell hybridisation.

Piasticulture

Plasticulture can help in aquaculture through lining of ponds/tanks in static/stagnant waters and under running water conditions through cage or pen culture. It can also assist in transportation of fish seed/fingerlings through effective plastic containers. The use of plastic culture in drip irrigation, application of fertilizers, insecticides in liquid form could be important in agriculture and needs to be more suitably exploited. Operational research projects and lab-to-land programmes will be initiated by ICAR and SAUs with the co-operation of industry.

Computer-aided Instruction (CAI) and Computer-aided Extension (CAE)

ICAR will launch a dynamic programme of CAI and CAE at IARI, IVRI, NDRI and CIFE during the Eighth Plan period. These institutions will develop the software essential for the field use of these techniques by SAUs and State departments of agriculture and animal husbandry.

Recycling of Plant and Animal Fibres

Application of plant and animal fibres and processing wastes of textile industries can be made to conserve soil moisture, improve germination under moisture stress conditions, control of soil erosion through improved drainage. Plant and animal fibres being biodegradable, will improve soil fertility. There is need for detailed studies on use of these fibres in improving agricultural production.

CHAPTER 6

RESEARCH AND TRAINING FOR THE ECONOMICALLY AND SOCIALLY HANDICAPPED

1. Resource Poor Farmers

Out of the 80 per cent of the Indian people dependent for their livelihood on agriculture, resource poor farmer viz. small and marginal farmers constitute a substantial component. By 1990-91, it is expected that over 90 million of the 100 million operational holdings in the country will belong to the small and marginal farmer categories. *The future of Indian agriculture, therefore, depends upon our success to improve the efficiency of small farm agriculture.* As per the census figures, the percentage of this group has increased in the last 20 years from 62 to about 75 per cent, whereas the area cultivated by them has increased from 19 to 23 per cent only during the same period. It was also noted that the benefits of the green revolution had not percolated down to this section. The agricultural technology being developed by the research institutions has yet to become applicable to the small land holdings. The land use pattern of these holdings is characterised by low productivity due to inadequate or total absence of input application, low inherent soil fertility, heavy indebtedness of the owners and little access to the modern/improved technology. Most of the small and marginal farmers belong to what is commonly known as dryland areas where apart from the above constraints the moisture stress further lowers the crop and animal productivity.

Under the Lab-to-Land Programme, emphasis has been laid on the dissemination of low-cost production technologies appropriate to the socio-economic and ecological conditions of small and marginal farmers and landless labourers. The technologies introduced cover crop and animal production, bee keeping, horticulture etc. This has helped to increase productivity of crops by 48 to 340 per cent. Similar, increases have also been recorded in animal productivity.

Research, Training and Transfer of Technology Programmes directed towards these farmers should aim at the following.

a) To study and understand the socio-economic background and resources of the selected farmers and landless agricultural labourers and study the feasibility of introducing low-cost relevant agricultural and allied technologies on their farms/houses for increasing their employment production and income.
b) To assist the farmers to develop feasible farm plans keeping in view the availability of technologies, needs and resources of the farmers, and the resources which could be made available from external sources agencies.

c) To guide and help the farmers in adopting improved technologies as per their farm plans, and demonstrate to them the economic viability of those technologies as well as methods of cultivation and farm management.

d) To organise training programme and other extension activities in relation to their adopted practices and prepare them for active participation in agricultural development programmes of the State Departments of Agriculture.

e) To make the farmers aware of the various opportunities and agencies which they could utilize to their economic advantage.

f) To develop functional relations and linkages with the scientists/institutions for future guidance, advisory services and help.

g) To utilize this project as a feed-back mechanism for the agricultural scientists and extension functionaries.

(i) Comprehensive techno-economic surveys for strengthening research, training and extension education programmes relevant to small & marginal farmers should focus at the economic status of small and marginal farmers, landless labour families, productivity of their land and animals, constraints facing them. This will be useful in developing a database to provide valuable help in identifying appropriate needs for intensifying research and training efforts.

(ii) Research should be carried out in an integrated farming manner in different agro-ecological situations to develop low-cost technologies for these farmers.

(iii) Research programmes to develop appropriate systems for research management, credit management and resource management applicable under small and marginal holding conditions and under different agro-ecological situations are urgently required. Risk management would involve standardisation of different mixed crop, livestock and fish farming systems to offset the losses due to weather aberrations or other calamities.

(iv) There is also an urgent need for diversification of land use, livestock farming, mulberry plantation, agroforestry fruits and vegetable cultivation, bee keeping etc.

(v) In the post-harvest sector, development of on-farm storage devices and village level processing units of agricultural and animal products should be standardised and extended to the farmers. Agricultural engineering support, especially improved tools and implements, need to be introduced to reduce drudgery and improve production.

(vi) An integrated approach for major operations like soil and water management, pest and disease management and fertiliser use should be adopted in an integrated manner.

(vii) Delivery system of technology and inputs to these target groups should be estimated.

2. Scheduled Tribes and Scheduled Caste and Tribal Farmers

(a) Scheduled Tribes

There are about 250 scheduled tribes in the country, some of whom are still engaged in food gathering, and shifting cultivation. The total tribal population is around 516 million. No serious effort to develop appropriate technologies to suit the tribal situation has been made. The great strength of tribal populations is their social cohesiveness. They can take up much more easy technologies like

integratd pest management and scientific water management which need group cooperation, in comparison with non-tribal population. Unfortunately, the approach in research and development programmes has so far been more individual than group oriented. The research project oriented towards tribal people must take into consideration, the tribal situation, the inaccessible hill areas in which they live, the tribal produce that is grown traditionally by them and, also the problem of shifting cultivation, and viability of the projects being framed by the State Government from time to time for resettlement. There are several research institutes/stations/Krishi Vigyan Kendras of the ICAR which are directly serving the tribals. Important among these are ICAR Research Complex, Shillong and Central Agricultural Research Institute, Port Blair which have developed agro-technologies for increasing crop, animal and fisheries production. Alternative land use to the shifting cultivation and suitable cropping systems on watershed basis to ensure conservation of soil and water for the tribals have been developed. The Lac Research Institute at Ranchi has also developed technologies related to lac production and has extended it to the tribals in Chhota Nagpur Area of Bihar. ICAR is also operating multi-locational and multi-commodity based operational research projects for scheduled tribes at 26 centres covering 11 states.

The objectives of the project are as follows:

(i) To evolve alternate models of technology packages for evaluating them against a given agro-ecological and socio-economic milieu for their feasibility and economic viability.
(ii) To act as a catalyst with its science and technological input of the type that is most relevant to each of the given tribal communities or blocks.

This project has helped 60,000 families to improve their income from an average of Rs. 1000/- per year to Rs. 3000/- per year. Improved varieties and production technologies of cereals, pulses, fruits and vegetable crops, goats, poultry, and rabbits have been introduced. Apart from these, adequate training in rural vocational subjects such as carpentry, tailoring, mushroom production, collection and sale of minor forestry production, bee-keeping, etc. is being given importance. The impact of these efforts could have been greater if more scientists could be attracted and retained to serve these communities. Most of the scientific positions in such areas are vacant. Serious consideration needs to be given to the development of special personnel policies for scientists serving ecologically and socially handicapped areas, on the model of the non-family postings prevalent in defence services. Otherwise it will be very difficult to elevate and stabilise biological productivity in tribal regions.

(b) Scheduled Castes

The total population of scheduled castes in the country is roughly 104.7 million. A majority of these are engaged in agriculture for their livelihood. They suffer from handicaps similar to those experienced by small and marginal farmers apart from their inherent socio-economic handicaps. No major attempt has been made to identify the constraints specific to these communities, which are responsible for the low productivity of their land. ICAR had taken up an Operational Research Project for Scheduled Castes and other backward communities with the following objectives:

(i) Improving agriculture and livestock production through the introduction of modern technology which would be of great help to advance the economics to the small and marginal farmer and agricultural labourers of the target community.

(ii) Creating viable and appropriate technology modules to approach problems of the area in an integrated manner and to create better production potential and rural employment opportunities not only to ensure adequate economic return to the small and marginal farmers by way of creating better market demand for their produce but also to absorb gainfully the rural landless labour in various agricultural and allied vocations.

Ninteen centres located in 16 States are operating under the control of the SAUs. Around 10,500 families have benefited from the project and their average income has risen from Rs. 1500 to Rs. 4,000 per year. This has resulted from the introduction of improved varieties and practices in crops production, horticulture, animal and other homestead vocations. The Project will need further strengthening and similar effects for research, training and extension education as for small and marginal farmers would be required for SC and ST communities.

More emphasis should be given to research on the position of scheduled castes in agriculture who are primarily agricultural labour. Their methods of work, technology and tools, productivity, safety, health and socio-economic betterment should be considered as a part of agricultural research. Research study should also bring out the way to reduce drudgery of the Scheduled Caste labour and improve productivity so that they got better wages.

3. Farm/Rural Women

The farm/rural women constitute a large percentage of the farm population. However, their participation in agricultural operations is neither given explicit recognition nor documented. The 1981 census reveals that about 35 million women are engaged in agriculture. However, the number of women agricultural labourers has been increasing every year indicating an increas e in poverty and landlessness. Recently an international conference on the issues of appropriate technology for farm women was organised in New Delhi to spell out recommendations. No research and training programmes specific to the needs of farm women have been initiated. Similarly, most of the transfer of technology programmes for disseminating improved farm technology and the training imparted, have been confined to male members of the farming community. The only activity directly related to the women is home science component in the KVKs. The National Perspective Plan for Women (1988) has accorded high priority to the farm sector with reference to income and employment generation for women. Women need training and retraining. Their skills will be of particular value in seed technology, tissue cultures, induced breeding of fishes, animal husbandry and computer technology.

It is recommended that a *National Research Centre for Women in Agriculture* should be established for undertaking research relevant to the needs of farm women. The centre should develop technologies related to crop production, livestock production, fisheries with major emphasis on seed production, post harvest technology, integrated pest management, etc. Women should take a leading

part both in technology development and dissemination. Research on the generation of jobs involving flexibility in time, duration and place of work for women should receive high priority.

There is need for national database and information network on the role of women in agriculture and it should be established by SAUs and ICAR. Existing research institutions should develop inventory of technologies most suited to women. The farming systems research and on-farm research programmes should take into consideration the needs of farm women for income and livelihood security.

The KVKs in addition to providing training in domestic activities such as nutrition, child care and recreation should lay greater emphasis on training of farm women in agricultural, livestock and fish production technologies; post harvest technologies, especially storage should also be emphasized. The productive role of women should receive priority attention in Home Science Colleges. Home Science Colleges should have sections such as the following:

(a) Seed Technology.
(b) Biotechnology and bio-processing as applied to crop husbandry and animal husbandry.
(c) High Tech. Aquaculture including induced breeding.
(d) Integrated pest Management.
(e) Improved Post-harvest Technology.

It may be appropriate to redesignate some of the Home Science Colleges as Colleges for Women in Agriculture, in order to place greater emphasis on the productive role of women.

CHAPTER 7

STRENGTHENING LINKAGES IN AGRICULTURAL RESEARCH AND EDUCATION

There is full realization of the fact that there are two problem areas in linkage between research, education and extension: (a) formal linkage mechanisms exist in some cases among institutions/organizations, and (b) there are institutions in agriculture and allied areas where formal mechanisms for linkage do not exist. In the case of the former, in spite of formal groups/committees, the functional linkages are not as effective.

Collaboration is a two way process. Many times this aspect is not realised and therefore, one keeps on blaming the other for ineffective linkage or failure in effective collaboration. There is another dimension of the problem: linkage requires not only technical/scientific input but also socio-psychological input. If both these aspects are properly synchronised in individuals, interactions between individuals or institutions are more likely to succeed.

Accountability for proper linkages has to be fixed on individuals and on non-performance, necessary follow-up action will be essential. On the same plea the successful performance of such collaboration, the incumbents concerned should get appreciation and encouragement. In other words, the 'reward and punishment' concept as an integral part of the functioning of institution/ organization should find its due place.

It is a happy augury that in the field of agriculture, integrated function of research, education and extension is being promoted and actively pursued. Still the desired level of interactions between national and international institutions are not taking place. Some suggestions in this regard are given below:

1. Agricultural Education

(i). Teaching, research and extension in agriculture in SAUs or Research Institutes are being carried on as an integrated concept. The formula of 2/3 and 1/3 either teaching or research or any other combination of the three functions are considered desirable. In other words, all the scientists/teachers should get exposed to either of the three fields/functions of which extension is the most crucial. The scientists must be involved in extension work as per the above formula or even indirectly so that the problems of farmers are reflected in the research and teaching/training programmes. In spite of this accepted approach, hardly 10% of the scientists are involved in field extension works or field training programmes.

This formula needs to be readily available to the scientists. The field involvement would mean mainly in the first-line transfer of technology activities and to some extent in the extension programmes and activities of the State Department of Agriculture in their respective areas.

(ii) Planning for effective education would mean basing the curricula on the felt-needs of the end users/clientele systems, whether they are farmers or workers in the industry. Therefore, occasional interaction in the form of seminar or symposia between teachers/ scientists and people working in industries or farming will have positive influence on the curricula as well as teaching approach and methodology. In fact, occasionally people with lot of field experience and background should be invited for special lectures or seminars involving scientists as well as post-graduate students. The Land-to-Lab scheme of the ICAR is meant to encourage such interactions in the SAUs and the Research Institutes.

(iii) Field practicals are other avenues for the students as well as teachers for exposure to the field problems. However, in majority of the cases teachers prefer lab practicals or on-campus field practicals; village practicals by and large are rare. The latter need to be strengthened both by involvement of scientists as well as providing mobility and other field facilities.

(iv) At post-graduate level, in each discipline, there is a need for field oriented courses where the students are made to demonstrate in the fields the technologies in their respective specializations using extension methods and techniques. Such orientation will give them insight into the field work as well as interest in and linking for such interaction in future. In addition 'Internship' as well as "Earn while learn" scheme must be popularised and adequately supported with necessary resources.

(v) The existing forums like Academic Council, Advisory Committees, etc. must function in letter and spirit. In such forums, the end users should find place as members.

2. Agricultural Research

(i) Agricultural Research being applied and inter-disciplinary, team work between allied scientists including social scientists has been emphasized all through (but unfortunately this has not been realised to a great extent) in the interest of quality research work and generating location-specific technologies. Foremerly there exists Researeh Council and such other bodies at different levels where there is a need for improving their working specially in terms of involving (a) scientists of allied branches, (b) social scientists including agricultural economics, statistics, home science etc., (c) extension staff of the Institutions as well as State Department of Agriculture and clientele group comprising farmers, farm women and representatives of industrial sector. Such interactions should be encouraged at all stages of research i.e. planning, implementation, review, recommendations, and follow-up.

(ii) Post-graduate students can support the research systems for multiplier effects. In reality, however, this resource partly goes waste, for their research programmes normally do not emanate from the planned research schemes of the research institutions. A well projected and planned research for coming decades should master research frame-work in which all

should work in order to achieve the projected goals. Steps are necessary to realize this kind of integrated approach in the research systems.

(iii) A systems view of research has yet to emerge where all elements of research can find their relative place ultimately contributing to the whole on effective correlation and inter-play. In this approach, all the processes in the research system should have systematic interaction including marketing of products and the national and international markets. Industrial sectors which utilise the agricultural raw material and have bigger stake in the marketing world, must be directly involved in the research process which hitherto has been a night-mare.

(iv) For developing appropriate and location-specific farm technologies, adaptive trials, field trials, operational research and farm trials/research have been talked about with some success. Such efforts need further support and strengthening. The concept of participatory research needs to be promoted where farmers become active research partners. At least 50% of the research work of any research scheme should be on the farmers fields in the form of on-farm research where farmers should be deliberately involved.

(v) So far in our country, research is, by and large, a government supported endeavour where the accountability is somewhat diluted in the name of research. The concept of commercialization needs promotion where investments in research is in tune with expected outcome in a specified period of time. Advanced countries where resources are unlimited, follow this approach where research is not a losing proposition. Commercialization would also mean utilizing research resources from the private quarters on contractual basis. A lot of resources on such linkage can come from business houses/private organizations.

(vi) In future research thrusts are needed in two directions: First on farm research as mentioned earlier and farming system research vis-a-vis cropping systems followed so far. In both cases there is a need for developing appropriate methodologies and training and orientation to our scientists. Farming system research is all the more important, integrated exploitation of all the limited resources available has to be synchronised and utilized for total impact on economic well being of such farmers. Farming systems research would mean a lot more interaction in allied disciplines including even non-agricultural sectors.

(vii) All research forums should have representation from both government and non-government institutions including industrial sector for instance, Research and Development Co-ordination Committee at the ICAR Headquarters, eight Regional Research Committees of the ICAR, Research Review Committees of the SAUs including NARP work. Feedback from such Committees could be an important channel for identifying appropriate research projects. Follow-up actions of such Co-ordination Committee Meetings therefore, becomes very essential.

(viii) There is an urgent need to identify all institutions/organizations which can contribute towards research outcomes and utilize them in various Co-ordination Committees including Directors' Conferences and Vice-Chancellors' Conferences. Departments/Institutions like CSIR, ICMR, DST, Space Research, BARC, Wasteland Development Board, Department of Forestry and Environment, Department of Food and Civil Supplies, Seed/Fertiliser/Pesticide industries, State Trading Corporation etc. require greater involvement in our research efforts than has been possible so far.

3. Agricultural Extension

(i) From an effort of an Evaluation Committee of the Directorate of Extension of the Ministry of Agriculture, Government of India, a recommendation has been made to constitute an Extension Advisory Council at the Centre with representation from all acts of Departments/Institutions which have extension programmes in agriculture, with a view to linking and integrating the extension efforts for better working and outcome. Similar Review Councils have been proposed at the state level also. If these two Advisory Councils function properly with involvement of officers who matter, the extension work in the field will have definite impact on agricultural production. While such higher level Committees may meet perhaps, annually, there should be lower level committees at the local/district level for more frequent interaction but certainly not less than twice in a year.

(ii) Some important occasions for research-development interaction and feed-back are the monthly workshop of Subject-Matter Specialists of the State Department of Agriculture and the scientists of the respective SAUs, the Zonal Agricultural Research and Extension Committee Meetings of the development staff and the farm scientists and the diagnostic joint team visits of the farm scientists and the extension staff. All that is required that such interaction should be made meaningful by active participation and follow-up action.

(iii) In the research-development linkages, the ICAR Research Institutes and its transferof technology projects including Zonal Co-ordination Units have been by and large bypassed. These should also be brought into the mainstream of interaction.

(iv) The development of package of practices for the State should be based on the interaction of all the research parties in the State including SAUs, ICAR Research Institutes/Projects and non-government/private institutions. Such an approach will avoid the criticism of different recommendations on the same project by different institutions. The Institutions should also maintain discipline by not allowing scientists to advocate recommendations beyond the package of practices so that farmers and extension agencies are not confused.

(v) A closer linkage between extension systems and input agencies including agricultural implements and credit, is imperative to make impact on production. At present these two aspects are not functioning in a synchronised manner. The extension system should not give advisory services and information or training for which requisite inputs are not available.

4. International Collaboration

(i) International collaboration will be beneficial in all the three agricultural broad functions namely, education, research and extension, both for learning the latest as well as contributing to the international pool of knowledge in agriculture. International interactions are necessary to keep pace with the rapid advancement in agriculture all over the world. Complacency leading to the feeling we know everything will be a costly mistake.

(ii) Collaboration between the research system in India and the other nations or International Institutions should be based on mutuality of interest.

(iii) The present international collaborations in agriculture are rather ad hoc and not based on

well conceived research collaboration strategies. At present the interaction with international research institutions and foreign countries is restricted to 15 protocols. There is great scope for strengthening collaboration with other developing countries. Annual interactions with organisations, like FAO, UNDP, USAID, EEC, IDRC, CIDA, SIDA, SAARC etc., may be useful.

(iv) Indian experts and post-graduate students abroad have not been utilized in a systematic manner to benefit the Indian research system by way of collecting potential and worthwhile breeding materials from foreign countries. Perhaps there is scope to take a look at this aspect more critically.

(v) In view of advancement of agriculture in India, the country should also think of sharing its expertise with other countries, specially African countries. Indian farm scientists are well recognised and popular specially in developing countries because of the relevance of their know-how to resource poor nations.

(vi) ICAR should develop a strategy for effective utilisation of programme such as TCDC and ECDC and the TOKTEN Scheme of UNDP. It should develop leadership in partnership.

(viii) In view of the growing privatisation of applied agricultural research in developed countries, ICAR should develop clear guidelines, towards patenting and intellectual property rights and for public-private sector partnership. ICAR may consider setting up of a Committee to establish rules and procedures. Collaboration between Agricultural Universities and public and private sector industries should also be fostered.

CHAPTER 8

EIGHTH PLAN PRIORITIES

The major aim of Eighth Plan will be to provide thrusts in the following areas:

1. Conservation and planned exploitation of germplasm resources. Complete inventory of natural resources.
2. Enhancing production through evolution of new varieties/breeds/strains.
3. Improving nutrient management system.
4. Improving dry farming technology.
5. Energy management in agriculture.
6. Post-harvest technology with emphasis on on-farm storage and preparation of value-added products from biomass.
7. Improving information and communication systems.
8. Fostering excellence in research and educational programmes.
9. Human resource development.
10. Export-oriented commodity researches.
11. Diversification of agriculture with emphasis on horticulture, livestock and fisheries.

In each of the different sectors of agricultural research, education and extension education, the priority programmes have been identified and listed under each sector.

CROP SCIENCES

1. Priority

The priority areas for the Crop Sciences are identified as follows:

(a) Collection of germplasm of agriculturally important crop plants from unexplored areas. Also, priority for the conservation, exchange, evaluation and utilization of germplasm.
(b) Development of promising varieties of oilseeds, pulses, cereals and coarse cereals with inbuilt resistance to diseases and pests.
(c) Major emphasis needed on hybrid research in order to exploit heterosis for increased productivity, earliness, drought tolerance and resistance to diseases and pests in crops such as rice, maize, *bajra*, sorghum, sunflower, cotton, castor, pigeonpea and *Brassica juncea*.

(d) Genetic improvement in quality traits of wheat, rice, maize, sorghum, sugarcane, tobacco, jute, cotton, oilseeds, pulses, etc.Emphasis required on the development of export-oriented varieties and also for diversified uses as value-added products.
(e) Breeding crops for tolerance to abiotic stresses, especially drought, salinity, frost and heat. Breeding for location-specific environments such as deep water and upland rainfed conditions.
(f) Development of seed production and seed technology strategies for various crops, with greater emphasis on breeder seed production and its monitoring, especially for oilseeds, pulses, coarse cereals, forages and sugarcane.
(g) Development of integrated pest management strategies to optimise plant protection practices. Surveillance and monitoring programmes are to be strengthened for developing medium and long term forecasting and forewarning systems. Greater emphasis is to be given to biological control of insect pests, plant pathogens and weeds with main thrust on mass multiplication and development of appropriate systems for dissemination of biological control agents.
(h) Emphasis on research relating to biotechnology as a promising tool for evolving new and superior genotypes.

2. Thrust Areas

The major new thrust areas have been identified crop wise for research during the Eighth Plan. In addition to exploration and conservation of plant genetic resources of food and oilseed crops, emphasis must also be laid on horticultural crops, agro-forestry species and forage species. The work of plant genetic resources should involve characterization and evaluation of available resources. Plant genetic resources in tribal areas should be widely explored. Considering the limitations of physical facilities to allow taking over the plant genetic materials available, the Bureau may take up the listing of such materials available at different centres and develop a network of plant genetic resource conservation units and have a complete information on these genetic resources through a computer database. An off-shore quarantine facility may be established for introduction of exotic germplasm. The *in situ* conservation through biosphere reserves would be the responsibility of Department of Environment and possibly of the Defence Research and Development Organisation. The Bureau of Plant Genetic Resources will have the responsibility for only *ex situ* conservation. The gene bank should be established fully and also in duplicate and, in addition to conventional methods of preserving seed in conventional temperature control chambers, a permafrost conservation unit may be established in places like Ladakh.

In irrigated rice, the emphasis will be on a development of technology packages for different agroclimatic conditions, diversification of rice based cropping systems, acceleration of research on hybrid rice, scented rice, breeding of varieties for special situations and development of integrated pest/disease management. In rainfed rice, the emphasis has to be laid on breeding for moisture stress, research on characterization of environments for rice growth and development of appropriate machinery for pre- and post-harvest operations.

In wheat, research may be intensified on disease resistance (rusts, Karnal bunt and smut) and improvement of grain quality. Research on rainfed wheat should be given high priority.

Research in maize will focus on production of early maturing hybrids and composites. For *rabi* maize, greater thrust will be laid. Sorghum and pearlmillet research will concentrate on breeding new varieties for grain-cum-fodder, and also types for different harsh environments. Major emphasis must be laid on *rabi* sorghum research. In the case of pearlmillet a greater emphasis is required to be given on early maturing hybrids resistant to downy mildew.

The research thrust in pulses, forages, *guar*, under-utilized crops and hill crops will concentrate on areas like breeding for resistance to diseases and pests from diverse sources, maintenance, characterization and utilization of germplasm, etc.

Special areas of emphasis will be breeding of lucerne and berseem and cultivated fodders and grasses and legumes for pasture improvement. Major thrust would also be on seed production.

In the case of cotton, emphasis will be on breeding early maturing, medium staple hybrids for northern India and evolving integrated pest management to control *Heliothis* and whitefly. In the case of jute, greater emphasis on germplasm characterization and conservation, evolving of photo-insensitive varieties for jute with high fibre yield, improvement of mesta for higher biomass production and management of pests and diseases is to be given.

In sugarcane, varieties with earliness and high sugar yield with resistance to red rot are required to be evolved; suitable varieties for planting after wheat are to be bred. Emphasis on seed production as well as integrated pest management with greater emphasis on mass production of parasites has to be laid.

Emphasis in tobacco should be to evolve varieties with low tar and nicotine content. Also, alternative uses of tobacco and tobacco wastes have to found on priority basis.

Major thrusts in plant protection research will concentrate on strengthening of investigations on biological control of plant diseases and pests. Integrated Pest Management (IPM) concept will be promoted and biotechnology and other modern techniques should be used for pest and disease control. Research on botanical pesticides and agricultural chemicals must also be strengthened.

In the area of seed technology, major emphasis should be given to production of breeder seed of different crops. Provision of a Revolving Fund has to be made and facilities created for cold storage so as to take care of excess seed produced to be carried over to the next season. Emphasis has to be laid on production of seeds of forage crops, sugarcane, coarse cereals, pulses and oilseeds. Seed technology research to support seed production and seed certification aspects should also be strengthened, particularly with regard to greater emphasis on seed health research.

Research thrust on biotechnology, especially genetic engineering for pest and disease

resistance, wide hybridization, protoplast fusion, RFLP for gene mapping, tissue culture for germplasm conservation, plant quarantine and micropropagation, etc. should be given by establishing effective biotechnology research groups on important commodities in order to achieve desired results quickly.

3. Institutional Support

The Crops Division operates through 10 Institutes, 6 National Research Centres, 4 Project Directorates, 25 All India Coordinated Research Projects besides the State Agricultural Universities. Need-based research support in the form of *ad hoc* schemes is also provided through A.P. Cess Fund under the technical control of 5 Scientific Panels relating to the disciplines of Plant Breeding, Plant Physiology and Biochemistry, Plant Pathology, Entomology and Nematology. Their strengthening in terms of better working facilities including farm, laboratory, mobility, etc. should receive priority attention. Sufficient funds would be required to make the existing infrastructure efficient.

Emphasis must be given to provide sufficient support to the newly created centres/projects during the Seventh Plan so that they become functional, operative and efficient.

It would also be desirable to develop centres of excellence to cater to the basic and strategic research requirements for achieving the desired results, especially to overcome the gaps in the existing knowledge.

During the Eighth Plan, following institutional rearrangement would be desirable:

i) Creation of an independent Wheat Directorate.
ii) Upgradation of Pulse Directorate to the level of a National Institute of Pulse Research. Also, reorganization of the Pulses Coordinated Project by creating 3 All-India Coordinating Research Projects, one each on chickpea, pigeonpea and other pulses.
iii) Reorganization of *Guar* Coordinated Project for undertaking research on tropical legumes such as *guar*, cowpea, moth bean, and horse gram.
iv) Creation of a National Research Centre on rapeseed-mustard group of crops.
v) Renaming the Jute Agricultural Research Institute, Barrackpore as Agricultural Research Institute on Jute and Allied Fibres so as to cater to the research requirements with added thrust on ramie, mesta, sisal and sunnhemp instead of creating a new National Research Centre on Allied Fibres, as approved in the Seventh Plan.
vi) Restructuring and establishing an independent Directorate on Biological Control.
vii) Strengthening of upland rice research centre of CRRI at Hazaribagh.

4. Financial Projections

Against an allocation of Rs 83.7657 crores for the Crops Division during the Seventh Plan, a sum of Rs 350.00 crores would be required during the Eighth Plan to implement projected thrust areas in this document. Commensurate with gains expected, such an investment would be fully justified.

(b) Improvement in cotton processing methods so as to get high quality yarns from indigenous cotton varieties.

(c) Testing of Indian cottons and resultant yarn to new spinning and weaving methods.

(d) Pilot plant studies on laboratory proven technologies in-house and in cooperation with other agencies on diversified uses of cotton, cotton stalks, cotton-seed, and wastes.

(e) Training of Gin Filters/supervisors and consultancy in cotton ginning.

4. Jute Technology

(a) Grading and spinning quality evaluation of jute/bast fibres for improved fibre quality.

(b) Development of diversified products with export potential such as carpets, blankets, decoratives, light postal bags, and items of industrial use.

(c) Improvement of colour fastness in jute and allied fibres, dyeing and bleaching.

(d) Packaging material from jute sticks, tea-chests, fruit packages and corrugated paper boards, etc.

(e) Development of non-wovens for industrial and geotextiles.

(f) Pilot plant studies and industrial liaison on newsprint from mesta whole plant and other diversified use items.

(g) Transfer of Technology centres in Bihar/Orissa, Andhra Pradesh, Assam, and Uttar Pradesh.

5. Lac Technology

(a) Improving lac production technologies for increasing productivity and quality of shellac and brood lac.

(b) Improving lac and host-plant management, modernisation and removal of drudgery.

(c) Upscaling/pilot plant studies on laboratory proven diversified uses of lac and its by-products and establishing techno-economic feasibility.

(d) Dissemination of improved technologies of lac production, processing and utilisation to the farmers and processors through training demonstration, advertisement and consultancy.

6. Soybean Processing and Utilisation

(a) Upscaling of technologies relating to full-fat soy-flour, soypaneer, soy-snacks production.

(b) Development of appropriate technologies for partial and defatted soy-flour for food uses.

(c) Development of appropriate technologies for soy-dal, and protein rich foods from edible grade partial and deoiled cakes/meals.

(d) Pilot plant studies, techno-economic feasibility of different soy-processing and use technologies.

(e) Industrial liaison, market and entrepreneurship development.

7. Plastics in Agriculture-Processing and Environment Control

(a) Development and evaluation of low cost plant and animal environment control chambers, surface covered cultivation.

(b) Plastics application in processing, packaging and storage (temporary as well as long term)

(c) Plastics in handling, distribution, and storage of fluids.

(d) Plastics in aquaculture engineering.

Agricultural Energy and Power

1. Energy audits in production agriculture, post-harvest and rural living operations and identification of wasteful uses of energy.
2. Development and field evaluation of energy efficient practices, man-machine-material systems.
3. Development of domestic on-farm rural agro-processing level solar, wind, biogas and producer gas gadgets that reduce dependence on commercial energy, adopting innovations and creativity from all possible sources for the benefit of agriculturists and improvements/cost reduction in existing devices.
4. Integrated energy and plant nutrient plans for identified typical villages and operational research before recommendations are made for popularisation.
5. Development and use of alternate major fuels for IC-engines used on farms.
6. Study of draftability of draft animal species/breeds, development of matching implements for the physical dimensions and power available for different operations. Efforts will be made to increase work output without fatigue/ill effects on animals or operator through proper work-rest cycles, and increased total annual use to improve their economic competitiveness as a source of farm power to marginal and small farms.
7. Study of anthropometry of farm workers in typical regions of the country, applying principles of ergonomics to rationalise human energy use, improve manual tools and equipment for better and safe operations. Hazards associated with man-machine-environment/material will be studied and efforts made to design them out or come up with affordable safety and personal protection equipment.

Soil and Water Engineering

1. Diagnosis and rectification of problems associated with pumping units, wells and tubewells enhancing system efficiency.
2. Design and development of energy efficient water lifting devices for animate and mechanical farm power sources.
3. Optimisation of groundwater use through mathematical modelling and simulation.
4. Technical and economic evaluation of improved/alternative drainage methods e.g. surface, sub-surface, well and recharge.
5. Estimation of drainage coefficient for surface and sub-surface drainage.
6. Feasibility study of using different drainage materials, their installation, hydraulic performance, durability and cost.
7. Field evaluation and demonstration of proven technologies, industrial liaison, etc.

Instrumentation and Hardware for Modernising Agriculture

1. Interaction with DOE and DST on development of sensors and instruments of interest to agriculture and their testing and evaluation.
2. Promotion of agri-electronics relating production agriculture—quick determination of nutrient level, quality of water, soil moisture, produce moisture, oil, protein content, etc.

3. Development and promotion of experimental field plot machinery to reduce human error and reduce excessive dependence on labour.
4. Development of appropriate automation and controls for agricultural systems.
5. Liaison and initiatives to develop appropriate software for inventory, modelling and simulation studies.

Research thrust in the area of agricultural engineering would be mainly directed towards consolidating on-going programmes and transfer of proven results by refining the process and prototypes, industrial and technology transfer liaison and removing operational and structural bottlenecks. The priority areas include the following:

1. *Farm Implements and Machinery*
   a) Seedbed
   b) Interculture equipment
   c) Plant protection equipment
   d) Harvesting and threshing
   e) Farm equipment manufacturing technology
2. *Post-Harvest Engineering and Technology*
   a) Shelling and decortication
   b) Cleaning and grading
   c) Drying and storage
   d) Primary processing/milling
   e) By-product utilization
   f) Cotton technology
   g) Jute technology
   h) Lac technology
   i) Soybean processing and utilization
   j) Plastics in agriculture
3. *Soil and Water Engineering*
   a) Wells and pumps
   b) Agricultural drainage and technology
4. *Agricultural Energy and Power*
   a) Energy requirement in agricultural sector
   b) Integrated use of renewable energy sources
   c) Animate energy utilization
5. *Industrial Liaison and Training Facilitating Commercialisation of Power Technologies.*

ANIMAL SCIENCES

The priorities in Animal Science Research are identified as follows:

1. Animal Genetic Resource Evaluation and conservation through extensive field surveys and supported by studies on gene marker characters - *ex situ* and *in situ* conservation of threatened breeds.

2. Basic research in animal genetics related to cytogenetics, immunogenetics, biochemical and molecular genetics for genetic resource evaluation and genetic enhancement, development of transgenic animals.
3. Genetic studies on draft species, viz., cattle, buffaloes, equine, camel and yak.
4. Survey of animal feeds, their utilisation and development of new non-conventional feed resources, determining incriminating agents, and their incorporation in livestock feeding system.
5. Mycotoxicosis and mineral imbalance in animal production and health.
6. Standardisation of newer reproduction technologies, viz. embryo-transfer technology and cryo-preservation of ram and buck semen.
7. Basic research in nutrition and physiology specially on energy and protein metabolism, rumen microbiology and endocrinology.
8. Basic research in immunology to help in better understanding of immune responses specially to parasitic diseases.
9. Development of newer biotechnologies related to immuno diagnostics and prophylactics.
10. Animal disease surveillance and monitoring to allow forecasting and taking up strategic control and eradication measures.
11. Development of processing and packaging technology for indigenous dairy products.

Animal science research is aimed at

(i) Improve production and productivity of different domesticated livestock species.
(ii) Reduce losses arising from mortality and morbidity due to various livestock diseases.
(iii) Reduce losses during handling, storage and processing value addition and increasing shelf-life.
(iv) Develop livestock production systems based on socio-economic and agro-ecological considerations.

I. ANIMAL BREEDING

I. Improving Production and Productivity

(i) Animal Breeding

(a) Animal Genetic Resource Identification, Description, Evaluation, Conservation and Management. Very little work on identification, description and evaluation of indigenous breeds of livestock has been carried out except for a few important breeds and that too based on institutional herds primarily maintaining selected animals under very different management conditions than in the farmers' herds/flocks. Further, due to lack of organised breeding activities for specific breeds, tremendous inter-mixing and crossbreeding of superior exotic breeds, there is likelihood of loss of important breeds which have been created through natural selection for adaptation to tropical heat and disease problems and poor feed availability. It is necessary to ensure the maintenance of genetic variability both inter and intra breeds and for this purpose, proper conservation and management systems will have to be developed.

The National Bureau of Animal Genetic Resources along with species Institutes to the ICAR system, the state agricultural universities and other state and private agencies will take up a network project. The field surveys will be supported by laboratory studies on gene marker characters related to cytogenetics, immunogenetics, biochemical and molecular genetics. Units of the project will be established at the cooperating agencies both in terms of survey staff and laboratory facilities and manpower.

(b) Basic Research in Animal Genetics. Most research in species Institutes is on genetic improvement of different livestock species, breeds within each breed for specific goals. Basic research in the areas of cytogenetics, immunogenetics, biochemical and molecular genetics has not been carried out and applied for the purpose of identification of parentage, determining inter and intra breed genetic variability and correlating them with characters associated with production, reproduction, adaptation, disease resistance, etc. The availability of techniques in genetic engineering involving DNA sequencing, identification of specific genes, their cloning and introduction into fertilised embryo through micro-manipulation have opened avenues for developing newer genetic materials bypassing reproductive barriers. Genetic enhancement centres for developing new genetic materials through genetic engineering are required. The National Institute of Animal Genetics established during the Seventh Plan will be further strengthened to develop these capabilities.

(c) Genetic Improvement in Cattle. Large scale crossbreeding in cattle has been taken up and the country has around 13 million crossbred cattle. Further genetic improvement in crossbreds will come through selection within crossbreds. This will require undertaking performance recording of large number of pedigreed animals and utilisation of such records in selection of breeding males. ICAR has taken up a collaborative project with the Ministry of Defence where initially 40 and subsequently 100 bulls will be tested each year. This will also help not only in genetic studies and the performance of crossbreds but also in generating large superior crossbred germplasm. The project will be further strengthened and facilities of MOET will also be established. This will support Technology Mission on dairy development.

(d) Improving Draftability and Meat. So far attention has been both in cattle and buffaloes on improving milk production. Draft and meat have not received serious attention. Sixty per cent of the total energy in agriculture is from draft animals and it is likely to continue to be an important source of farm power. Physiological studies on determining draftability as well as genetic studies for improving draftability of different livestock species viz., cattle, buffalo, equine, camel and yak will be taken at the existing species Institutes/centres and further intensified. Similarly, research on breeding buffalo for improved growth efficiency of food conversion and quality meat without affecting milk production will be taken up at CIRB.

(e) Improving Poultry for Meat and Eggs. In poultry, so far research is confined to intra population selection within purelines and their crossing for developing commercial chicks for meat and egg production. Alternative breeding strategies and manipulation of genes such as dwarfing gene in broiler female, and genetic studies for improving efficiency of feed conversion will be taken up during 8th Plan at the Project Directorate on Poultry and under the All India Coordinated Research Projects on Poultry for egg and meat. Efforts will also be made for developing improved purelines and making them available for commercial exploitation. Work on indigenous breeds of poultry as well as on other avian species viz., guinea-fowl and duck will be taken up as part of research activity of CARI.

(f) Improving Small Ruminants for Meat Production. The major emphasis for improvement of small ruminants viz., sheep and goat will be for meat, although emphasis in sheep for carpet wool will also be given. The approach for improvement of indigenous breeds will be to involve farmers' flocks Emphasis will also be given for improving rabbits for meat and fur-skins and fibre production. An advance centre for fur animal breeding will be established at the Northern Regional Research Station of CSWRI. The research programmes on buffalo, sheep, goat and pigs will be taken up as network programmes and will be fully integrated with the research programmes of species Institutes/ centres and the universities research programmes.

A National Research Centre on Pigs will be established in North-East at the NEH Research Complex to evaluate indigenous breeds and take up studies on their improvement through selection and crossbreeding with exotic pig breeds. Research on various aspects of nutrition and health will also be undertaken.

(ii) Animal Nutrition

(a) *Non-conventional Feed Resources.* Major emphasis in animal nutrition will be on determining available feed resources, their utilisation, identification and evaluation of non-conventional feed resources (NCFR), determining incriminating factors and incorporation of NCFR in animal feeding.

(b) Mycotoxicosis and micro-nutrients imbalances have been causing serious problems to animal production. Studies to determine the mycotoxin content in different animal feeds; cheaper systems of detoxification, reducing their ill effects through dilution, increasing protein contents, etc. will be investigated. Similarly, micro-nutrients in different animal feeds, micro-nutrients requirement and systems for balancing micro-nutrients in livestock feed will be experimented with. For the purpose two advance centres on mycotoxicosis and micro-nutrients will be established with 3 or 4 centres and the two projects will be taken up as network projects.

(c) Basic research in animal nutrition specially related to rumen microbiology particularly for identifying micro-organisms more capable of degrading lignocellulosic materials and on energy and protein metabolism in different livestock species have been virtually non-existent. Such studies are extremely important for improving utilisation of crop residues and other fibrous feeds for production as well as for improving productivity in feeds. These researches will be taken up at the National Institute of Animal Nutrition and Physiology.

(iii) Animal Reproduction

(a) The newer reproductive biotechnologies, specially Multiple Ovulation Embryo Transfer with sexing, cloning, micro-manipulation have opened wide avenues for increasing genetic progress through selection and developing new genetic materials. The technique will have to be adapted to different species and developed specially in buffaloes.

(b) For maximising utilisation of the superior male germplasm, specially in small ruminants, technology for cryo-preservation of semen is required. This is under development at the CIRG and CSWRI and will be further intensified so that suitable protocols for cryo-preservation are soon available.

(c) There is no accurate measure of draft available. There is an urgent need for developing suitable measures for draft related to physical, physiological, biochemical parameters. In addition to the work on camel and equine at the existing centres, work on cattle will be taken up at Veterinary College, Bikaner.

(d) Work on adaptation physiology and management will be intensified at the existing Institute and under AICRP on poultry. Similar work will also be taken up in other regional Institutions such as NEH Research Complex, CARI, Port Blair and CAZRI.

(e) Basic research in animal physiology, specially on endocrinology, nutritional physiology, growth, neuro-physiology, etc. has not been given serious attention. Such basic studies are necessary for developing proper production methodologies. This research will be undertaken at the National Institute of Animal Nutrition and Physiology to be established during 8th Plan.

II. Reducing Losses Arising from Mortality and Morbidity due to Various Livestock Diseases

(a) Basic research involving aspects of pathology, virology, bacteriology, toxicology, pharmacology, experimental medicine and surgery and veterinary public health.

(b) Application of newer biotechnologies such as monoclonal antibodies, DNA probes for disease diagnosis, DNA recombinant technology for developing synthetic and subunit vaccines.

c) Basic research on immunology involving immuno-mechanism, development of immuno- o-
diagnostics.

(d) Research and development of improved protocols for preparation and quality testing of veterinary immunobiologicals.

(e) *Animal Disease Monitoring and Surveillance.* The three ongoing projects of FMD, Haemoprotista and disease surveillance and monitoring will be combined with respect to their coordination and central laboratory facilities and field units and a Project Directorate on Animal Disease Monitoring will be established. The present centres of these projects will be linked so that a large number of centres can work on more than one disease.

(f) *Specific Disease Research.* The present centres of IVRI on FMD at Bangalore, parasitic diseases of sheep and goat at Srinagar, nutritional diseases especially plant toxicology at Palampur will be further strengthened, given proper orientation.

Studies on Blue Tongue and toxicology and kinetics of agrochemicals especially pesticides, industrial pollutants and other toxic residues in relation to animal health will be studied at IVRI and selected agricultural universities as network projects.

For immunology, toxicology and biotechnology, advance centres will be established at ICAR Institutes/SAUs with 3 or 4 cooperating centres. Projects will be implemented as network projects.

(g) *Exotic and Emerging Diseases.* The high security animal diseases laboratory sanctioned for establishment in the Seventh Plan will become fully operational.

The species Institutes will have strong animal health research units involving both the institutional flocks/herds and farmers' flocks/herds in extension area and will have close collaboration with the proposed Project Directorate on Disease Surveillance and Monitoring as well as with IVRI on specific animal health research.

III. Reducing Losses in Processing and Handling

(a)Dairy Technology

The major emphasis will be on indigenous dairy products and on utilization of modern processing technologies such as UHT, Membrane technology, LP System for fluid milk preservation, energy conservation, genetic engineering of dairy microbes etc. NDRI will be the nodal institution for research in dairy technology and NDDB, selected State Agricultural Universities and other Universities/Institutions will participate. The Project will be taken up as network project on traditional Indian milk products technology. There will be an advance centre on dairy technology located at NDRI which will coordinate the Network Project and will strengthen the infrastructure in modern milk processing technologies. Considering the need for research in dairy technology in the Eastern and Southern Sectors, the SRS and ERS of NDRI will also be strengthened.

(b) Meat Technology

The emphasis will be on development and standardization of carcass and meat evaluation and meat processing technologies. The National Research Centre on meat and meat products technology will continue at IVRI and in the next 10 years it will develop into a fulfledged Institute in meat science and technology and will be given the status of an independent Institute. The species Institutes will also strengthen their Meat Processing Research.

(c) Animal Fibre Technology

Studies involving physical, mechanical and processing characterization of animal fibres would continue at the CSWRI. Surveys of availability of different wools under various trade names will be carried out and such wools will be subjected to laboratory and processing evaluation. Emphasis will be on carpet wool for manufacture of hand-knitted carpets for which the Arid Zone Campus of CSWRI will also be involved.

IV. Livestock Farming Systems' Research

A network Project involving regional institutes of the ICAR and selected SAUs will be initiated to develop livestock farming systems suited to different socio-economics and agro-ecological situations.

FISHERIES

Thrust Areas

1. *Brackishwater Farming.* ICAR Research support to backyard hatchery technology, low cost feed formulation and culture operation would help in extending brackishwater culture in the country.
2. *Mariculture.* It would be essential to survey amenable areas for mariculture and standar-

dise commercial feeding of tin fish, shell fish, sea cucumber and link the post-harvest aspect to the weed cultivation technology.

3. *Post-harvest Technology*. The current demand of the country is for research support on reduction in wastage of fish and development of new products from unconventional fish species.

4. *Reservoir Ecology and Management Strategy*. ICAR Institutes concerned would formulate management strategies for selected reservoirs based on their ecology for enhancement of their productivity.

5. *Fish Diseases and their Control*. Aetiology of fish diseases, UDS and their control measures would need an elaborate investigation through multi-locational research support.

6. *Culture of High Yielding Coldwater Fisheries*. Establishment of National Research Centre on Coldwater fisheries would ensure the much needed support to the development of hill area fisheries for food and support specially for the benefit of tribal population.

7. *Intensive Freshwater Aquaculture*. With the horizontal growth of inland aquaculture for the benefit of rural poor, there is enough justification to enlarge potential through technologies for vertical increase in productivity and to impart an industrial status to aquaculture to ensure quantum jump in fish production from Inland resources.

8. *Graduate and P.G. Level Education in Fisheries*. With modernisation of aquaculture science, it has become essential to upgrade the graduate and post-graduate level education in fisheries and hence the grant of a deemed to be university status for CIFE, Bombay.

AGRICULTURAL EDUCATION

Although by now all the major States of India have been brought under the State Agricultural University System, only some smaller States of North-East Hill Region and some of the Union Territories remain to be brought under the Umbrella of the State Agricultural Universities System. The education needs of most of the Union Territories are directly met by the ICAR. The proposal to establish the Central Agricultural University for the North-East Hill Region is in progress.

It is felt that the institutional capacity already established is quite adequate to meet the scientific/technical manpower requirements in various field specialisations during the next 10-15 years. Some shortages experienced in the area of veterinary science/home science/agricultural engineering etc., in certain States are a temporary phase and if needed this shortage could be met from other States.

The degree programmes being offered at present are 11 in number, which seems to be adequate. The structure of undergraduate curricula has been so designed that it permits partial specialization through elective programmes during the final year. However, there has been a criticism over the quality of graduates and inadequacies in practical experience. It is also often mentioned that the teaching methods and aids are poor due to lack of educational technology input. This has to be restricted through appropriate programmes.

Post-graduate education at present consists of more than 55 disciplines in various fields of specialisation. The range of degree programmes seems to be adequate. However, it would require

appropriate expansion in certain fields like agroforestry, agricultural communication, agricultural business management, agricultural meteorology, biotechnology, computer applications, educational technology, agricultural marketing, agro-industry, etc.

It is also necessary to give rural orientation to the entire educational programme in agriculture to meet the challenging needs of the rural areas of the country. Education programmes should also emphasize education of women in agriculture and allied sciences. It has been felt that the present day home science education programme may not suit rural needs.

The ICAR Review Committee which recently examined the educational role of ICAR had pointed out that though the Agricultural University System has been developed for the last 30 years and all the major States have been brought under the umbrella of the agricultural universities, 40% of the agricultural graduates are still being produced by the sub-standard affiliated colleges without enforcing minimum standards of education. Necessary steps may be taken to abolish the above Institutions. The Committee also felt that the present education systems have resulted in a large degree of in-breeding due to restrictive admission and recruitment policies. It recommended that at least 25% of the seats should be reserved for candidates from other States.

Referring to the poor standards of education in affiliated agricultural colleges, the Committee recommended that ICAR should be entrusted with statutory powers to function as a UGC like body with regard to Agricultural Education. The Norms and Accreditation Committee should be reconstituted in the light of the earlier experience and be provided with suitable authority for determining and maintaining standards.

The major recommendation made by the Committee about funding of Agricultural Universities in the light of decisions of various States Governments to establish new Universities/New Colleges without taking into consideration the manpower requirements was that the "primary objective of establishing at least one Agricultural University in each major State has now been fulfilled. Establishment and development of additional Universities/Colleges should be the responsibility of the State concerned. Instead, ICAR should divert its attention to develop Centres of Excellence in emerging areas of importance, and improve the quality of education and research in the Universities".

The SAUs were established on land grant pattern of U.S. Farm Universities integrating Education, Research and Extension. Further, faculties of Agriculture, Veterinary and Animal Sciences, Fisheries, Agricultural Engineering, and Home Science were to be located on the same campus so as to share faculty members, common farm, laboratory facilities, have cooperative projects and to have better understanding of agriculture in totality. Not only there has been a tendency to proliferate agricultural universities in each State, but colleges of different faculties have been started at different places thus deviating from the basic concept by land grant universities. When we are realising the urgent need of farming systems approach to our agricultural research, education and extension, it is necessary that different faculties have greater interaction and develop collaborative programmes. Fragmentation of agricultural universities to start university in separate disciplines e.g. Horticulture and Forestry, Veterinary Science may not be in the best interest of our serving the small

farmer who is a mixed farmer. The colleges/faculties located at independent campuses can, however, be provided with sufficient autonomy and administrative supports required for their effective functioning.

The Model Act of Agricultural Universities which was formulated in 1966, needs modifications in the light of present day status of State Agricultural Universities.

The Council have already initiated a series of discussions among the State Agricultural Universities with regard to quality of education. The first Regional Seminars conducted in Tamil Nadu Agricultural University, Coimbatore have suggested various steps for improving quality education in the country. The major recommendations of the Committee pertaining to the reorientation of courses, funding, etc. will be taken into consideration for developing the pattern of assistance during the Eighth Plan. The Vice-Chancellors of the State Agricultural Universities at their meeting held in May 1989 have also made valuable suggestions with regard to formulation and implementation of the Eighth Plan Schemes. These suggestions would be incorporated when detailed Schemes are developed.

Though the State Agricultural Universities have been in existence for the last 25-30 years, the growth of these institutions has not been uniform and is still at various stages of development. The main reason for this disparity is poor State Government support and lack of leadership. Therefore, the main thrust during the Eighth Plan would be to maximise the efficiency of the existing institutions to establish/create minimum infrastructure facilities for imparting quality education at undergraduate level.

Proposals for Eighth Plan

Institutions Development

As mentioned above, the Council will not support the establishment of any State Agricultural University/Colleges during the Eighth Plan. However, it is proposed to establish a Central Agricultural University for North-East Hills Region during the Eighth Plan.

IARI in 1958, IVRI in 1983, NDRI and CIFE in 1989 had been given 'deemed to be University' status by the University Grants Commission and enjoy complete autonomy in their academic programmes and degree granting responsibilities. These Institutions play an important role in basic and strategic research and post-graduate education and should also be given maximum autonomy in administrative and financial matters subject to the overall coordination by the Council.

Since during 1990s and beyond, there will be over 90 million small and marginal families who will by and large depend on mixed farming for their livelihood security, it is important that research and education programmes become increasingly farming systems-oriented. The four National Institutions viz. Indian Agricultural Research Institute (IARI), Indian Veterinary Research Institute (IVRI), National Dairy Research Institute (NDRI) and Central Institute of Fisheries Education (CIFE) will have to play an important role in generating new farming systems technologies. For this

purpose it is recommended *that a Joint Research and Academic Coordination Board be set up to advise these four Institutes on joint research projects and academic programmes.*

Under-graduate Programmes

The intake capacity existing in various degree programmes is considered to be adequate to meet the manpower requirements. It may be seen from the data that though the number of institutions have been increased by 45% during the Seventh Plan, admission capacity has remained more or less the same. Therefore, many institutions have the possibility of increasing admission capacity with little additional facilities. Instead of this, many States are often trying to establish new institutions for reasons other than academic ones. Therefore, the Council will not assist the establishment of any universities/colleges during the Eighth Plan other than the Central Agricultural University and colleges in new disciplines mentioned earlier. The development assistance towards under-graduate education will be directed at improving the quality of education. The pattern of assistance to the State Agricultural Universities will be suitably modified to include items such as:

i) Replacement of equipment;
ii) Strengthening book banks/book depots;
iii) Establishment of educational technology cells;
iv) Establishment of students counselling and monitoring cells;
v) Assistance for preparation of teaching manuals and aids etc;
vi) Preparation of questions banks;
vii) Revision of syllabus etc;
viii) Participation of teachers in National Seminars/Symposia;
ix) Organisation of workshops on teaching methods and evaluation;
x) Contribution for organisation of Mock Parliament.

During the Plan period, the Council assistance to affiliated colleges will be very limited. The number of institutions which received ICAR assistance during the Seventh Plan was only 9 out of 35 and odd institutions still functioning outside the Agricultural University System. The status of these institutions will be further reviewed before deciding continued assistance during the Eighth Plan. However, the three agricultural faculties of Central Universities will continue to be supported during the Plan period for creation of infrastructural facilities and equipment procurement to a limited extent.

Post-graduate Programmes

Considerable facilities for Post-graduate education were developed during the last Plan period. The major achievement has been the conferring the status of deemed to be University to National Dairy Research Institute at Karnal and Central Institute of Fisheries Education at Bombay. These institutions will mainly concentrate their efforts on Post-graduate education in Dairy Science and Fisheries Science respectively; this was a major gap in the education System in India. The Centre of Advanced Studies in Inland Fisheries, Forestry, Agricultural Meteorology, Land Use Planning,

etc. established under the UNDP assisted Scheme of establishment of centres of Advanced Studies has also strengthened Post-graduate Educational Programmes. However, to cope up with the modern science advancement, development of Post-graduate programmes in fields such as Biotechnology, Management Sciences, Post-harvest Technology, Environment Sciences, Remote Sensing, Energy Resources, Integrated Nutrients and Pest Management, Animal Ecology, Bio-climatology, Bio-engineering, etc. will get special attention during the Plan period. The Agricultural Universities System would be the main agency to establish and develop Post-graduate educational programmes. ICAR Institutes, will, however, continue to impart educational programmes in specific fields due to their expertise and superior infrastructural facilities. However, their educational programmes would be supplementary to the Agricultural University Programmes and would be limited to the mandate of each Institution.

Non-formal Education

The demand for training of various levels of workers for the expanding agricultural/rural development programmes in the country is increasing rapidly. The resources available for training young people, particularly the farmers and the rural youth and school drop-outs, in advanced technology in crop and animal production and rural development are not adequate. The Agricultural Universities would be assisted to strengthen their extension directorates for imparting non-formal non-degree educational programmes for the farming community in their jurisdiction.

Deemed to be Universities

IARI in 1958, IVRI in 1983, NDRI and CIFE in 1989 had been given 'deemed to be University' status by the University Grants Commission and enjoy complete autonomy in their academic programmes and degree granting responsibilities. These Institutions play an important role in basic and strategic research and post-graduate education and should also be given maximum autonomy in administrative and financial matters subject to the overall coordination by the Council.

Since during 1990s and beyond, there will be over 90 million small and marginal families who will by and large depend on mixed farming for their livelihood security, it is important that research and education programmes become increasingly farming systems-oriented. The four National Institutions viz. IARI, IVRI, NDRI and CIFE will have to play an important role in generating new farming systems technologies. For this purpose it is recommended that a Joint Research and Academic Coordination Board be set up to advise these four Institutes on joint research projects and academic programmes.

NATIONAL AGRICULTURAL RESEARCH PROJECT (NARP)

For on-going programme, an amount of Rs 82.03 crores will be required during the Eighth Plan. In addition the Mid-term Review Team for the NARP (II) has identified a few new areas for investment. Both the ICAR and the Department of Economic Affairs, Government of India, have agreed for investment in the new areas recommended by the Mid-term Review Team of NARP (II).

AGRICULTURAL ECONOMICS AND MARKETING

AGRICULTURAL ECONOMICS AND POLICY RESEARCH

Strengthening/Functionally Establishing National Centre for Agricultural Planning and Policy Research

This Centre would strengthen the discipline of Agricultural Economics by establishing more effective coordination and linkage between the work done at various divisions/departments of Agricultural Economics at the ICAR Institutes and the State Agricultural Universities.

The following network projects will receive priority during the Eighth Plan:

1) Economic Analysis of Impact of Subsidies on Agricultural Growth in India.
2) Impact of Infrastructure and Institutions on Agricultural Development in India.
3) Economics of Agro-processing: Problems and Prospects.
4) Impact of Technological Change on Employment and Income of Agricultural Labour Household.
5) Economics of Production and Marketing of Pulses and Oilseeds.
6) Diversification of Agriculture in India.

These network projects will be located under a senior and competent agricultural economist at a 'Land Institute' with a few centres in various agro-climatic conditions and socio-economic situations. The Lead Institute will analyse the results obtained from various centres and evolve policy prescriptions.

The following priority areas will receive attention at IASRI and SAUs through establishment of network projects.

A Agricultural Statistics

1. Modelling for biological and economic phenomena.
2. Use of remote sensing in forecasting and estimation.
3. Improved techniques for analysis of survey and field experiment data.
4. Development of designs in livestock, fisheries and agro-forestry research.

B. Computer Applications in Agriculture

1. Development of computer software and database management system.
2. System modelling and simulation.

C. KRISHINET

To accelerate the pace and increase productivity and efficiency of agricultural research, education and development, it is necessary to take up a systematic and comprehensive study of the information exchange back-up with efficient information processing through an effective computer network.

For creating local capabilities, all research institutes and State Agricultural Universities will be equipped with need based mini-computers. A national research facility as an apex body with a powerful computer system such as VZX/8200 system will be developed at a central place like IASRI where computerised agricultural information system to be termed KRISHINET will be established. The KRISHINET system will also be linked with space and remote sensing organisations and IMD.

AGRICULTURAL EXTENSION

A lot of thought is being given to reorganization and consolidation of Extension Education Projects so that they are properly monitored and managed, and can serve as a "light house" for the farmers as well as extension agencies on one hand, and for the research and education systems, on the other. The following strategy is now envisaged from the Eighth Plan onwards:

(i) The future model of Extension/TOT Projects of the ICAR is intended to be Krishi Vigyan Kendra - one in each district as a "light house" for dissemination of latest technologies. In order to orient the training towards the generation of skilled jobs, ICAR in collaboration with CSIR, CAPARD, KVIC and ICFRI should develop the KVKs, where appropriate, into *Krishi aur Udyog aur Van Vigyan Kendras*.

(ii) All the functions relating to various extension projects namely: National Demonstrations, Operational Research Projects, Krishi Vigyan Kendras and Lab-to-Land Programme will be fully integrated with KVK itself. Thus, broadly speaking, there will be three functions of KVKs: *farm advisory services* (will incorporate functions of National Demonstrations and Lab-to-Land); (ii) Vocational training of the farmers (original function of the KVK); and (iii) Operational Research/On-farm trials/adaptive trials.

(iii) To cope up with all the three functions, the staffing structure and the level of funding are proposed to be enhanced. Other projects/centres like Lab-to-Land, National Demonstrations and ORPs will be done away with.

Implementation

(i) Out of the existing KVKs (100), all have not yet been provided with funds for a second hostel for farm women and quarters for the staff.

(ii) An exercise has been done as regards financial requirements, if all the three functions, (farm advisory services, vocational training and operational research) are integrated with the KVK.

(iii) There are 8 existing Trainers' Training Centres (TTCs). TTCs in the areas of Plantation Crops, Water Technology, Sugarcane, Grassland and Fodder Management, Pulses and Oilseeds, are in demand.

(iv) The eight Zonal Coordination Units, in view of their changed role, which will mean monitoring and supervising all the KVKs with triple functions will be strengthened.
(v) Strengthening of Division of TOT at ICAR Headquarters.

Policy Issues

(i) While finalizing the KVK project for the Seventh Plan, it was suggested that the pattern of funding the KVKs may change where State Government may also take on some share. Finally the formula suggested was as follows:
   a) First five years, it may be funded by the ICAR on 100% basis;
   b) In the second five year phase, the funding may be shared by the ICAR and the State Government on 50:50 per cent basis; and
   c) After 10 years, the funding between the ICAR and the State Government may continue on 25:75 per cent basis.
(ii) The KVKs under the ICAR Institutes may be brought under the Non-Plan Scheme of ICAR.
(iii) Most of the KVKs will be implemented by the SAUs; one each by the ICAR Research Institutes in their respective districts; and some by the well established and reputed voluntary organizations. This pattern has been followed so far, and the experiences have been rewarding.
(iv) One KVK may be established with each of the NARP Centres.

The Working Group, however, feels that the KVK is a scheme of national importance and further since all the Transfer of Technology schemes of ICAR are being integrated with the KVKs, the funding may be as follows:

(i) First 100 KVKs may be maintained by ICAR to develop them as models in different parts of the country. They will serve as the mother KVKs.
(ii) For new KVKs to be established from the Eighth Five Year Plan onwards, the funding pattern may be as follows:
   (a) First 10 years, 100% funding by ICAR (it takes almost 10 years to develop all the infrastructures for the KVK), and
   (b) After 10 years 50% by the ICAR; 25% by the Department of Rural Development, Ministry of Agriculture, Govt. of India; and 25% by the State Governments.

CHAPTER 9

FINANCIAL REQUIREMENTS AND FINANCIAL MANAGEMENT

Considering the additional mandate given to ICAR for looking into the problems related to the broader area of rural development, including post-harvest technology and support it is to provide to the various technology missions, specially Technology Mission on Oilseeds which DARE/ICAR is implementing, Technology Mission on Dairy Development, Technology Mission on Wasteland Development, it is necessary that adequate financial resources are provided in the Eighth Plan. ICAR is also developing inter-institutional collaboration with a number of Institutes in USSR and USA on long term basis under the bilateral cooperative programmes and it is necessary that funds are available to support the institutes in India for participating in these programmes.

A large number of Institutes/NRCs were initiated in the last year of the Sixth Plan or in the Seventh Plan and because of inadequate Seventh Plan allocation these Institutes/NRCs could not be provided adequate funds for infrastructure development; this will have to be provided for in the Eighth Plan.

The Plan allocation to the ICAR from the Fourth to Seventh Plan as a percentage of the total plan outlay was 0.36, 0.38, 0.36 and 0.23 respectively which shows that there has been a large decline in the plan allocation to the agricultural research and education sector in the Seventh Plan. Similarly, the Plan allocation to the ICAR as a percent of allocation to agricultural sector had increased from Fourth to Sixth Plan (3.6, 5.0 and 6.0 percent) whereas it declined in the Seventh Plan and was only 4.2 per cent.

Comparing the Plan allocations for agricultural research and education and the total R&D expenditure, it can be seen that it was 20.6% in 1977-78, 22.2% in 1980-81 and since then it has been declining, being 14% in 1982-83, 11.4% in 1984-85 and 9.2% in 1986-87. This shows that adequate consideration has not been given recently to the financial needs for Agricultural Research and Agricultural Education.

Unlike most other Science Councils/Departments, ICAR is charged with the responsibility of agricultural education and agricultural extension education. The ICAR is playing the role of UGC with respect to agricultural education and is providing development grants, assistance for faculty development, fellowships to under-graduate and graduate students of twenty six SAUs. In the Seventh Plan, more than 60% of the Plan allocation was spent on the programmes related to education and research and extension education in the SAUs. There has always been a demand that the benefits of agriculture research should reach the farmers and the scientists generating the technology should

be able to demonstrate it to the farmers to ensure its socio-economic viability. The ICAR has consequently increased its extension education role both in Institutes and SAUs.

In the 60s when the reorganisation of ICAR took place and the SAUs were established, considerable assistance for manpower training and establishment of the various departments/ divisions was available under Indo-US collaboration. This assistance is no longer available. It is very necessary to expose our scientists and teachers to newer technologies such as biotechnology, information technology and space technology. Most of the equipments and instruments made available in the 60s have become obsolete or unserviceable and need immediate replacement. There is thus need for a large one time grant for manpower training, specially in frontier technologies as well as in basic sciences and for upgrading of laboratories in the Institutes and SAUs. This will call for large investment in the Eighth Plan.

Financial Management

The allocation of resources in the Seventh Plan both for Institutes/NRCs/PDs/ICAR Headquarters, All-India Co-ordinated Research Project, Agricultural Extension, PL-480 schemes, other Government Departments and Agencies, AP Cess Fund is given in Table 2.

The expenditure during Seventh Plan in major sectors viz. Agricultural Education, Engineering, Extension etc. is given in Table 3.

The requirement of funds for strengthening on-going programmes, providing for the projects initiated at the fag end of Sixth Plan and in the Seventh Plan which could not be provided for adequately because of low Seventh Plan allocation and for a few new programmes in high priority areas is given in Table 4.

So far the allocations in each Plan have been for each Institute/Co-ordinated Project/Agricultural Education and were not linked with specific programmes/projects. In the Eighth Plan, a beginning will be made to link budget and programmes/projects in a manner that monitoring of expenditure and accomplishments become better structured and direct.

Contingencies for research would be the first charge along with staff salaries. Efforts will be made to bring down the proportion expended on salaries to 60% of the budget of the institution. Provision for work would be kept at approximately 25% of the Plan allocation.

While considering the allocation for the Eighth Plan complete analysis of the existing non-plan resources of each sector and the concept of Zero-Based Budgetting would be implemented.

Steps would be taken to link the National Agricultural Research Project Regional Centres with the Agro-Climatic Planning of Agricultural Research. The All-India Co-ordinated Project Units located in the Universities will be linked with the NARP Centres to the extent desirable.

Table 2
Allocation of resources in Seventh Plan

(Rupees in Lacs)

	Actuals 1985-86		Actuals 1986-87		Actuals 1987-88		Budget Estimates 1988-89		Revised Estimates 1988-89		Budget Estimates 1989-90	
	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan
	1	2	3	4	5	6	7	8	9	10	11	12
Institutes/National Research Centres/ Project Directorates Headquarters												
Expenditure	7323.48	2988.53	8540.16	3237.21	9380.30	3430.00	10290.00	4228.00	10290.00	4213.00	11660.00	4678.00
Receipts	771.04	—	709.38	—	811.86	—	600.00	—	600.00	—	835.00	—
AICRIPs												
Expenditure	—	1210.66	—	1443.00	—	1849.09	—	1930.00	—	1934.00	—	2205.00
Receipts	—	—	—	—	—	—	—	—	—	—	—	—
Agricultural Education												
Expenditure	—	1140.35	—	1305.97	—	1136.65	—	1900.00	—	1880.00	—	2224.00
Receipts	—	—	—	—	—	—	—	—	—	—	—	—
N.A.R.P.												
Expenditure	—	1097.88	—	1019.54	—	866.51	—	900.00	—	900.00	—	1193.00
Receipts	—	—	—	—	—	—	—	—	—	—	—	—

Table 2 (contd)

(Rupees in Lacs)

	Actuals 1985-86		Actuals 1986-87		Actuals 1987-88		Budget Estimates 1988-89		Revised Estimates 1988-89		Budget Estimates 1989-90	
	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan
	1	2	3	4	5	6	7	8	9	10	11	12
Agricultural												
Extension												
Expenditure	—	482.26	—	712.40	—	721.38	—	642.00	—	642.00	—	700.00
Receipts	—	—	—	—	—	—	—	—	—	—	—	—
PI-480 Schemes	34.48	—	—	—	55.05	—	41.48	—	73.19	—	42.04	—
Govt. Deptt. & Other Agencies	37.42	—	—	—	—	—	—	—	—	—	—	—
A.P. Cess Fund												
Expenditure	894.97	—	625.18	—	556.60	—	802.73	—	1086.51	—	1012.60	—
Receipts	7.79	—	10.32	—	11.55	—	2.73	—	12.60	—	12.60	—
Total Expenditure	8290.35	6919.58	9165.34	7718.12	9991.95	8003.63	11134.21	3600.00	11949.70	9558.00	12714.64	11000.00
Receipts	778.83	—	719.70	—	823.41	—	602.73	—	612.60	—	647.60	—

Table 3
Expenditure during the Seventh Plan

(Rupees in Lacs)

Sl. No.	Disciplines	Seventh Plan Outlay	Actuals 1985-86		Actuals 1986-87		Actuals 1987-88		Budget Estimates 1988-89		Revised Estimates 1988-89		Budget Estimates 1989-90	
			non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan	non-plan	plan
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Agricultural Education	6500.00	—	1140.25	—	1305.97	—	1136.65	—	1900.00	—	1869.00	—	2224.00
2.	Agricultural Engineering	1850.00	267.10	220.14	317.44	264.69	342.27	301.14	410.25	414.00	398.75	362.00	440.45	500.00
3.	Agricultural Extension	2950.00	—	482.26	—	712.40	—	721.38	—	642.00	—	642.00	—	700.00
4.	Animal Sciences	5090.00	1551.33	957.82	1840.44	856.09	1945.49	1033.59	1999.95	937.00	2037.20	992.00	2299.95	984.00
5.	Crop Sciences	6610.00	2218.77	1162.60	2573.87	1385.86	2702.72	1408.14	2860.50	1641.00	3159.25	1791.00	3380.85	1948.00
6.	Fisheries	1910.00	680.74	299.57	794.76	253.52	889.63	312.91	901.00	400.00	929.75	324.00	1035.75	550.00
7.	Horticulture	2995.00	679.57	344.44	739.69	538.90	807.66	531.81	933.50	650.00	944.75	684.00	1047.80	762.80
8.	N.A.R.P	6700.00	—	1097.88	—	1019.54	—	886.51	—	900.00	—	900.00	—	1193.00
9.	Oilseeds	1175.00	34.44	121.04	39.32	148.26	45.25	173.54	58.00	251.00	49.75	251.00	55.20	305.00
10.	Soil Agronomy	5350.00	863.58	834.41	964.99	987.26	1050.64	1198.12	1134.25	1153.00	1136.00	1032.00	1311.05	1029.00
11.	ICAR Headquarters & others including A.P.CESS & F.A.P.	1370.00	1922.92	259.17	1894.83	245.83	2173.24	319.84	2795.28	712.00	3221.06	711.00	3111.75	805.00
	Total	42500.00	8218.45	6919.58	9165.34	7718.12	9936.90	8003.63	11092.73	9600.00	11876.51	9558.00	12672.60	11000.00
												42.00		
	PL-480	—	71.90	—	—	—	55.05	—	41.48	—	3.19	—	42.04	—
	Grand Total	42500.00	8290.35	6919.58	9165.34	7718.12	9991.95	8003.63	11134.21	9600.00	11949.70	9600.00	12714.64	11000.00

ICAR is functioning as UGC for Agricultural Education and expenditure on items which form part of a non-plan in the UGC would be converted into non-plan budget of the ICAR.

The financial resources obtained by Institutes through consultancy, over and above those initiated in revolving funds for utilisation of processing plants, farms for seed/planting material production, through projects sponsored by other agencies within the country or under foreign aided projects should be considered as additional to plan and non-plan allocations.

The financial allocations for the Eighth Plan for Agriculture Research Education and Extension Education are given in the Table 4.

Table 4

Financial Requirement for the Eighth Plan (Rs in crores)

1.	Agricultural Research	1,020.00
	(i) Soil Science, Agronomy & Forestry	195.00
	(ii) Crop Sciences (crop production and crop protection)	290.00
	(iii) Animal Sciences (animal production, animal health and animal products technology)	195.00
	(iv) Horticulture	110.00
	(v) Fisheries	60.00
	(vi) Agricultural Engineering	70.00
	National Agricultural Research Project	100.00
2.	Agricultural Education (Human Resource Development, University Development & Central Agricultural University for N.E.)	250.00
3.	Agriculture Extension Education	100.00
4.	Support to the National Academy of Agricultural Sciences & Professional Societies	10.00
5.	Headquarters, including DARE, Foreign deputation/training; Bilateral cooperation, Indo-USSR LTP & Publication and Information.	200.00
		1,580.00
	External assistance and consultancy (to be treated as additional to plan allocation)	200.00
	Total :	1,780.00

CHAPTER 10

STRATEGY FOR IMPLEMENTATION OF EIGHTH PLAN

Good scientific research can be carried out only by well-trained and dedicated scientists. To remain dynamic and effective any research organisation should be able to attract, retain and reward outstanding scientists. Effective and meaningful integration of autonomy and accountability enforces the impact of an R&D organisation. As mentioned earlier, the productivity of a scientist is a product of interaction between the ability and dedication of the scientist and the management efficiency of the research administration. Also, applied research is a team effort. The ability to work as an active member of a research team is another requirement in fields like agricultural research.

The ICAR was reorganised first during 1964-65 and again during 1973-74 to be made into a totally autonomous non-government organisation with the status of a registered society, envisaging freedom from inelastic rules in its technical, financial and administrative responsibilities. Unfortunately, even today, the Council is not in a position to exercise its autonomy largely because it continues to follow *mutatis-mutandis* Government of India rules, thus being obliged to follow financial and administrative procedures which take unduly long time and enormous paper work. This has had an adverse effect on the pace of progress of research. Flexibility in operation, especially in financial matters, has become severely restricted. Considering what was envisaged for the reorganised set up of the Council and also because, in the meantime, the Council has expanded enormously in size (number of Institutions and AICRPs), sphere of activities and manpower, it is necessary to undertake certain special measures by which the Council should be able to exercise its autonomy effectively. The ICAR Review Committee headed by Dr G.V.K.Rao has given valuable suggestions for making ICAR and its constituent units functionally autonomous. These have recently been accepted by the G.B. of ICAR. They should be implemented as soon as possible. We also suggest the following additional measures:

1. Functions of ICAR

The primary mandate of ICAR is planning, aiding, promoting, co-ordinating and undertaking agricultural research and education in the country. As suggested by the Dr G.V.K. Rao Committee, the existing mandate of ICAR should be modified to cover broader areas of rural development and post-harvest technology. Its direct involvement in research activities should be confined to basic and strategic research or other problems of national importance. The ICAR may continue to tackle regional problems only where they cannot be handled by the existing research infrastructure with the agricultural universities and other state agencies or where such infrastructure cannot be created now. ICAR should take responsibilities of frontier areas of agricultural research e.g. Bio-technology,

Space-technology, Informatics, Computer Application, Environmental Education, Energy Management, etc. The Council should at the same time provide assistance to the SAUs for developing scientific expertise to work in new and emerging areas in addition to applied research and education.

ICAR should concentrate mainly on Post-graduate Programmes in its Institutes in specialised areas of their mandate and expertise and leave all the Under-graduate programmes to the SAUs. Specialised non-degree programmes should also receive attention from ICAR Institutes.

ICAR should not undertake any field level extension work; for this the extension infrastructure of the development departments of the States should be utilised. The ICAR and SAUs should be involved only on a limited scale in first line extension activities and in education and training of the extension personnel of the State agencies and farmers.

ICAR should also properly reorganise its management information system to enable it to serve as an effective management tool for the research managers and administrators. ICAR should also take necessary steps to provide adequate documentation and information storage and retrieval services in all its Institutes including the Council's headquarters to enable the scientists to keep pace with scientific developments with the rest of the world. ICAR should make efforts to provide sufficiently qualified manpower in required number to operate its services more effectively. The long term agricultural research planning should be geared to meet the requirements of the country and should give more attention to the economic analysis of the research programmes and projects.

2. Autonomy of ICAR

A quick and concerted approach should be made to streamline the existing operational procedures for according real autonomy to ICAR and immediate steps should be taken by the Council to develop its rules and regulations in a manner that will ensure its complete financial and administrative autonomy.

3. ICAR Society

ICAR Society is the Supreme Body and is responsible for providing policy directions to the Governing Body and other Constituent Units of the Society, as also to review the progress and performance of different constituent units. The Group considers that in order to ensure effective functioning of this Supreme Body, it should be provided with a restructured Governing Body which could assume overall responsibility for providing superintendence, direction and control overall affairs of the Council. The Society could meet twice a year and should have well structured agenda with detailed notes which should be available to the members at least 4 weeks before the date for the meeting.

3 (a) Governing Body and ICAR Headquarters

The Governing Body should be a small and compact body composed of eminent profession-

als, holding expertise in agricultural research and education and capable of leading the Council to achieve higher and yet higher goals. The Governing Body should, in turn, be assisted by a *Strategic Planning Committee* to Advise on major policy issues related to Agriculture Research and Education, finalisation of new research thrusts and their *inter-se* prioritisation and allocation of resources. The *Scientific Panels* may be given a broader function to review research programmes in a major discipline/area and assist the Policy Planning Committee. *The existing Regional Committee* may be converted into Agro-Ecological Zones Advisory Boards in order to monitor progress in research and training in the 15 agro-ecological zones determined by the Planning Commission. These Boards should also identify critical gaps in on-going efforts in agricultural research and education in the region.

3. (b) Subject-Matter Division

The Governing Body should execute its policies through the Director-General, who is the Chief Executive of the Council, assisted by other Subject-matter Divisions and a Secretary of the Society incharge of Administrative and Services Division (comprising Personnel, Finance and General Administration). In view of the growing importance of international co-operation in agricultural research and education, which is (i) there should be a strong technical division in International Co-operation headed by one of the DDGs. The Subject-matter Divisions in the Councils headquarters should be under the charge of Senior Managerial Scientists of the status of Deputy Director-General, who should be assigned exclusive responsibility for national level planning and finalisation of the major research and education programmes of their division and their allocation to different Institutes according to their mandate and to the SAUs as part of AICRPs/network projects keeping in view the needs and strength of existing infrastructure, (ii) to review and monitor the progress of the implementation of these programmes, (iii) to allocate financial resources to the different programmes and to ensure their optimum utilisation and exercising complete freedom for re-allocation of funds from one primary unit to another within the Institute and from one Institute to another Institute under their charge, (iv) to provide required superintendence, direction and control over the activities of the Institutes, particularly with regard to relationship with the Headquarters and other outside agencies. (v) to provide liaison between the research Institutes of the Council and the SAUs with regard to co-ordination and implementation of research programmes and also to identify demarcation of research programmes and also to identify demarcation of R&D responsibilities, (vi) to act as Divisional Heads at the Headquarters and to be fully responsible to the Director-General for the activities of the Institutes under their charge, (viii) to exercise financial nd administrative powers to the same extent as vested in the Director-General, of course under the overall policy framework decided by the Director-General from time to time.

3 (c) Administrative and Services Division

As suggested above, while the Subject-matter Divisions should be under the charge of Deputy Directors-General, the Administrative and Services Division should be under the charge of the Secretary of the Society. Our attention has been drawn to the fact that at present there is no post of Secretary, ICAR in the Council but the functions of this post are discharged by a Joint Secretary to

the Government of India in the Department of Agricultural Research and Education with ex-officio status as Secretary, ICAR. We consider that it would be more appropriate to provide for the position of Secretary on the strength of the Council iteself, so that the Secretary is solely responsible to the Society. The functions of the Secretary should be clearly redefined so as to enable him/her to discharge the functions as listed for the Secretary of any Society. This is particularly necessary because we have suggested that the Deputy Directors General should be the Heads of the Subject-matter Division, both in respect of administrative and scientific spheres. This will necessitate redefining the functions of Secretary, ICAR so as to assign him/her total responsibility in respect of (i) Headquarters establishment, (ii) to deal with all policy matters relating to administrative support to the scientific managers in the Divisions, (iii) to act as Principal Adviser to the Director-General in all administrative and personnel matters, (iv) to discharge all other functions of the Secretary to the Society as laid down in the rules and regulations and bye-laws of the Society. Such a step is all the more necessary because we are suggesting elsewhere the complete delegation of powers to the Institutes and their Management Committees which would apparently reduce work of the Headquarters to the absolute minimum and will be confined only to policy and budgetary matters.

4. Appraisal and Approval of Plan Schemes

The currently followed EFC/PIC procedure for each individual scheme (Institute/AICRP, etc.) should be dispensed with. Instead, consolidated programmes of each division and Plan resources required could be considered by a suitable Group under the Chairmanship of Director-General, ICAR. This Group should not only approve the financial allocations but should also approve all items of expenditure viz.,Staff, Equipment,Vehicles, etc. The Projects duly scrutinised by Subject-matter Divisions and Finance Unit of Administrative and Services Division may be circulated to all Members of the Group constituted for approving Plan Programmes of a Division, for their comments which may be considered at the meeting alongwith counter-comments of the Division.

The consideration and approval of these proposals should be done expeditiously (preferably within 3 months of the first year of the Plan). The respective Divisions should then allocate specific projects and resources to individual units in full consultation with their Heads. Greater flexibility should be given to the Subject-mattter Divisions in initial allocation of total plan or re-allocation of Annual Plan Funds. Directors of the Institutes should be provided 10% of funds which could be allocated by them to any specific item needing additional resources. Escalation due to likely increase in emoluments and process of equipments etc. should also be suitably built into the budgetary provisions.

5. Research Institutes

Each ICAR Institute should operate with a specific and well-defined mandate and an identified set of objectives. The mandate should be defined keeping in view the changed agricultural research scenario in the country with Regional Research primarily being undertaken by the SAUs. Further, the redefined mandate should be within the framework of the overal research planning and policy of the council, as determined by the strategic Planning Committee. Each Institute will have

a *Research Committee* with Chairman and Members as eminent Scientists from outside the ICAR system in major disciplines of the Institute and Director as Member Secretary, to scrutinise specific projects for approval and financial support and their continuing evaluation and monitoring.

Directors of the Institutes, directly or with the approval of Management Board/Committee should enjoy full powers, both financial and administrative, within the budgetary grant and specific items of responsibility. The Institutes will also have the responsibility of recruitment and assessment of all positions except Research Management positions. The ASRB will be responsible for conducting qualifying examination for suitability to entry to Agricultural Research and Education positions in the ICAR and State Agricultural Universities (SAUs). The financial powers will be delegated down the line up to the Project Leaders.

6. Scientific Panels

At present these panels only scrutinise the technical soundness and feasibility of project proposals submitted for funding through A P Cess fund and US-India fund and monitor the progress of their implementation. Now that we are suggesting constitution of a Strategic Planning Committee at the Headquarters' level, the Scientific Panels should assume the responsibilities of assisting this Committee with their recommendations on areas within their purview. The involvement of Scientific Panels in the appraisal and evaluation of scientific research programmes of ICAR should bring about overall improvement in the research functions of the Council. With the introduction of this process, Director-General, ICAR could sanction the research schemes and implement other recommendations of the strategic Planning Committee with a degree of better satisfaction about the merits of each proposal, and without loss of time spent in following the currently available routine procedures.

7. Norms and Accreditation Committee

This Committee which is charged with the responsibility of looking into academic matters, should be reconstituted and provided with suitable authority to ensure effective role of ICAR in determining and maintaining the standards of agricultural education. ICAR should also strive to attain suitable authority for this Committee in order to make its functioning more effective. This Committee should follow procedures similar to that of UGC with respect to funding Agricultural Universities.

8. Management Committees/Boards

Each Institute of the Council has a Management Committee/Board, to broadbase decision making on all Institute matters. These bodies are currently more of advisory nature rather than as Executive Bodies vested with full administrative and financial powers. Keeping in view the basic mandate of granting autonomy to the research institutes of the Council, it is necessary that full technical, financial and executive powers should be vested with the Institute Management Committees. Once the budget is allotted for specific items to the Institutes by Headquarters after careful scrutiny and approval of the Governing Body, complete authority should be given to these

Committees for their functioning without any reference to Headquarters as also to decide matters falling outside the purview of the delegated powers of the Directors. These Committees should in fact function like Management Boards of the Agricultural Universities.

9. Delegation of Powers

Consistent with the requirement of functional autonomy for the Council, the Group feels that there should be decentralisation of powers down the line up to the level Principal Scientists, who are Principal Investigators of Projects. In order to relieve the Director-General of carrying on the routine administrative burden and to enable him to concentrate more on the research and educational policy, it will be necessary to delegate, as appropriate, the powers vested in the Director-General to the Deputy Directors-General who, with the introduction of revised pay scales, now carry the status comparable to that of Additional Secretary to the Government of India and who are now proposed to be assigned as the Heads of Subject-matter Divisions at the Headquarters. Director-General, ICAR, would be in overall command to exercise over-riding powers notwithstanding the powers delegated to the Deputy-Directors General. The same process could be adopted at the Institutes.

Certain apprehensions have been expressed to us that such a large delegation, particularly at the Research Institutes, might adversely affect ensurance of accountability. On this issue, the Group is firm to observe that the proposed decentralisation of powers does not envisage doing away with the codal and procedural requirements of purchase rules or for incurring contingent expenditure. Otherwise also the prosposed decentralisation does not envisage any deviation in the mode of purchase or implementation of other programmes. As such, there should be no difficulty in ensuring financial accountability. Even, otherwise each Institute has a machinery under the existing set up to ensure proper accountability at different stages and so is the case with the Headquarters. Nevertheless, any additional procedural checks and balances that are necessary to ensure accountability could be made but the process of decentralisation should not be sacrificed at any cost. Once the budget of an Institute has been approved by the Council on the recommendations of the Management Committee, there should be complete freedom for the Institutes to exercise full powers for incurring expenditure with the approval of Director/Management Committee, as the case may be, subject to the condition that this freedom of incurring expenditure is restricted only to items/purpose as initially approved by the Council at the Budgetary stage. No deviation should be permitted by any functionary either within the Institute to cause deviation of purpose because this will otherwise defeat the very object of optimum utilisation of funds. Accountability to deliver results from the research and training angle should receive greater attention. There should be periodic peer reviews of the work of individual scientists.

10. Recruitment Procedures

Currently, the Agricultural Scientists' Recruitment Board (ASRB) is responsible for conducting recruitment to all Scientists' positions through All-India Examination at the initial level and through open competition for lateral entry. It also conducts five-yearly assessment of Scientists for career advancement. The introduction of UGC pay pattern in ICAR has changed the complexion of

ARS from Scientists-oriented to Post-oriented System. There are 1,900 posts vacant out of the sanctioned strength of 6,500. There are undue delays in recruitment and assessment. The current training and placement also do not serve the requirements of the Institutes.

After a very careful consideration of the entire situation, the Group feels that it will go a long way to improve the working of the research Institutes if they are allowed to have the right type of persons as required by them for manning different research projects. This can be better achieved if the ASRB restricts its role on recruitment only to conduct the All-India Examination for entry to initial grade of the ARS, as also to conduct recruitment for Senior Managerial positions like that of Joint Directors, Project Directors, Project Co-ordinators, etc. Once the ASRB makes available the names of scientists in various disciplines, the Institutes should be at liberty to select suitable candidates of their choice from out of this list. These candidates could be provided in service training at the Institute itself to suit the job requirements. The Institutes should also be empowered to conduct at their own level through Lateral Entry System against other scientific posts (other than Senior Managerial positions like that of Joint Directors, Project Directors, Project Co-ordinators etc.) The procedures adopted by CSIR for recruitment of scientists for different institutes could be suitably adopted by the ICAR.

This process will enable the Institutes to hasten their recruitment process without any loss of time and also achieve a proper match between the experience and expertise of the scientist recruited and the requirements of the job. For recruitment to Senior Managerial positions (e.g. Joint Directors, Directors, Project Directors, Project Co-ordinators), the existing procedure of notifying the vacancies to the ASRB and conducting selection through them could continue, although ASRB would do well to modify its procedures along the lines of CSIR procedures.

11. Minimum Qualification for Entry to ARS

The Group is of the view that the requirement of Masters' degree in the relevant subject should not be dispensed with in respect of any discipline including Engineering/Technology and Veterinary Sciences. However, realising the dearth of adequate persons in the field of Engineering/Technology and Veterinary Sciences, we suggest that additional fellowships in the two areas should be granted and of a comparatively higher value to induct meritorious graduates who should be sent for postgraduate education at the Council's expense in the disciplines which are considered to be in the interest of the Council. These graduates should be awarded fellowships and should be made to sign a bond to serve the ICAR for a minimum of 5 years. These candidates should be paid full salary of experimental scientists as well as provided with suitable fellowships. After completion of their training, these persons could be appointed against the vacant posts for which they were initially recruited.

The number of agricultural scientists at present is small in relation to the diversity and complexity of the research challenges facing Indian agriculture. The vacant positions should be redeployed where appropriate and filled up soon. Additional positions should be created, where necessary.

12. Remedying Regional Imbalances

A serious problem facing ICAR today is the unwillingness of many bright and qualified scientists to work in ecologically and economically handicapped areas. Many positions in these areas remain vacant. Suitable procedures like those adopted by Defense Services for postings in remote areas should be introduced by ICAR. The Council should constrict Transit Residential Quarters in major cities for enabling family members of scientists posted in neglected areas to stay, so as to avoid disruption in the education of children. Unless imaginative personnel policies are introduced, "*orphans will remain orphans*", as far as problems in neglected areas are concerned.

PROPOSED ORGANISATIONAL CHART OF ICAR

PRESIDENT

VICE PRESIDENT

ICAR SOCIETY

STRATEGIC POLICY PLANNING COMMITTEE

GOVERNING BODY

D.G.

STANDING FINANCE COMMITTEE

AGRICULTURAL UNIVERSITY DEVELOPMENT BOARD

SCIENTIFIC PANELS

AGRO-ECOLOGICAL ZONE ADVISORY BOARD

SUBJECT-MATTER DIVISIONS

CROPS, ANIMAL SCIENCE
HORTICULTURE, SOILS
FISHERIES, EDUCATION,
EXTENSION EDUCATION

INTERNATIONAL COOPERATION

ADMINISTRATIVE AND SERVICE DIVISION

MANAGEMENT BOARDS/ COMMITTEES

DEEMED TO BE UNIVERSITIES

INSTITUTES
NRCs, PDs
AICRPs, NETWORK PROJECTS
AD HOC SCHEMES,
BILATERAL/FOREIGN AIDED PROJECTS

RESEARCH COMMITTEES

SAUs

ANNEXURE I

COMPOSITION OF THE WORKING GROUP ON AGRICULTURAL RESEARCH AND EDUCATION

1.	Dr M.S. Swaminathan, Hon. Director, Centre for Research on Sustainable Agricultural and Rural Development, 11, Rathna Nagar, Madras-600 018.	*Chairman*
2.	Dr M.V. Rao, Special Director-General, Indian Council of Agricultural Research, Krishi Bhavan New Delhi-110 001.	Member
3.	Shri P.B. Krishnaswamy, Secretary, Planning Commission, New Delhi-110 001.	-do-
4.	Joint Secretary (Plan Finance), Ministry of Finance, North Block, New Delhi-110 001.	-do-
5.	Deputy Director-General (Soils, Agronomy & Engineering), Indian Council of Agricultural Research, Krishi Bhavan, New Delhi-110 001	-do-
6.	Deputy Director-General (Animal Sciences) Indian Council of Agricultural Research, Krishi Bhavan, New Delhi-110 001.	-do-
7.	Deputy Director-General (Fisheries) Indian Council of Agricultural Research, Krishi Bhavan, New Delhi-110 001.	-do-

8.	Deputy Director-General (Crop Sciences), Indian Council of Agricultural Research Krishi Bhavan, New Delhi-110 001.	Member
9.	Deputy Director-General (Horticulture), Indian Council of Agricultural Research, Krishi Bhavan New Delhi-110 001.	-do-
10.	Deputy Director-General (Education) Indian Council of Agricultural Research Krishi Bhavan New Delhi-110 001.	-do-
11.	Deputy Director-General (Transfer of Technology) Indian Council of Agricultural Research Krishi Bhavan New Delhi-110 001.	-do-
12.	Financial Adviser, Indian Council of Agricultural Research Krishi Bhavan New Delhi-110 001.	-do-
13.	Dr A.M. Michael Director Indian Agricultural Research Institute Pusa New Delhi-110 012.	-do-
14.	Dr V.D. Mudgal Director Central Institute for Research on Buffaloes Hissar (Haryana)-125 001.	-do-
15.	Dr K.V. Raman Director National Academy of Agricultural Research Management Rajendra Nagar Hyderabad-500 030.	-do-
16.	Dr R.V. Singh President Indian Council of Forestry Research & Education Dehradun.	-do-

17.	Dr R.M. Pandey, Director Indian Institute of Horticultural Research 255, Upper Palace Orchards Bangalore-560 080.	Member
18.	Dr V.R.P. Sinha Director Central Institute of Fisheries Education Jayparkash Road Versova Bombay-400 061.	-do-
19.	Dr Sukhdev Singh Vice-Chancellor Punjab Agricultural University Ludhiana.	-do-
20.	Dr Har Swaroop Singh Vice-Chancellor Haryana Agricultural University Hissar.	-do-
21.	Dr Mahatim Singh Vice-Chancellor G.B. Pant University of Agriculture & Technology Pant Nagar (U.P.)	-do-
22.	Dr P.V. Salvi Vice-Chancellor M.A. University Parbhani (Maharashtra)	-do-
23.	Dr S. Jayaraj Vice-Chancellor Tamil Nadu Agricultural University Coimbatore.	-do-
24.	Dr (Smt.) K. Bhansali Vice-Chancellor S.N.D.T., Bombay.	-do-
25.	Dr K.N. Nag Vice-Chancellor Rajasthan Agricultural University Bikaner.	-do-

26.	Dr Appa Rao Vice-Chancellor Andhra Pradesh Agricultural University Hyderabad.	Member
27.	Dr P.C. Bora Vice-Chancellor Assam Agricultural University Jorhat-785 013.	-do-
28.	Agricultural Commissioner Department of Agriculture & Cooperation Krishi Bhavan New Delhi-110 001.	-do-
29.	Horticulture Commissioner Department of Agriculture & Cooperation Krishi Bhavan New Delhi-110 001.	-do-
30.	Animal Husbandry Commissioner, Department of Agriculture & Cooperation Krishi Bhavan New Delhi-110 001.	-do-
31.	Fisheries Development Commissioner Department of Agriculture & Cooperation Krishi Bhavan New Delhi-110 001.	-do-
32.	I.G. Forests Department of Environment, Forests & Wild Life, CGO Complex Lodhi Road New Delhi-110 001.	-do-
33.	Director-General CSIR, Rafi Marg New Delhi-110 001.	-do-
34.	Adviser (Education) Planning Commission New Delhi-110 001.	-do-
35.	Chairman, U.G.C. (or his nominee) Bahadur Shah Zafar Marg New Delhi-110 002.	-do-

6.	Joint Secretary (Tribal Development) Ministry of Home Affairs North Block New Delhi-110 001.	Member
37.	Representative of Department of Science & Technology New Mehrauli Road New Delhi-110 016.	-do-
38.	Dr S. Varadarajan AB-13, Pandara Road, New Delhi-110 003.	-do-
39.	Dr N.K. Nauthani Director (Agriculture) Bhabha Atomic Energy Commission Trombay, Bombay-400 035.	-do-
40.	Shri S.M. Patankar, Director-General, Council for Advancement of Peoples' Action and Rural Technology (CAPART) Guru Nanak Foundation Building New Mehrauli Road New Delhi-110 016.	-do-
41.	Dr B.R. Barwale Chairman Maharashtra Hybrid Seeds Co. Ltd., 19, Rajmahal, 84, Veer Nariman Road Bombay-400 020.	-do-
42.	Shri Nanubhai Amin Chairman & Managing Director Jyoti Limited Vadodara-390 001	-do-
43.	Shri J.N. Baki Chairman Indian Petro-Chemical Corporation Ltd., Vadodara-390 001.	-do-
44.	Dr P.M. Bhargava Director Centre for Cellular & Molecular Biology CSIR, Uppal Road, Hyderabad-500 007.	-do-

45.	Dr (Smt.) Vinodini Reddy Director Institute of Nutrition Research Hyderabad-500 001.	Member
46.	Dr Baldev Sahai Space Application Centre Jodhpur Tikra Ahmedabad-380 001	-do-
47.	Dr (Smt.) Chubala Ao Chairman Social Welfare Board Kohima, Nagaland.	-do-
48.	Dr (Smt.) Manju Sharma Chief (Science) Planning Commission New Delhi-110 001.	-do-
49.	Shri Jai Lal Dalal Rtd. Director (Agriculture) Haryana H. No. 303, Sector 16-A Chandigarh-160 017.	-do-
50.	Adviser (Agriculture) Planning Commission New Delhi-110 001.	-do-
51.	Dr R.M. Acharya Deputy Director-General Indian Council of Agricultural Research Krishi Bhavan New Delhi-110 001.	Member-Secretary

ANNEXURE II

SUB-WORKING GROUPS OF THE WORKING GROUP ON AGRICULTURAL RESEARCH AND EDUCATION FOR THE FORMULATION OF EIGHTH FIVE-YEAR PLAN

I. New Frontiers: (biotechnology, information technology, space technology, management technology and futurology), achieving self-reliance, research in support of exports and strengthening basic research and establishment of Technology Alert and Assessment Centre at the ICAR Headquarters.

1.	Dr S. Varadarajan AB—13, Pandara Road New Delhi-110 003.	Chairman
2.	Dr P.M. Bhargava Director Centre for Cellular & Molecular Biology CSIR, Hyderabad-500 007.	Member
3.	Dr Baldev Sahai Group Director Remote Sensing Application Group Space Application Centre (ISRO) Jodhpur Tikra, Ahmedabad-380 053.	-do-
4.	Dr G.P. Talwar Director NII, New Delhi.	-do-
5.	Dr N.K. Nauthani Director (Agriculture) Bhabha Atomic Energy Commission Trombay, Bombay.	-do-
6.	Dr V.L. Chopra Prof. of Eminence & Director Biotechnology Centre Indian Agricultural Research Institute New Delhi-110 012.	-do-
7.	Dr (Smt.) Manju Sharma Chief (Science) Planning Commission New Delhi-110 001	-do-

8.	Dr H.C. Srivastava Department of Biotechnology New Delhi.	Member
9.	Dr Kunthala Jairaman Director Biotechnology Centre Anna University Madras-600 040.	-do-
10.	Dr Prem Narain Director IASRI, New Delhi.	-do-
11.	Dr R.P. Sarkar Director-General Indian Meteorological Department Mausam Bhavan Lodhi Road New Delhi-110 003.	-do-
12.	Mr P.R. Seshan Joint Secretary National Committee on the Use of Plastics in Agriculture Ashoka Estate 10th Floor 24, Barakhamba Road New Delhi-110 001.	-do-
13.	Dr Mangla Rai Assistant Director-General Indian Council of Agricultural Research Krishi Bhavan New Delhi-110 001.	Member-Secretary

II. Remedying imbalances in progress among regions and commodities for example rainfed areas, eastern region, pulses and oilseeds, buffaloes and goats, meat production, etc.

1.	Dr A. Appa Rao Vice-Chancellor Andhra Pradesh Agricultural University Hyderabad.	Chairman

2.	Dr R.P. Singh Director Central Research Institute for Dryland Agriculture Hyderabad.	Member
3.	Dr K. Kanungo Member Agriculture Scientists Recruitment Board (ASRB) New Delhi.	-do-
4.	Shri P.C. Bora Vice-Chancellor Assam Agricultural University Jorhat.	-do-
5.	Dr (Mrs.) I.K. Barathakur Adviser, Planning Commission Yojana Bhavan New Delhi.	-do-
6.	Dr R.V. Singh Director-General Indian Council of Forestry Research & Education Dehradun.	-do-
7.	Dr Y.L. Nene Programme Director (Legumes) Pulse Improvement Programme ICRISAT Hyderabad.	-do-
8.	Dr R.N. Prasad Director ICAR Research Complex for NEH Region Shillong Meghalaya.	-do-
9.	Dr R. Nagarcenkar Director National Dairy Research Institute Karnal.	-do-
10.	Dr V.D. Mudgal Director Central Institute for Research on Buffaloes Hissar.	-do-

11.	Dr N.K. Bhattacharyya Director Central Institute for Research on Goat Makhdoom Farah, Mathura (U.P.)	Member
12.	Dr V. Rangarao Project Director Oilseeds Directorate Hyderabad.	-do-
13.	Dr Shankar Lal Project Director Pulse Directorate Kanpur.	-do
14.	Dr M. Velayutham Assistant Director-General (S) Indian Council of Agricultural Research New Delhi.	Member-Secretary

III. Research and training oriented towards needs of economically handicapped sections of the community (small and marginal farmers and landless labourers, rural women and tribals), equity considerations, Research on Delivery System.

1.	Dr Har Swaroop Singh Vice-Chancellor Haryana Agricultural University Hissar.	Chairman
2.	Dr S.M. Patankar Director-General, CAPART, Guru Nanak Foundation Building, New Mehrauli Road, New Delhi.	Member
3.	Dr Jai Lal Dalal Retd. Director (Agri.), Haryana, H. No. 303, Sector, 16-A, Chandigarh.	-do
4.	Dr S.S. Khanna Adviser (Agriculture) Planning Commission New Delhi.	-do

5.	The Joint Secretary Tribal Development Ministry of Home Affairs New Delhi.	Member
6.	Dr (Smt.) Nandani Azad Consultant, Women Development National Institute of Public Cooperation & Child Development Hauz Khas New Delhi.	-do-
7.	Dr (Smt.) K. Bhansali Vice-Chancellor, SNDT, Bombay.	-do-
8.	Dr (Smt.) Vinodini Reddy Director National Institute of Nutrition Hyderabad.	-do-
9.	Dr (Smt.) Chubala Ao Chairman Social Welfare Board Kohima, Nagaland.	-do-
10.	Dr Nirmala Buck Adviser Planning Commission New Delhi.	-do-
11.	Dr V.R.P. Sinha Director CIFE, Bombay.	-do-
12.	Smt. Krishna Bhatnagar Financial Adviser (DARE) Krishi Bhavan New Delhi.	-do-
13.	Shri P.R. Seshan Joint Secretary National Committee on the Use of Plastics in Agriculture Ashoka Estate, 10th Floor 24, Barakhamba Road New Delhi-110 001.	-do-

14. Dr G.L. Kaul — Member-Secretary
Assistant Director-General (H)
Indian Council of Agricultural Research
Krishi Bhavan
New Delhi-110 001.

IV. Conserving environmental assets linking sustainability with productivity, profitability, equity (Rural Systems Research).

1. Dr M.S. Swaminathan — Chairman
5, Janaki Avenue
Opp: Abhirampuram
4th Street
Madras-600 018.

2. Shri S. Parthasarathy — Member
Joint Secretary
Ministry of Agriculture
New Delhi.

3. Shri A.G. Oka — -do-
Inspector General (Forests)
Ministry of Environment & Forests
Paryavaran Bhavan
New Delhi.

4. Dr D.K. Biswas — -do-
Department of Environment
Paryavaran Bhavan
New Delhi.

5. Dr K.K.S. Chauhan — -do-
Chairman
KRIBHCO
New Delhi.

6. Dr P.V. Shenoi — -do-
Special Secretary & Director
Technology Mission on Oilseeds,
Krishi Bhavan,
New Delhi-110 001.

7. Dr P.V. Salvi — -do-
Vice-Chancellor
M.A. University
Parbhani (Maharashtra)

8.	Shri P.B. Krishnaswamy Special Secretary Planning Commission New Delhi.	Member
9.	Dr A.M. Michael Director Indian Agricultural Research Institute New Delhi-110 012.	-do-
10.	Dr V.V. Dhruva Narayana Director Central Soil & Water Conservation Research & Training Institute, Dehradun.	-do-
11.	Dr D.S. Balaine Director National Bureau of Agricultural Genetic Resources, Karnal.	-do-
12.	Dr P. Das Project Director National Bureau of Plant Genetic Resources, New Delhi.	-do-
13.	Dr R.S. Rana Director National Bureau of Plant Genetic Resources, New Delhi.	-do-
14.	Dr. J. Venkateswarlu Director Central Arid Zone Research Institute Jodhpur.	-do-
15.	Dr Manju Sharma Planning Commission, New Delhi.	-do-
16.	Dr R.M. Acharya Deputy Director-General Indian Council of Agricultural Research New Delhi.	Member-Secretary

V. Strengthening Linkages including International Collaboration

1.	Dr M.V. Rao Special Director-General Indian Council of Agricultural Research New Delhi.	Chairman
2.	Dr B.R. Barwale Chairman Maharashtra Hybrid Seeds Co. Ltd. 19, Rajmahal, 84, Veer Nariman Road Bombay.	Member
3.	Shri Nanubhai Amin Chairman & Managing Director Jyoti Limited Baroda.	-do-
4.	The Managing Director NABARD, Express Building 10, Bahadur Shah Zafar Marg New Delhi.	-do-
5.	Smt. Satyabhama Chairman National Seeds Corporation New Delhi.	-do-
6.	Dr N.S. Dutt BAIF, Wagoli Pune.	-do-
7.	Dr (Mrs) Amrita Patel Secretary NDDB, Anand.	-do-
8.	Shri J.N. Baki Chairman Indian Petro-Chemical Corporation Baroda.	-do-
9.	Smt. Jaya Arunachalam	-do-
10.	Dr A.K. Chatterjee Animal Husbandry Commissioner Ministry of Agriculture Krishi Bhavan New Delhi.	-do-

11.	Dr R.M. Pandey Horticulture Commissioner Ministry of Agriculture Krishi Bhavan New Delhi.	Member
12.	Shri K.H. Joseph Offg. Commissioner (Fisheries) Ministry of Agriculture Krishi Bhavan New Delhi.	-do-
13.	Representative of the Department of Science & Technology New Delhi.	-do-
14.	Dr A.P. Mitra Director-General CSIR, New Delhi.	-do-
15.	Representative of NAFED New Delhi.	-do-
16.	Representative of State Trading Corporation New Delhi.	-do-
17.	Dr C. Prasad Deputy Director-General (AE) Indian Council of Agricultural Research Krishi Bhavan New Delhi.	Member-Secretary

VI. Human Resources Development (Education and Training) including National Agricultural Research Project, Research on Delivery Systems and Implementation at National and International Levels

1.	Dr Sukhdev Singh Vice-Chancellor Punjab Agricultural University Ludhiana.	Chairman
2.	Dr T.V. Sampath Agricultural Commissioner Krishi Bhavan New Delhi.	Member

3.	Dr P.V. Dehadrai Deputy Director-General (Fisheries) Indian Council of Agricultural Research New Delhi.	Member
4.	Dr K.V. Raman Director National Academy of Agriculture Research Management Hyderabad.	-do-
5.	Dr K.N. Nag Vice-Chancellor Rajendra Agricultural University Bikaner (Rajasthan).	-do-
6.	Dr M.R. Kolhatkar Adviser (Education) Planning Commission New Delhi.	-do-
7.	Prof. Yash Pal Chairman, UGC Bahadur Shah Zafar Marg New Delhi (or his nominee).	-do-
8.	Dr R.M. Pandey Director Indian Institute of Horticultural Research Bangalore.	-do-
9.	Dr S.K. Sinha Secretary Federation of Indian Societies of Agricultural Science and Technology (FISAST)	-do-
10.	Dr Rajammal Dev Das Vice-Chancellor Avinashilingam Home Science University Coimbatore (Tamil Nadu).	-do-
11.	Dr Anand Laxmi Principal Lady Irwin College New Delhi.	-do-
12.	Dr U.C. Upadhyay Assistant Director-General (Edn) Indian Council of Agricultural Research New Delhi.	Member-Secretary

VII. Financial Resources for Agricultural Research and Education

1	Dr M.S. Swaminathan	Chairman
2.	Dr S.S. Khanna Adviser (Agri.) Planning Commission New Delhi.	Member
3.	Smt. Manju Sharma Chief (Science) Planning Commission New Delhi.	-do-
4.	Dr P.V. Shenoi Special Secretary & Director Technology Mission on Oilseeds DARE Krishi Bhavan New Delhi.	-do-
5.	Dr R.M. Acharya Deputy Director-General (Animal Sciences) Indian Council of Agricultural Research New Delhi.	-do-
6.	Dr R.S. Paroda Deputy Director-General (CS) Indian Council of Agricultural Research New Delhi.	-do-
7.	Dr K.L. Chadha Deputy Director-General (Horticulture) Indian Council of Agricultural Research New Delhi.	-do-
8.	Dr C. Prasad Deputy Director-General (AE) Indian Council of Agricultural Research New Delhi.	-do-
9.	Dr Maharaj Singh Deputy Director-General (Education) Indian Council of Agricultural Research New Delhi.	-do-

10.	Dr P.B. Dehadrai Deputy Director-General (Fisheries) Indian Council of Agricultural Research New Delhi.	Member
11.	Dr I.P. Abrol Deputy Director-General (Soils) Indian Council of Agricultural Research New Delhi.	-do-
12.	Dr A. Alam Deputy Director-General (Agricultural Engineering) Indian Council of Agricultural Research New Delhi.	-do-
13.	Smt. Krishna Bhatnagar F.A. Department of Agricultural Research & Education Krishi Bhavan New Delhi.	Member-Secretary

ANNEXURE III

AGRO-CLIMATIC REGIONS IDENTIFIED BY PLANNING COMMISSION FOR REGIONAL PLANNING

i) Western Himalayan Region
ii) Eastern Himalayan Region
iii) Lower Gangetic Plains Region
iv) Middle Gangetic Plains Region
v) Upper Gangetic Plains Region
vi) Trans-Gangetic Plains Region
vii) Eastern Plateau & Hills Region
viii) Central Plateau & Hills Region
ix) Western Plateau & Hills Region
x) Southern Plateau & Hills Region
xi) East Coast Plains & Hills Region
xii) West Coast Plains & Ghats Region
xiii) Gujarat Plains & Hills Region
xiv) Western Dry Region
xv) The Islands Region.