II Research Achievements

Research in the Centre is organised into 5 theme areas, viz., Technology Policy, Sustainable Agricultural Systems, Markets and Trade, Institutional Change, and Agricultural Growth and Modelling. Research achievements under different theme areas of the Centre during the year are given below.

TECHNOLOGY POLICY

Delineation and Characterization of Agro-Ecoregions

Raka Saxena, Suresh Pal and P.K. Joshi

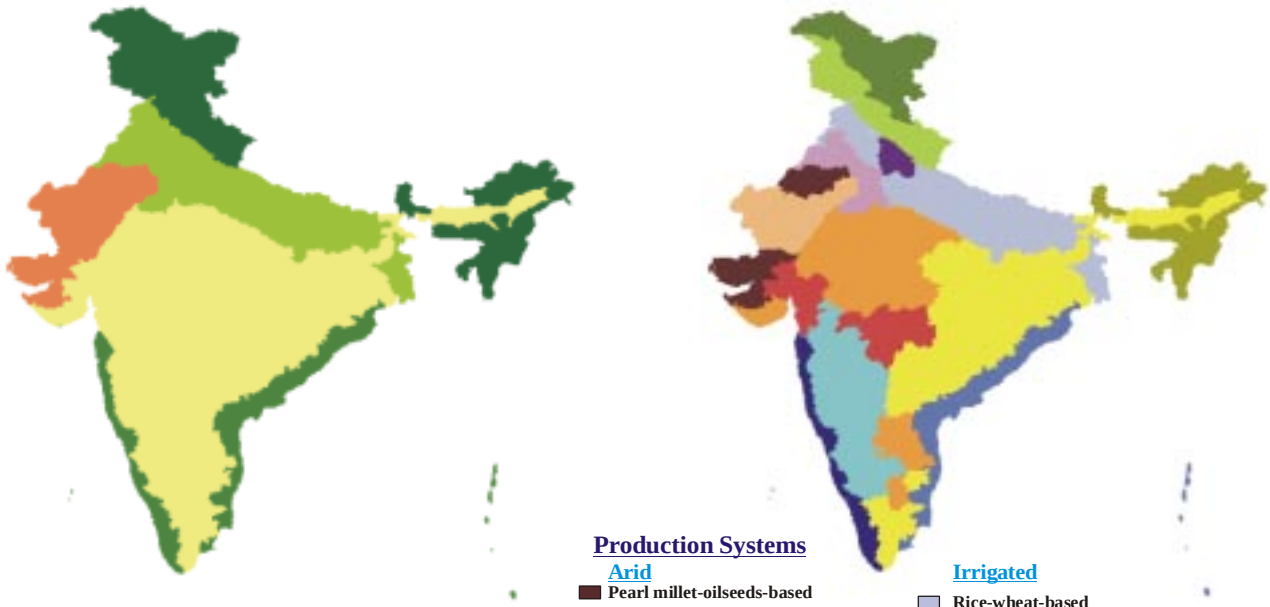
Enormous diversity in agro-climatic, economic and socio-cultural environments in India necessitates delineation of the country into homogeneous regions for proper planning of agricultural research and to maximize benefits therefrom. This study has delineated the country into five agro-ecosystems viz. Arid, Coastal, Hill & Mountain, Irrigated and Rainfed, with a number of production systems therein (Maps 1). The delineated agro-ecoregions and production systems cut across administrative boundaries. This suggests the need for closer linkages between research institutions, particularly State Agricultural Universities. Characterization of the agro-ecosystems and production systems reveals substantial contribution of livestock in all the agro-ecoregions and production systems, and therefore, suggesting the need to consider crop-livestock interactions in research and development strategies. The research strategies however may differ across regions depending on the input-output relationships.

Aggregate Level Priority Setting for Optimum Resource Allocation

Suresh Pal, Raka Saxena and P.K. Joshi

An attempt has been made to allocate research resources more objectively across agro-ecoregions and production systems. The proposed allocations are based on congruence approach, which takes into consideration the multiple research objectives of efficiency, equity and sustainability. The results suggest reallocation of NATP research resources across various agro-ecoregions.

Map 1: Agro-ecological zones and production systems



Irrigated agro-ecoregion should get 9 percent more of the research resources (Figure 1). Further, results suggest that about half of the research resources should be allocated to livestock sector in Arid agro-ecoregion. Similarly, about 30 percent of research resources should go to horticultural crops in Coastal agro-ecoregion (Table 1).

Figure 1: Existing and normative allocation of resources (percent)

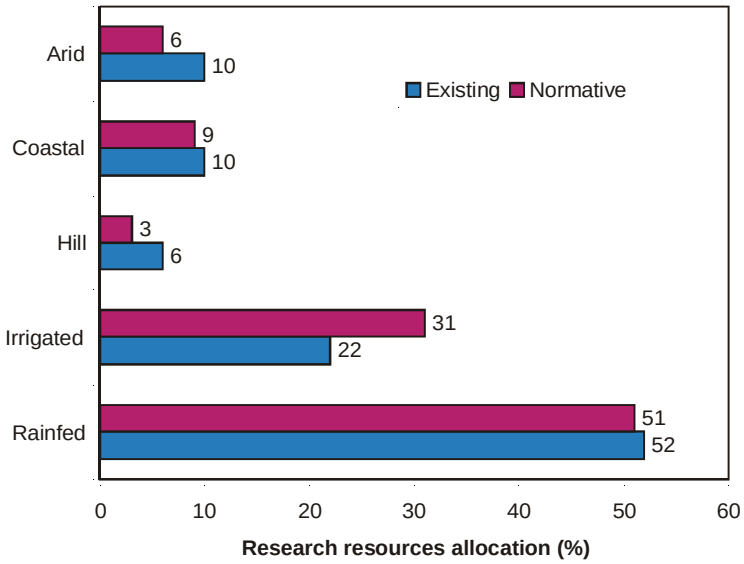


Table 1: Research resources allocation across agro-ecoregions and commodity groups (percent)

Commodity	Agro-ecoregions					Overall
	Arid	Coastal	Hill	Irrigated	Rainfed	
Cereals	17	37	38	38	26	31
Pulses	4	1	neg.	3	6	4
Oilseeds	24	5	2	4	13	10
Livestock	51	21	44	39	34	36
Horticulture	2	30	10	8	11	11
Other crops	2	6	5	8	10	8

Opportunities in Pulse Production

P.K. Joshi and Raka Saxena

This study investigates opportunities in pulses production and examines their shifts in new production domains using state level data, covering a period of three decades. Total pulse production in India during 1997-98 was about 13 million tonnes, coming from 23 million hectares. Chickpea, pigeonpea, blackgram and greengram occupied nearly 76 percent of total area and contributed about 80 percent to total pulses production. Total production of pulses over the last two decades however has increased marginally. A large share in the increased production came from blackgram (39 percent) followed by greengram (21 percent), lentil (20 percent) and chickpea (17 percent). Evidences suggest that farmers have been shifting towards relatively shorter duration pulses like blackgram, greengram and lentil in place of long duration and medium duration pulses like pigeonpea, horsegram and lathyrus (Figure 2). The shorter duration pulses have advantage of escaping terminal drought, and in some cases avoid infestation of insect pests. As new crops are emerging, so are the new areas. A shift in pulses production from northern and eastern states to central and western states is taking place (Figure 3). Southern states are also coming forward in pulses production.

Prioritization of Pulses Research

P.K. Joshi and Raka Saxena

Supply of pulses is short of demand in India. To increase production of pulses, research resources need to be allocated more efficiently across different pulses and states. The study aims at examination of existing and normative allocation of research resources. Amongst various commodity groups, pulses should receive 7 percent of research resources. Existing and normative allocation of research resources across different pulses are given in Table 2. Some reallocation of incremental resources across commodities is desirable. Prioritization across states indicates more resources for pulse research to Madhya Pradesh, Orissa, Rajasthan and Maharashtra. In case of chickpea, 70 percent incremental resources should be allocated to four states, namely, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh.

Figure 2: Pulse production: Major contributing pulses

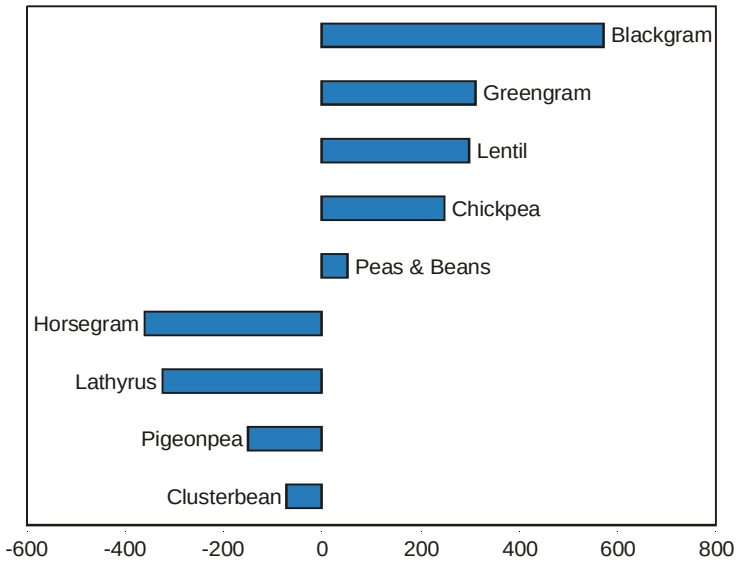


Figure 3: Pulse production: Major contributing states

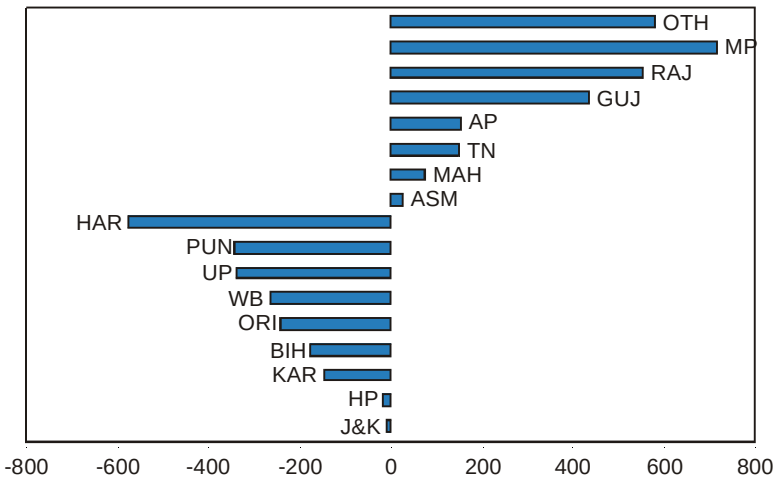


Table 2: Existing and normative resource allocation across different pulses (percent)

Commodity	Normative allocation		Existing	Deviation allocation
	I	II		
Chickpea	35	25	24	+1
Pigeonpea	23	16	21	-5
Blackgram	12	8	14	-6
Greengram	10	9	12	-3
Peas & beans	5	4	7	-3
Lentil	6	17	7	+10
Lathyrus and clusterbean	9	21	15	+6

I : 100 percent weight given to efficiency

II : 40 percent weight given to efficiency, 20 percent weight given to each indicator, namely, sustainability, exports and imports.

Total Factor Productivity of Rice and Wheat in Indo-Gangatic Plains

P.K. Joshi, Laxmi Tewari and B. C. Roy

Total factor productivity of rice and wheat in Indo-Gangetic Plains (IGP) has been estimated for the period of 1966-67 to 1995-96. Indo-Gangetic plains are divided into four agro-ecological zones: (i) Trans-Gangetic plain, (ii) Upper-Gangetic plain, (iii) Middle-Gangetic plain, and (iv) Lower-Gangetic plain. Each of these is further divided into sub-zones depending upon soil and agro-climatic conditions.

The impressive performance of TFP resulted in quantum jump of rice and wheat production during 1967-96. Rice production has increased by 34 million tonnes and wheat production by 48 million tonnes between 1966/67 and 1997/98. Trans-Gangetic and Lower-Gangetic plains contributed about 67 percent to increased rice production. In case of wheat, about 70 percent increased production came from Trans-Gangetic and Upper-Gangetic plains.

Yield growth rates of rice and wheat however has become more input based. Use of modern inputs in Indo-Gangetic Plains has already been achieved to a very high level. The organic sources of nutrients like organic manure have

declined. The negative and stagnating growth in TFP is a matter of concern (Table 3). Deceleration in productivity will influence the cost of production and adversely affect the profitability. Input based yield growth rate may not be sustained if further technological innovations do not occur.

Table 3 : Growth rates in total factor productivity of rice and wheat in different agro-ecoregions (percent /annum)

Agro-ecoregion	Rice			Wheat		
	1966-76	1977-86	1987-96	1966-76	1977-86	1987-96
Trans-Gangetic plains						
Foothills of Shivalik	8.22	0.93	2.03	5.12	0.30	0.28
Plains	9.00	2.79	0.82	2.41	-3.23	-3.77
Arid	13.26	5.44	3.27	3.52	0.29	-0.57
Upper-Gangetic plains						
North western plain	1.12	-1.97	-8.62	1.43	-0.51	-8.26
South western plain	0.72	-0.47	6.33	1.59	-1.03	-8.72
Central plain	1.04	-1.05	-3.31	3.23	-0.63	-8.90
Middle-Gangetic plains						
Eastern plain	2.07	3.15	0.26	6.65	-1.55	-9.99
Vindyan	1.52	-1.48	3.79	3.34	-0.88	-18.79
South Bihar plain	1.84	-6.06	-5.73	2.55	-2.11	-1.06
North Eastern plain	1.12	0.87	-1.84	1.37	0.22	-8.85
N. Bihar plain	4.43	-2.66	-4.60	4.10	-2.96	-1.65
North east plain	5.81	-7.06	0.30	0.68	-3.57	-5.22
Lower-Gangetic plains						
Barind plain	0.35	1.99	-0.74	29.46	-6.06	-12.49
Central alluvial plain	0.88	2.20	0.12	19.87	-2.26	-10.46
Rorh plain	-1.27	0.32	-0.52	15.32	-0.26	-9.16
Alluvial coastal saline plain	-0.58	0.76	-1.15	26.25	-1.99	-12.93

Future Sources of Growth in Production of Rice and Wheat in Indo-Gangetic Plains

P.K. Joshi, Laxmi Tewari and B. C. Roy

A study was undertaken to assess the future sources of growth in Indo-Gangetic plains. Different regions were delineated based on the rate of growth in productivity and level of productivity. About half of rice and wheat area has yield levels less than 2.0 tonnes/ ha and 2.5 tonnes/ ha, respectively (Table 4). These areas are largely confined to Middle and Lower-Gangetic plains. In these areas, farmers are yet to fully exploit the technological potential. Infrastructural development is also weak in low growth regions. Both high and low growth regions offer opportunities to increase production. But they require different technological solutions and research strategies.

Table 4: Rice and wheat area according to yield levels and yield growth rates (percent)

Yield (tonnes/ha)	Annual growth rate		
	> 2 percent	< 2 percent	Total
Rice			
> 3	3.84	5.00	8.84
2.5-3	3.20	8.52	11.72
2-2.5	20.25	9.59	29.84
< 2	25.29	28.01	53.30
Total	50.00	50.00	100.00
Wheat			
> 3	21.00	15.00	36.00
2.5-3	8.00	8.00	16.00
2-2.5	22.00	14.00	36.00
< 2	9.00	3.00	12.00
Total	60.00	40.00	100.00

Techno-Economic Evaluation of Potential Pest Control Strategies

Pratap S. Birthal

Integration of biotechnological inputs with the existing pest control methods is intended to reduce use of chemical pesticides without demanding additional financial resources and affecting the crop yields. To test the hypothesis, experimental data on cotton, paddy and chickpea from different locations were analysed. The results provided a mixed picture. In case of cotton in Gujarat, use of biotechnological inputs alone as well as in an integrated mode was found to have a better yield saving potential over chemical control strategy. In Tamilnadu, biotechnological inputs proved effective when used in conjunction with chemical pesticides. While in Punjab, chemical pest control strategy retained its superiority. Similar trends were obtained on evaluation of these strategies for their comparative economic advantage. In chickpea, on the other hand, integration of biotechnological inputs with chemical pest control emerged as a better option technically as well as economically. In case of paddy, use of biotechnological inputs alone did not show any advantage over chemical pest control. However, conjunctive use of biotechnological inputs and chemical pesticides proved better over chemical pest control strategy, technically as well as economically.

These findings have some important implications for research and palnt protection policy. First, there is a need to standardise the technology considering the level of pest infestation and agro-ecological conditions. Development of pesticide resistance in living organism based pest control inputs would help increase their efficacy further. Secondly, at present, markets for these products are limited and imperfect. Current prices donot seem to provide much incentives to adoption of these inputs. The research institutions as well as the industry should aim at reduction in cost of production of such inputs through commercial production.

Technical Efficiency in Sorghum Production

A.K. Jha, P.K. Joshi and Suresh Pal

Sorghum is an important crop occupying 16.4 percent area in the country and 31.7 percent area in the Sorghum-based Production System (SPS). Nearly

36 percent of the sorghum area in SPS falls under *kharif* sorghum and rest is under *rabi* sorghum. The corresponding production figures are 57 and 43 percent, respectively. There exists a wide gap between actual and potential yields, which perhaps could be due to technical inefficiency at the farm level. Based on cross-section farm survey data from 160 sample farms in the districts of Mehboobnagar (Andhra Pradesh) and Solapur (Maharashtra), an attempt was made to estimate the technical efficiency in sorghum production.

Nearly 57 percent of the difference between realized and potential yield is due to prevailing inefficiency. However, the difference in efficiency of *rabi* sorghum producing farms is even more apparent. In this system, nearly 78 percent yield gap is due to inefficient performance of the farms. The mean technical efficiency in *kharif* as well as in *rabi* sorghum production is only about 38 percent. This suggests considerable scope to improve technical efficiency and thereby sorghum production even at existing level of technology and input use.

Dairy in Sorghum-Based Production System

A. K. Jha, P. K. Joshi and Suresh Pal

Dairying is an important activity in Sorghum-based Production System (SPS). However, it is fettered with several technical and socioeconomic constraints. Gap in milk yield has been estimated as high as 88 percent in indigenous cows, 55 percent in buffaloes and 37 percent in crossbred cows. Animal health and nutrition related problems reduced the yield potential of a crossbred cow by 0.58 tonnes a year accounting for 68 percent of the yield gap. Chronic nutrient deficiencies, fodder scarcity and inferior feed quality are some other factors responsible for such a wide gap. Lower conception rates, failure of artificial insemination and incidence of diseases like *Foot and Mouth disease (FMD), Anthrax, Mastitis, T. thilerasis* and *Hemorrhage Septicemia (HS)* are the other critical constraints in cattle production. But, nutrient deficiency is the prime reason for wide yield gap in indigenous cattle. In buffaloes, poor stall-feeding, failure of artificial insemination, *FMD*, *mastitis*, frequent miscarriage, *prolapse* and *HS* are common constraints. The value of milk lost due to different constraints is to the tune of Rs. 42 crores per annum in this system. Thus, research projects addressing the problems of nutrient

deficiency, failure of artificial insemination, *FMD, etc*. need to be accorded high priority.

Efficiency in Crop Sciences Research

A.K. Jha, P.K. Joshi and Suresh Pal

Public-funded research in India is facing a more stringent situation today. At present, while the ICAR is promoting a new culture in its functioning and taking more and more objective decisions, evaluation of productivity and technical efficiency may be a matter of interest to the research managers. The technical efficiency, which is a ratio of the observed and frontier output of a research organisation satisfying *ceteris paribus* condition, is a useful tool for assessing the performance. This study attempts to measure the technical efficiencies of 22 crop science institutes of the ICAR using stochastic production function, which captures the random effects outside the control of decision maker as well as estimates deviations from the frontier due to inefficiency. Based on the list of publications of the Institutes alongwith their budgets and scientific cadre strength, efficiencies have been worked out. In order to ensure quality work only published research articles in national and international and journals are taken as indicators of scientific productivity. Assigning suitable weights, an average index of productivity score was prepared. Applying dummy for size of Institute, scientist productivity score was regressed on per scientist budget of the institutes.

Preliminary results indicate mean efficiency level of the crop sciences Institutes of the ICAR at 55 percent (Table 5). The value of lambda indicated that 69 percent of the difference in the efficiency of the crop science research was due to technically inefficiency in the concerned institutes. The rest of the inefficiency might be due to reasons beyond control of the research managers at the institute level. Higher availability of funds per scientist has a positive impact on scientific productivity. However, size of the Institute was negatively associated with research productivity. This has important implications for deciding appropriate size of the institutes.

Table 5: Estimates of stochastic frontier production function

Variable	OLS	MLE
Constant	-1.6882*	-1.2768
	(0.5509)	(0.8310)
Budget (Rs. lakh / Scientist)	0.9419*	0.93656*
	(0.2524)	(0.3133)
Size dummy	-0.5362**	-0.4817
(1 for big institute, 0 otherwise)	(0.2570)	(0.3473)
$\sigma^2(v)$	-	0.13605
$\sigma^2(u)$	-	0.3061
λ	-	1.4999
γ	-	0.6923
σ	-	0.6649
R^2	0.4543	-
Log-likelihood	-15.7893	-15.6913
Number of alterations	-	11
Number of observations	22	22

* Significant at 1 percent probability level.
Figures in parentheses are standard error

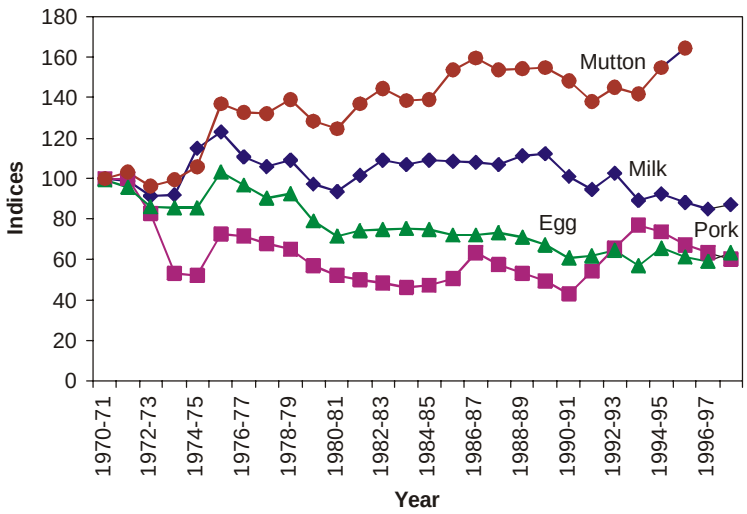
Technological Change and Livestock Product Prices

Pratap S. Birthal

In the livestock sector, significant research advances have been achieved in areas of animal breeding, nutrition and health over the last few decades. And, technologies such as genetic improvements coupled with improvements in feed-fodder availability have accelerated growth in livestock productivity and production, which influenced the prices of livestock products. Figure 4 shows the behavior of real wholesale prices of mutton, milk, pork and egg since 1970-71. The real price of milk has been on a declining trend since 1970s though with marginal fluctuations. Prices of egg have declined sharply. The price of pork too has been declining. On the other hand, the price of mutton has been on a rising trend. It may be

noted that there has been significant growth in milk, egg and pork production partly due to improvements in productivity or technological changes since early 1970s. The mutton output though has increased at a significant rate; improvements in productivity of small ruminants have almost remained static. These trends clearly demonstrate that wherever there have been improvements in productivity, the real prices of their products have declined.

Figure 4: Trend in real wholesale prices of livestock products



SUSTAINABLE AGRICULTURAL SYSTEMS

Sustainability of Rice and Wheat in Indo-Gangetic Plains

P.K. Joshi, Laxmi Tewari and B. C. Roy

Rice-Wheat Cropping System (RWCS) is one of the most productive systems in India. The system has significant historical contribution in making India food secure and self-sufficient. The system contributes about 50 percent to the food grain production, and more than 75 percent to the total food grain

procurement. The system however has started showing signs of fatigue due to several ecological problems such as depletion/pollution of ground water resources, soil salinity and waterlogging, nutrient mining, incidence of insect pests and weeds, and loss of bio-diversity. The present study measures the temporal and spatial variations in the sustainability status of the RWCS. Radar approach has been used by amalgamating economic objectives and resource conservation factors. Growth in production, yield levels and yield stability are the criteria considered for maximizing the economic objectives. Share of groundwater in net irrigated area, degraded land and Simpson index of biodiversity are taken as proxy for environmental indicators.

A larger area under rice and wheat in the system is showing clear signs of unsustainability (Map 2). It is estimated that about 62 percent of the rice area and 53 percent of the wheat area is not sustainable. It may be mentioned that the unsustainable sub-regions contribute about 55 percent to both rice and wheat production in IGP. Their share in increased rice and wheat production since introduction of green revolution technologies has been nearly 50 percent. The production increase has now been constrained due to plateauing of rice and wheat yields and limited scope of area expansion. In Trans-Gangetic and Upper-Gangetic plains, overexploitation of groundwater and declining biodiversity are responsible for unsustainability. Nonetheless, there exists considerable scope to raise yield levels in the Middle and Lower Gangetic plains through technological interventions and management of natural resources.

Growth and Sustainability of Agriculture in Eastern India

B.C. Barah

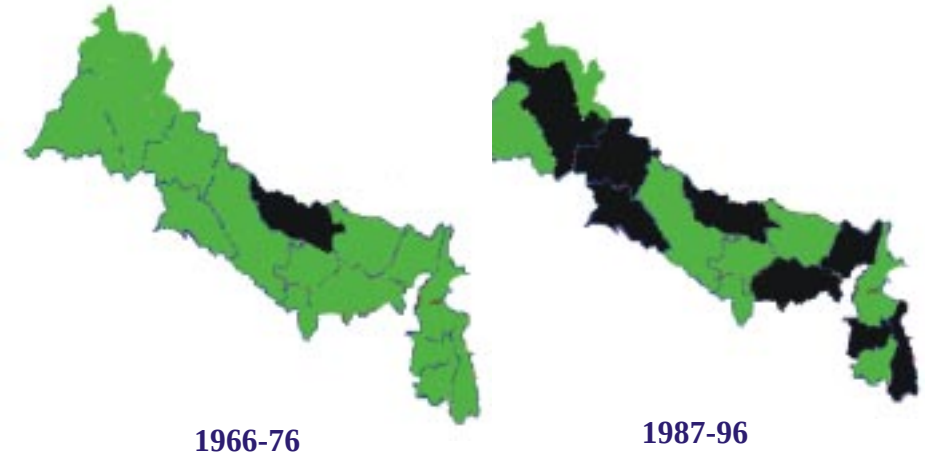
Eastern region of the country comprising of 8 states and covering 37 percent of the land mass with about half a billion population has been bypassed in the process of agricultural development. About 60 percent of the total cropped area remains rainfed. Population below poverty line ranges between 40 to 58 percent across different states. The infrastructure development index of the eastern India is below the all India average.

Map 2: Sustainability status of rice and wheat system.

Rice

1966-76 **1987-96**

Wheat

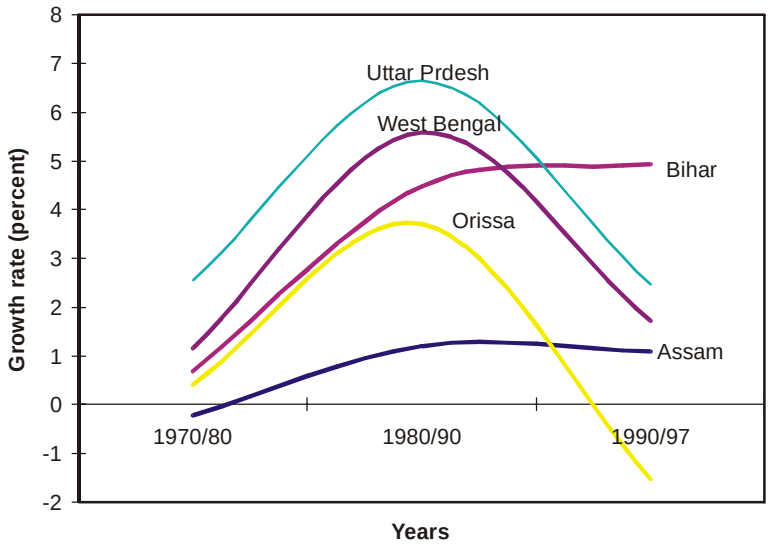


1966-76 **1987-96**

Sustainable region Unsustainable region

Rice is the major crop occupying 64 percent of the area. The productivity of rice is the lowest (1257 kg/ha for irrigated rice and 884 kg/ha for rainfed rice). The pattern of growth of agriculture in eastern India shows that during 1980s, the rice yield reached a satisfactory level, but unfortunately the same has fallen considerably during 1990s. The incremental gains in yield over the last three decades range from as low as 1 kg/ha per annum to 23 kg/ha per annum across different states. Except West Bengal and eastern parts of Uttar Pradesh, yield improvements are unsatisfactory (Figure 5). This is a serious concern for the region's food security.

Figure 5: Productivity growth scenario in Eastern India



Equity Impacts of Irrigation Distribution Policies

S. Selvarajan

Temporal distribution of inequality under current and Rawlsian distribution for 17 states is analysed with five farm size classifications at two points of time that is 1970/71 and 1990/91. There are wide inter-state variations in the level of inequality in the current distribution of flow and lift irrigated area across five

farm size classifications among different states. In 1970/71, highest inequality was recorded in Bihar and least inequality level in the distribution of irrigation was observed in Maharashtra. In 1990-91 maximum inequality was observed in Kerala and least in Gujarat. States have undergone changes in inequality over these two decades depending on the level of surface and ground water development, and other watershed related conservation programs.

The potential reduction in the inequality of irrigated area distribution following the Rawlsian approach in different states indicates some variation but consistently, the level of inequality comes down significantly in all the states. Least inequality in the Rawlsian approach is recorded in Madhya Pradesh. The scope for minimizing the inequality in the distribution of irrigated area across states is thus quantified and assessed by comparing the existing distribution of flow and lift irrigated area with the Rawlsian approach to the distribution of canal irrigated area. Ongoing institutional reforms in surface irrigation sector with the formation of water user's associations for decentralized management and use of water, in states like Haryana, Andhra Pradesh, Orissa, Tamil Nadu, Rajasthan, Uttar Pradesh and Rajasthan will help in minimizing such gaps to a large extent.

MARKETS AND TRADE

Equity Driven Trade Policy and Strategies for Indian Agriculture

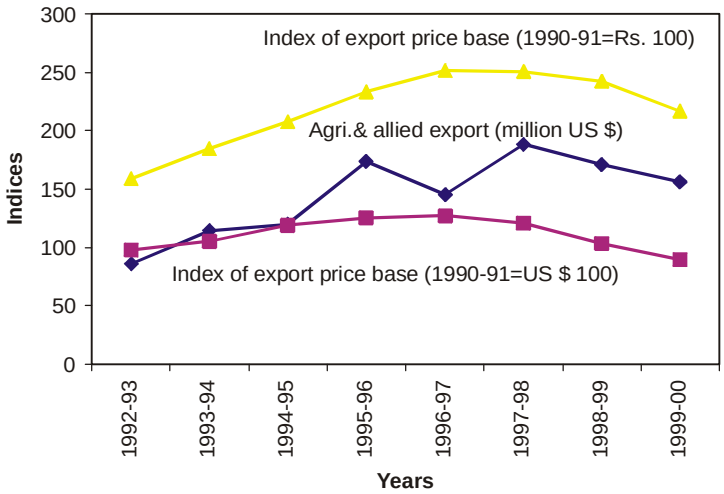
Ramesh Chand

India has emerged as a major exporter of rice and its share in global rice trade has reached about 20 percent in some years due to liberalisation of exports. The trade in wheat shows violent year-to-year fluctuations. In some years, country exported huge quantity, while in others, it had to go for massive imports. The study showed that export surpluses of wheat were of very transitory nature and their disposal as export necessitated huge imports subsequently, to stabilise domestic prices and to meet domestic requirement.

In recent years, international prices of agricultural commodities have plummeted to a very low level. This has hit India's agricultural exports, which had been rising at a fast rate after initiation of economic reforms programme.

International prices show very high volatility (Figure 6). If such shocks are transmitted to farm level, these would destabilise cropping pattern and cause uncertainty in farm income. Since vast majority of Indian farmers are either small or marginal, they do not have resources and capability to shift from one kind of crop pattern to another swiftly. Under WTO obligations, such temporary imports and shocks can't be checked through quantitative restrictions (QRs). There is a need for alertness to impose appropriate tariffs to regulate unwanted imports.

Figure 6: Indices of India's agricultural export in US $ and international agricultural prices in US $ and Indian rupee (base 1990=100)



Export Competitiveness of Livestock Products

Anjani Kumar

Export competitiveness of selected livestock products has been examined by computing nominal protection coefficient (NPCs). Butter has not been competitive internationally after triennium ending (TE) 1982. Although milk prices in India are significantly lower than in the United States and Western Europe, dairy product prices are considerably higher than the international prices. This may be attributed to the domestic processing inefficiencies in

India and high degree of production subsidises in the United States and Western Europe. India also lacks international competitiveness in poultry products though it was price competitive in TE1991. There has been an increase in NPCs after reforms and at present domestic price of poultry meat is about 50 percent higher than the world prices. Export of beef has been highly export competitive. Mutton and pork were not competitive initially, but became price competitive off late (Table 6).

Table 6: Nominal protection coefficients (NPCs) of selected livestock commodities in the global markets

Year/Item	Butter	Beef	Mutton	Pork	Poultry meat
1980-82	0.856	0.367	1.192	1.253	-
1983-85	1.262	0.414	1.012	1.162	-
1986-88	1.473	0.402	0.991	0.975	-
1989-91	1.532	0.176	0.825	0.314	0.988
1992-94	1.850	0.162	0.627	0.211	1.045
1996-98	1.978	0.258	0.795	0.259	1.531

Demand for Livestock Products in India

M.B. Dastagiri

This study estimates effects of income and price changes on demand for livestock products and predicts their demand by 2020. Using consumer expenditure data from 50th round of National Sample Survey Organisation pertaining to 1993-94, a complete demand system for milk, mutton and goat meat, beef and buffalo meat, chicken, egg, fish, other foods and non-foods has been estimated and demand thereof, has been predicted for 2020 (Table 7).

Livestock products exhibit high elasticity and are highly substitutable. The expenditure elasticities of livestock products are high particularly in rural areas compared to urban areas implying thereby acceleration in demand for livestock products in rural areas with rising per capita incomes. Further, the expenditure elasticities of livestock products are higher than other food expenditure

elasticities. This implies that there would be a shift in consumption pattern towards livestock products. This is evident from the demand projections for 2020. Demand for milk and meat is estimated to be 147 and 14 million tonnes, respectively.

Table 7: Demand projections of livestock products towards 2020

Product	1993	2000	2010	2020	Percent annual growth rate (1993-2000)
Milk	46.18	60.77	94.23	147.21	4.77
Mutton & Goat meat	0.83	1.36	3.81	12.72	13.25
Beef & Buffalo meat	0.49	0.61	0.84	1.15	3.39
Chicken	0.25	0.33	0.52	0.81	4.67
Eggs	9.62	13.88	24.79	44.06	6.02
Fish	1.95	1.91	1.79	1.64	-0.64

Note: All products in million tonnes except eggs (billion number)

INSTITUTIONAL CHANGE

Public and Private Sectors in Agricultural Research in India

Andy Hall, Rasheed Sulaiman V., Norman Clark, M.V.K.Sivamohan and B. Yoganand

The study examines the evolving relationship between the public and private sectors in Indian agricultural research and the opportunities for developing a dynamic and institutionally diverse agricultural innovation based system. Case studies conducted in the horticulture sector using the conceptual framework of National Systems of Innovation (NSI) reveal that significant institutional change has started to take place in this sector. The process is led by the private sector. The overwhelming challenge is to successfully engage the

public sector in this process. Despite efforts to reform the system (led by ICAR), institutional arrangements in the National Agricultural Research System has engendered a set of working practices and rigidities that are not always suited to the needs and styles of the private sector. Attempts to contract, both agricultural research institutes and agricultural universities, are plagued by administrative inefficiencies and the narrow professional mandate of the scientists involved. For example, lack of fit with commercial working practices, technology applications and the contingencies of foreign market are the problems in providing technical backstopping to the export horticultural sector. Where contractual arrangements have been put in place, it is difficult to impose sanctions for non-compliance. Mechanisms to make scientists and the organisations responsible for the utility of the service and technologies are also lacking. A related element of this problem is the absence of iterative learning process and particularly institutional learning. Currently there are limitations to the extent to which the public sector can operationally contribute technology and allied R & D capability.

If public sector organisations are going to enter into partnerships with a wide range of organisations, a higher degree of flexibility is required and this must be result oriented. The analytical principles of NSI could make an important contribution to designing a policy framework to foster such collaborative arrangements. A more extensive inventory of organisations and their capabilities is required to develop an overall picture of agricultural innovation system and to identify leverage points and focus the strategic role of the public sector research organisations.

AGRICULTURAL GROWTH AND MODELLING

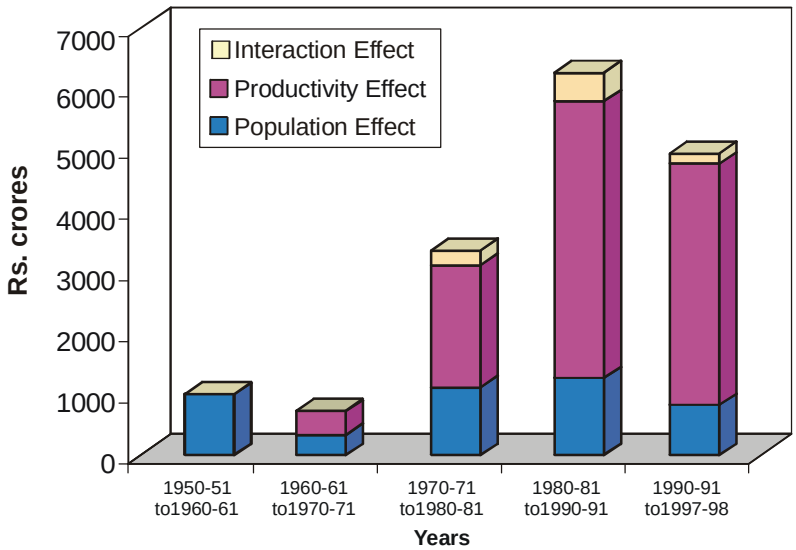
Performance of Livestock Sector in India

Anjani Kumar and Jabir Ali

Livestock sector in India has performed reasonably well considering growth in major components of livestock output. As output is determined by population and productivity, the growth in value of output of livestock sector (at constant prices) has been decomposed into population effect, productivity effect and interaction effect. At all-India level, maximum increase in livestock output has occurred due to increase in the productivity (Figure 7). However,

decade-wise results are more revealing. The growth in the output of livestock sector for the period 1950-51 to 1960-61 was mainly driven by population growth. The contribution of productivity was merely 2.38 percent while the contribution of population was 97.29 percent. There was a reverse trend since then. The contribution of productivity rose significantly.

Figure 7: Sources of growth in livestock sector



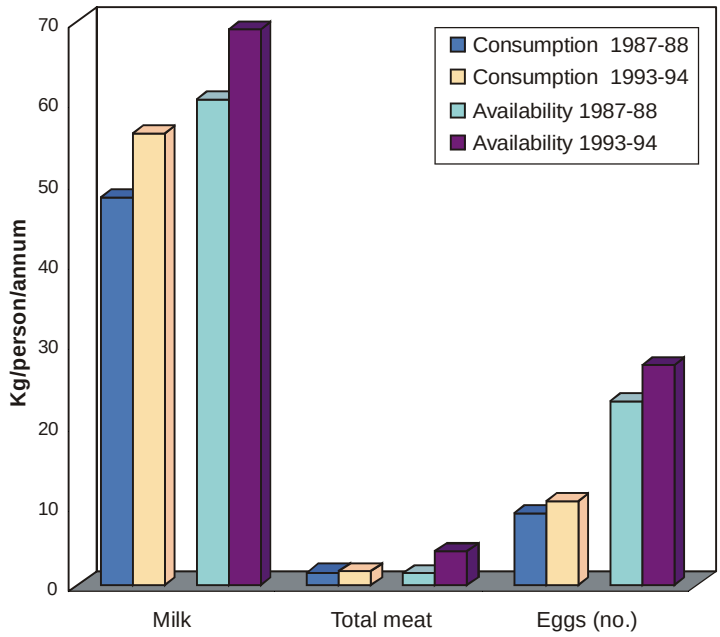
The Puzzle of Livestock Statistics

Anjani Kumar

Data on production and consumption of livestock products present some puzzles. The output availability has been calculated after taking care of trade in livestock commodities. The production figures have been collated from the publications of Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The data on consumption have been compiled from the NSSO reports. The divergence between the data on availability and consumption of meat and eggs was more than 150 percent. Ideally, both figures should be equal, particularly since there is little processing of these commodities (Figure 8). This poses a question as to which source is to be believed. The purpose of highlighting the problems

of livestock statistics is to make the point that researchers should be careful while using the official statistics. Another purpose is to suggest focus on collection of reliable data on livestock on a continuous basis.

Figure 8: Discrepancies in data on availability and consumption of live stock products



Evolution of Crop-Livestock Systems

Harbir Singh and Sant Kumar

The study analyzes temporal changes in the relationships among households, livestock and crop enterprises. At macro level, the study seeks to demonstrate how irrigation and associated agricultural development results into simultaneous development of livestock and crop sector. The changing relationships between crop and livestock in an agriculturally developed region were examined at three points of time, viz., 1954-57,

1967-68 and 1999-00. It was observed that substantial increase in the net irrigated area (33 to 51 percent) was accompanied by about 80 percent increase in bovine population and about 5 percent decline in ovine population (Sri Ganganagar district of Rajasthan). Substantial increase (315 percent) in ovine population in Jaisalmer district was recorded during 1972-97 on account of comparatively larger grazing area.

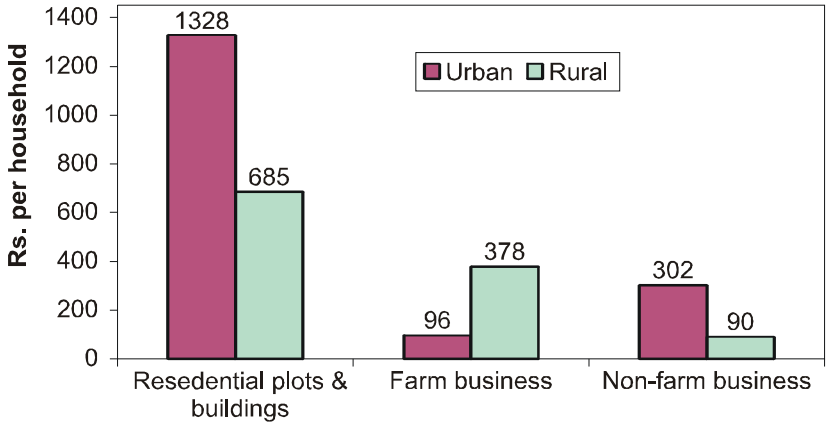
Share of income from livestock in total farm income was 14 percent in 1954-57, which declined to about 8 percent in 1967-68. While in 1999-2000, the share of crop and livestock enterprises was 70 percent and 30 percent, respectively. The declining share of crop enterprises in household income highlights the increasing economic importance of livestock. And at the same time, farm expenditures (excluding rental value of owned land) per farm and per hectare have considerably increased. This might be due to both increase in input prices and increasing importance of modern inputs. Investment on livestock per farm and per hectare has phenomenally increased. The study has clearly shown the increasing interdependence among households, livestock and crop production. Generally, any policy in crop or livestock sector is implemented uniformly either at state or at country level. Such policy implementation may not be much effective keeping in view the regional diversity.

Rural-Urban Linkage through Farm and Non-Farm Investment in India

M.B. Dastagiri and Linu Mathew Philip

One of the important rural-urban linkages takes place through private investment by rural households in non-farm sector and through private investment in farm sector by urban households. On an average, urban households invested Rs. 96 in farm business, while rural households contributed Rs. 90 to capital formation in non-farm business during 1991-92. Investments in farm business by urban households comprised 5.56 percent of their total investment whereas rural households invested 7.8 percent of their total capital expenditure in non-farm business (Figure 9). Among rural households, contribution to capital expenditure in non-farm business was Rs. 99 in the case of cultivators and Rs. 72 in the case of non-cultivators. At all India level, rural households contributed about 10 percent higher resources for capital formation in non-farm sector compared to the contribution of urban households to agricultural sector. Per household investment in farm business by urban households was much higher compared to that of non-cultivating rural households.

Figure 9: Contribution of rural and urban households towards agricultural and non-agricultural capital formation, 1991-92



Constraints in Agricultural Development in Western Uttar Pradesh

G. Singh, Harbir Singh and Rasheed Sulaiman V.

The study shows that irrigated agriculture in general and the dominant cropping systems of Indo-Gangetic plains in particular that is, rice-wheat and sugarcane-wheat, are facing several economic and ecological problems like deceleration in agricultural growth, falling water table and declining size of land holdings. This study attempts to test the hypotheses of stagnation in agricultural economy of district Muzaffarnagar (U.P.), where wheat–sugarcane is the dominant cropping system, and seeks to explore the development alternatives. The district level data shows that during the nineties, there was no significant improvement in the yields of wheat, rice and sugarcane. At the same time, the NPK ratio has shifted away (8.8: 1.1: 0.1) from the optimum combination (4: 2: 1). This is a cause of concern considering its effects on soil fertility in the long run.

Micro level evidences reveal that a majority of the farmers are small and marginal and have scattered holdings. The average holding size is 1.42 hectares. Sugarcane occupies the highest area, followed by wheat and fodder crops. Though the study area falls in the Green Revolution belt, food security seems to be a major concern for marginal and small farm holders. This is

distinctly clear from the inverse relationship between farm size and area under foodgrains (wheat and rice). Irregular canal water and electricity supply, crop damage by wild animals, lack of technical know-how and non-availability of suitable crop varieties are the major constraints in raising farm incomes. Intensity of milch cattle is the highest on marginal farms. On an average, about two milch cattle are maintained by the farm households and about two-third farm households are engaged in milk selling activity. About 75 percent of milk is sold to the local milkmen in the absence of milk cooperatives in the study area. The livestock contributes about 23 percent to total farm income. Among all categories of households, marginal farmers derive 37 percent of their income from livestock enterprise. Non-availability of good quality milch animals, poor veterinary infrastructure, inadequate marketing facilities and lack of artificial insemination and natural services are major constraints in increasing livestock production. Strengthening of extension and training and support services, and diversification in favour of dairying are the suggested interventions.

Changing Pattern of Variability in Rice and Wheat Production

B. C. Roy, P. K. Joshi and Laxmi Tewari

The study was undertaken to analyze the changing pattern of variability in production and yield of rice and wheat in the Indo-Gangetic plains of India. Using district level time series data, the study measured variability and changes therein; decomposed output variability; and identified the determinants of variability. Secular decline in variability was observed both in rice and wheat production since introduction of Green Revolution technologies. The decline is much larger in wheat than in rice. What is worrying is that the reverse trends are now being observed in some parts of the region especially in North Bihar, South Bihar and Vindhyan regions. Variance decomposition analysis indicates that changes in area variability were the most important determinants of changes in production variability during early green revolution period but subsequently yield variability and area-yield interaction became a major source of production variability. The area variability increased only in rice, that too in Trans-Gangetic plains of Punjab and Haryana. It was found that expansion of HYVs has resulted in reduction in yield variability. Expansion of irrigation schemes too reduced both area and yield instability.

PROGRESS UNDER NATP

At present the Centre is running five projects funded by NATP under different modes viz., Organization and Management Reforms mode, Mission mode and Production System Research mode. The emphasis under Organization and Management Reforms mode is on institutionalization of priority setting, monitoring and evaluation. Besides the Centre is encouraging agricultural economics research in a network mode. Attempts have also been made to develop a repository of information in social sciences. A number of SAUs and ICAR institutes have been identified for collaborative research on a continuos basis and in a network mode. Six workshops were conducted at different places in order to strengthen the capacity building of SAUs and ICAR institutes in agricultural economics research and education. During the period, the Centre has published proceedings of a workshop 'ICAR- Industry Interface in Agricultural Research' and three PME Notes under NATP. Besides, the Centre has constituted PME/NATP Cell and NATP Site Committee.

During the year the Centre has focused on delineation, mapping and characterization of agro-ecosystems and production systems, resource allocation across the identified agro-ecosystems and production systems and assessment of priorities for livestock sector. The summary findings of some projects have already been reported under Technology Policy theme. Progress of some other important NATP activities is given below:

Website on Networking of Social Scientists

Rajni Jain

The website on networking of social scientists has been developed to strengthen agricultural economics research in a cost-effective manner through rapid exchange of information, resource sharing and avoiding duplication in research. This website is expected to facilitate more collaborative and multidisciplinary research. The website incorporates information on organisation, personnel, research projects, publications, course curriculum, thesis research from 64 organisations from the ICAR and State Agricultural Universities. The website can be browsed at the address http://agrieconet.nic.in

Dr. M.S. Swaminathan launching website of NCAP

Early Impact of NATP Processes

Raka Saxena, S.K. Pandey, Suresh Pal and P.K. Joshi

A quick assessment was made to examine the early impact of new and innovative processes under NATP, and ascertain how these are facilitating the emergence of a transparent, stakeholder responsive, and efficient research system. A major step in this direction is targeting research for poverty alleviation. The research resources under NATP in the production system mode are allocated to different agro-ecosystems viz., Arid, Coastal, Hill & Mountain, Irrigated and Rainfed. Table 8 shows that incremental research resources should be targeted to rainfed and irrigated areas.

Table 8: Research resource allocation by agro-ecoregions

Agro-ecoregions	Budget allocation (percent of total)	
	Existing NATP	Normative
Arid	10	6
Coastal	10	9
Hill & mountain	6	3
Irrigated	22	31
Rainfed	52	51

The participatory research priority assessment and peer review is given emphasis under NATP. The research proposals submitted to production system research (PSR) mode for funding, are scrutinized by SAP (consisting of eminent scientists from multiple disciplines). The suggestions are made on all aspects of the projects. These include technical content, budget, target domain, HRD needs, duration, manpower requirement, etc. To improve the research efficiency and make larger impact of research investments in the target domains, research focus should be in a system mode by including relevant disciplines and the institutions in the target domains. It also includes socio-economic component to assess the feasibility of the technology and examine the socio-economic constraints for larger impact of research investments. The research quality has improved and research lag has reduced due to financial flexibility and decentralization.

A quick survey undertaken to assess how administrative and financial powers have been delegated in different organizations shows that most of the ICAR institutes have delegated powers to the Principal Investigators and Co-Principal Investigators, their implementation in the State Agricultural Universities is still lacking (Figure 10).

Figure 10: Delegation of administrative and financial powers in ICAR and SAUs