Assessment of Research Priorities for Livestock Sector in India

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEXURES

FOREWORD

In its continuing efforts to provide inputs to research planning, NCAP has taken up livestock sector for a detailed analysis. Livestock sector is a sunrise sector of Indian economy, and is expected to emerge as an engine of growth of the agricultural sector in the decades to come. Growing human population, sustained economic growth, changing lifestyles of the upwardly mobile middle class, and increasing urban population are driving rapid growth in demand for food of animal origin. However at the same time, productivity growth of livestock remains constricted owing to a number of factors, such as huge livestock population, inadequate feed and fodder supply, and poor adoption of technologies. Thus, it is increasingly felt that future growth has to be demand- and technology-driven. The importance of livestock sector goes beyond its food production function. It supplies draught power, organic manure and domestic fuel. Livestock is the lifeline of millions of landless, marginal and small landholders who own a sizeable proportion of livestock wealth. Since resources available are becoming scarcer to meet the challenges, it is critical to objectively evaluate livestock research priorities. This study provides an objective assessment of macro level research priorities for the livestock sector, in terms of regions, species and commodities. It covers all states and union territories, eight livestock species and their products and services. The study also gives a comprehensive picture of growth and contribution of livestock sector in the Indian economy and also the evolution of livestock research in India.

The main findings of the study have been vetted by peers and also in meetings with experts, policymakers and officials of the Government. It is hoped that the study will guide research resource allocation in the livestock sector for its accelerated growth.

Mruthyunjaya
Director

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EXECUTIVE SUMMARY

Livestock is emerging as a driving force in the growth of agricultural sector of India. Several factors underline this development. Contribution of livestock to agricultural gross domestic product (AgGDP) has been rising; it increased from 14 percent in 1980-81 to 23 percent in 1997-98. While the share of agricultural sector in gross domestic product (GDP) declined from about 35 percent to 26 percent during this period. Demand for livestock products is income-elastic, and sustained growth in per capita income, rising urban population, and changing food habits and lifestyles are fuelling further growth in it.

The importance of livestock goes beyond its food production function. It provides draught power and organic manure for agriculture and fuel for domestic purposes. Livestock is an important source of income and employment for millions of landless and small landholders particularly in the less favored environments. In general, livestock wealth is more equitably distributed than land. Growth in livestock sector is thus reckoned to reduce interpersonal and interregional inequities, and alleviate poverty.

On the other hand, there are apprehensions that the current growth momentum may not sustain long. A number of supply side factors such as burgeoning livestock population and its very low productivity, feed and fodder scarcity, deterioration in common grazing lands, inappropriate disease management, lack of appropriate technologies, poor infrastructure, sociocultural and legal rigidities and unfavorable external market conditions may act as impediments on the growth process. The past growth in many livestock outputs has largely been population-driven. Therefore, technology will be a key factor in sustaining the growth momentum. While the research resources are becoming scarcer to meet the emerging challenges. These forces thus underscore the need for a critical and objective evaluation of livestock research priorities at the national and regional level. This study provides an objective assessment of macro level research priorities for the livestock sector.

The study generates indices of research priorities for the livestock sector in terms of regions, species and commodities keeping in view the national developmental goals. It covers all states and union territories[1], eight livestock species, and their products and services. Required information

[1] The study reports results for 25 states only.

was collected from numerous published and unpublished sources. Multi-criteria scoring model, which is flexible to accommodate multiple research objectives, was used to assess research priorities. Research objectives have been derived from the developmental goals mentioned in different five-year plans. The objectives are: growth (efficiency), equity, sustainability and trade participation. The analysis begins by assessing priorities with the objective of improving efficiency, and then modifies these successively by superimposing other developmental goals to examine the tradeoffs between goals/objectives in the process of resource allocation. All goals have been considered equally important and assigned equal weights in the analysis.

Livestock research receives about 19 percent of the agricultural research resources. This however has witnessed considerable variation over time. In 1970s, share of livestock research was 27 percent, higher than the relative contribution of livestock sector to AgGDP. The emphasis during this period was to strengthen research infrastructure. The share of livestock research fell drastically (14 %) in 1980s, but increased in 1990s. Yet, it is low compared to its contribution to AgGDP. At present, India has well-developed research infrastructure with species/commodity orientation.

An assessment of priorities with the sole objective of accelerating growth suggests highest priority to Uttar Pradesh, followed by Maharashra, Punjab, Madhya Pradesh, West Bengal, Andhra Pradesh, Rajasthan, Bihar, Gujarat and Haryana. These states contribute considerably to the national value of livestock production. The considerations for equity, sustainability and export promotion cause tradeoffs in regional resource allocation. In the multi-criteria framework Haryana, Punjab, Jammu & Kahsmir, West Bengal and Kerala lose heavily over the growth-promoting criterion. While northeastern states, Orissa, Bihar, Goa, Maharashtra and Andhra Pradesh improve their stakes in incremental resources. Figure 1 depicts regional allocation of livestock research resources.

Most of the states that lose are in a fairly advanced stage of economic development with low incidence of poverty and undernourished population. While those gain are either backward or in the developing stage. For instance, in Punjab -the most agriculturally developed state, about 10 percent of the population is below poverty line, and less than 20 percent is undernourished. Corresponding figures for one of the least developed states Bihar are 54 and 29 percent respectively. Unfortunately, state level information on investment in livestock research is not available to examine the congruence between the suggested and existing allocations.

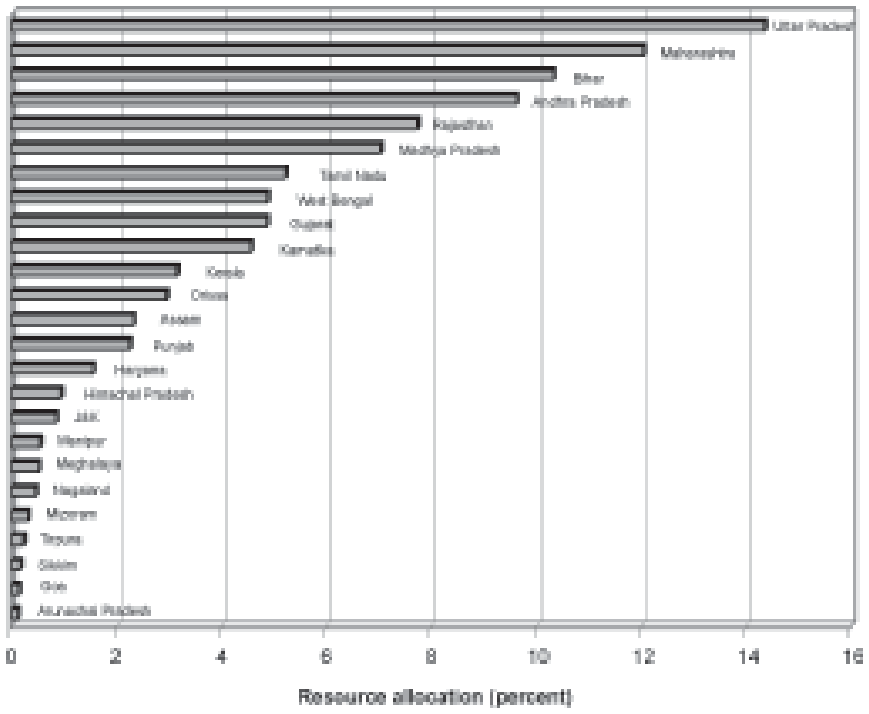

Fig. 1: Regional priorities in livestock research

India is rich in animal diversity. Some important livestock species in the country are cattle, buffalo, goat, sheep, pig, poultry, camel and equines. At the national level, buffalo research appears as the main priority demanding a share of 40 percent in the livestock research resources. Cattle research comes next with 38 percent. Though, buffalo population is considerably less than the cattle, higher priority to buffalo is due to its higher milk yield with better fat content that commands a premium price in the market. About 10 percent of the livestock research resources need to be allocated to poultry, and 7.5 percent to goat (Figure 2). Shares of other species are in the range of 1-2 percent. Is this pattern of allocation in line with the existing pattern of allocation of livestock research resources in ICAR? A comparison of the two indicates substantial under-investment in buffalo and cattle research (Figure 3) that needs to be corrected in future allocations. Cattle and buffalo have long generation interval compared to small ruminants and monogastrics, and thus the research on these animals is long-term and capital-intensive. The rates of return on bovine research may be lower compared to monogastrics and small ruminants. Besides, the wide distribution of cattle and buffalo cutting across agroecological and

socioeconomic boundaries also favours higher resources for research on these species.

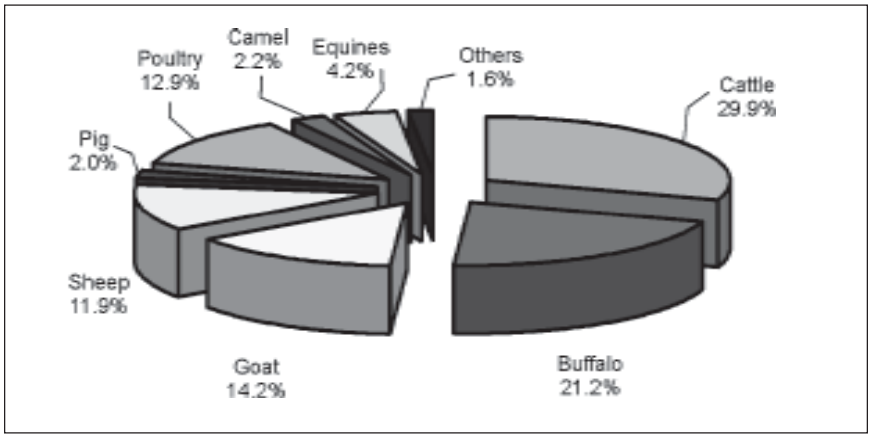

Fig. 2: Existing allocation of research resources by species

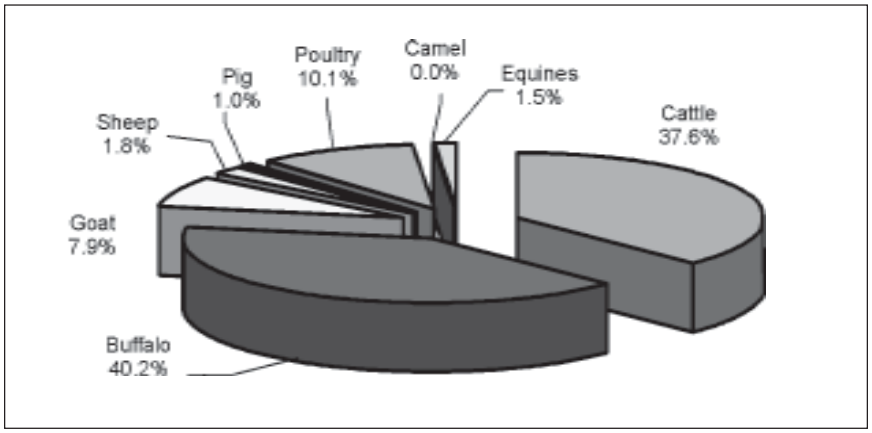

Fig. 3: Suggested allocation of research resources by species

Most of the livestock species in India are maintained for dual or multiple purposes. Thus, given the resources for research on a species we have identified commodity research agenda for each species. In case of buffalo, focus of research should be on milk production (93 %). So is in case of cattle research (73 %). But, draught power research should also be an important consideration in cattle research (17%). Research on goats should focus on meat production (57%), and followed by milk production (33%).

Investment in sheep research should be mainly for meat production (76%). Wool production shares only 11.4 percent. Poultry research resources should be allocated to meat and eggs in the ratio of 2:1. Meat production should be the main concern of pig research. For camel and equine, research should focus on improving their draughtability. The relative emphasis however varies greatly across states depending on the utility of products and services provided by a species. The details are provided in this study.

Most of the species are widely distributed cutting across agroclimatic boundaries, but in varying density depending on their relative utility in provision of food and other products and services. The species priorities therefore vary across regions. Cattle research should target mainly the western region (Madhya Pradesh, Rajasthan and Maharashtra). Uttar Pradesh, Bihar, West Bengal, Orissa, Tamilnadu, Assam and Gujarat are other target domains for cattle research. Most of these states are rainfed and have sizeable number of cattle for both milk and draught supplies. Buffalo research activities should concentrate in Uttar Pradesh in the north, Madhya Pradesh, Rajasthan and Maharashtra in the west, Andhra Pradesh in the south and Bihar in the east. Goat research should largely target eastern states mainly Bihar and West Bengal that together put a claim for about 43 percent of national goat research resources. Target domain for sheep research is southern region. Andhra Pradesh and Maharashtra are the main candidates for incremental poultry research resources. Pig research should focus northeastern states, and Bihar and Uttar Pradesh. Target domain for camel research is Rajasthan. Uttar Pradesh ranks highest in priority for equine research. The regional distribution of species-wise research resources thus indicates the necessity of taking into consideration the regional distribution of different livestock species and their relative utilities in the process of allocation of research resources.

Assumption of equal weights to different research objectives is liable to criticism, as the developmental goals themselves never receive equal emphasis. Thus, sensitivity of the regional and species priorities was examined by attaching varying importance to different developmental goals (research objectives). With higher importance to growth (efficiency) there are no significant changes in priority ranking of states. However, the states of Haryana, Punjab, Jammu & Kashmir, Madhya Pradesh and West Bengal are benefited considerably in terms of higher share in national research resources. While the shares of Andhra Pradesh, Maharashtra, Bihar and most of the northeastern states are reduced significantly. Other states either gain or lose at the margin. Higher emphasis on both efficiency and equity also results in a similar pattern of distribution. Species priorities too are not much sensitive to changes in weights to developmental goals of research.

In conclusion, the study suggests target domains, species and commodities for livestock research. It makes tradeoffs between efficiency and other developmental goals explicit. There are obvious limitations of data particularly the research investment data at state level. Reallocation and redeployment of resources has no operational significance in absence of such information. The research administrators and managers may use their wisdom and experience to moderate the results. Further, the study has not attempted the research agenda in terms of disciplinary research, which concerns the demand-side aspects of animal science research and requires considerable amount of information at the micro level. Next phase of this study targets this.

I INTRODUCTION

Background

Livestock is an important segment of agricultural sector in India. In 1998-99, it contributed about 23 percent to the agricultural gross domestic product (AgGDP). Livestock makes multi-faceted contributions to socioeconomic development. Its role in food and nutritional security has been well recognized since times immemorial. But, in the mixed crop-livestock systems its importance goes beyond direct food production function. It supplies draught power and organic manure to crop sector, and hides, skins, bones, blood and fiber to the industries. Livestock in India is kept mainly by the small landholders and the landless that constitute bulk of the rural population. Thus, by being as an important means of income and employment for these households livestock helps alleviate poverty and smoothen income distribution. In addition, livestock asset can be easily converted into cash, and thus acts as a cushion against shocks of crop failure particularly in the less favored environments.

Livestock makes substantial contributions towards conservation of environment. By utilizing huge amounts of crop residues and byproducts as feed and fodder it contributes positively to the environment. In addition, utilization of crop residues and byproducts by the animals makes substantial land available for food production, which otherwise would have been needed for fodder production. Direct contributions of livestock in terms of supplies of draught power and dung (organic manure and domestic fuel) save non-renewable environmental polluting energy sources (chemical fertilizers, diesel, petrol, etc.). Thus, in view of such interactions between crop and livestock it is increasingly realized that livestock production would be more sustainable and growth-promoting in the mixed cropping systems as in India (Sere and Steinfeld 1996, Hann et al. 1997).

Emerging economic forces are creating both challenges and opportunities for the livestock sector. Perpetual growth in human population and sustained growth in per capita incomes are driving rapid growth in demand for animal food. There are estimates that by 2020 demand for milk, meat and eggs under different income and population growth scenarios would be in the range of 126-183, 6.3-12.1 and 9.5-18.5 million tons respectively (Kumar 1998). In the recent past, livestock outputs (milk, meat and egg) have grown at an annual rate of about 5 percent. If these trends were to continue future demand for various livestock products could be met from

domestic supplies. Serious doubts have however been expressed regarding sustainability of these trends because these have by and large been population-driven (Birthal 2000).

Productivity of Indian livestock is low. For instance, cattle milk yield is about half of the world average of 2072 kg/animal/annum, and just 12-15 percent of the yield in the USA, Canada and Israel. Productivity of species other than dairy and poultry has been stagnating at an extremely low level. These figures suggest considerable scope for improving livestock productivity in India.

There is realization that WTO regime will exert more pressure on livestock production to be efficient to meet the challenges of global competition. At the current level of productivity, export competitiveness of Indian livestock products is ambiguous. There is an anxiety that cheap imports of livestock products would threaten the Indian livestock industry (Sharma and Sharma 2000). Further, there is increasing concern about the interaction between economic competitiveness and a number of social factors such as poverty, unemployment, food and nutritional security, and sustainability. Livestock is a means of livelihood for millions of landless, marginal and small landholders who are often poor and this group would be the most vulnerable to the forces of economic competition. To meet the challenges of globalization the key lies in continuous generation and dissemination of technologies that improve production efficiency of livestock. Well-targeted livestock research and development programs can meet the multiple challenges.

Evidences indicate very high payoffs to investment in livestock research (Kumar et al. 1977, Gaddi and Kunal 1996, Kumar and Birthal 2001), which imply that there is enormous scope to invest in livestock research. Unfortunately, the resources for agricultural research are limited and are becoming scarce. India spends only about 0.5 percent of AgGDP on agricultural research. This is below the average of the developed countries (2.5 %) as well as the developing countries (0.7 %). There is little optimism that, despite high rates of returns, investment in agriculture and livestock research will increase substantially at least in the immediate future. Nonetheless, there is scope to improve the growth of livestock sector by augmenting the productivity of different livestock species through better targeting of R&D efforts. That task necessitates objective articulation of priorities for research.

In recent years, priority setting has established itself an important tool in the management of limited research resources. It aims to improve strategic planning and accomplish efficient allocation of scarce research resources

to improve research efficiency within the framework of national policy goals (Contant 2001). Priority setting helps (i) review existing resource allocations, (ii) update research agenda, (iii) make resource allocations more transparent and unambiguous, and (iv) strengthen credibility of the institution in soliciting support for research.

Historically, the process of agricultural research resource allocation in India has largely been based on informed scientific opinion concerning problems and opportunities. This involves a lot of subjectivity. The new problems and challenges are calling for more objective and transparent mechanisms to allocate research resources. The new challenges include expanding research system, chronic scarcity of resources for research and increasing severity and complexity of research needs. These necessitate a systematic assessment of priorities for livestock research.

In a seminal work, Jha, et al. (1995) generated quantitative estimates for allocation of agricultural research resources across regions and commodities. The study also provided useful insights for setting priorities for the livestock sector. The thrust of the study was on livestock products. In practice however species is the focus of research. This study is an attempt to build on the earlier attempts to assess research priorities for livestock sector for regions, species and commodities.

Objectives

The specific objectives of this study are:

- To assess livestock research priorities to meet the economic and social objectives.
- To examine the tradeoffs between economic and social objectives in allocation of livestock research resources.

Organization of the Study

The study is organized into seven chapters. The next chapter provides an overview of the importance of livestock, and evolution of livestock research, and its impact. Chapter III describes analytical framework employed to assess research priorities. Regional priorities in livestock research are presented in Chapter IV. Species and commodity priorities at national and regional level are discussed in Chapter V. Chapter VI tests the robustness of the results by examining the sensitivity of priorities to changes in policy emphasis. The last chapter presents major conclusions and policy implications.

II GROWTH OF LIVESTOCK SECTOR: A PERSPECTIVE ON THE CONTRIBUTION OF RESEARCH

Predominance of mixed crop livestock systems is one of the most important characteristics of Indian agrarian economy, wherein crops and livestock contribute towards the growth and sustainability of each other through input-output linkages. For the last few decades, both the crop and livestock sectors have been growing satisfactorily, the latter however has grown faster. Since 1970, livestock sector output has been growing at an annual rate of about 3.6 percent compared to pre-1970 growth rate of 1.3 percent. The higher growth in later period was on account of market forces and technological change, and facilitated by increased availability of feeds and fodder, investment in animal health, and development of marketing network for livestock products. This chapter assesses the growth and contribution of livestock sector in the light of expanding livestock research system in the country.

Growth and Contribution of Livestock Sector

Livestock population

India possesses one of the largest livestock wealth in the world. In 1992, it had 205 million cattle, 84 million buffaloes, 115 million goats, 51 million sheep, 13 million pigs, 2 million equines and 306 million poultry birds (Table 1). And, the population of almost all the species has been growing. The observed pattern of growth however indicates a shift towards economically more efficient species such as buffalo, pig, goat and poultry. Further, in case of bovines the incremental growth is less in population of males compared to females mainly due to substitution of animal draught power by mechanical power. This shows that livestock sector of India is both expanding and adapting to emerging socioeconomic, environmental and technological forces.

Contribution to AgGDP

Table 2 presents trends in contribution of livestock sector to gross domestic product (GDP) and agricultural gross domestic product (AgGDP). Agricultural sector (including crops, livestock, fisheries, forestry) contributed about 40 percent to the GDP in 1960s. This gradually decreased to 36

percent in 1970s, 31 percent in 1980s and 26 percent in 1990s. The contribution of livestock to AgGDP however increased from 18 percent in 1980s to 22 percent in 1990s. Since 1980, livestock GDP has been growing at an annual rate of about 6 percent, which is higher than the growth in AgGDP and GDP. This indicates that livestock sector is likely to emerge as an engine of growth of the agricultural sector.

Table 1: Structure and growth of livestock population in India

Species	Population (millions) 1992	Annual compound growth (%) 1982-1992
Cattle		
Male	101.6	0.40
Female	103.0	1.26
Total	204.6	0.82
Buffalo		
Male	17.3	0.66
Female	66.9	2.25
Total	84.2	1.90
Goat	115.3	1.93
Sheep	50.8	0.54
Pig	12.8	3.43
Horse	0.82	-0.96
Mule	0.20	5.88
Donkey	0.97	0.04
Poultry	306.2	4.52

Source: Livestock Census, 1982 and 1992, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India.

Table 2: Contribution and growth of livestock sector, 1980-81 prices

	1971-80	1981-90	1991-97
Per capita GDP (Rs/annum)	1724	2177	2874
Share of AgGDP in GDP (%)	35.97	31.17	26.16
Share of livestock GDP in AgGDP (%)	na	17.60	21.38
Annual growth in GDP (%)	3.66	5.61	6.83
Annual growth in AgGDP (%)	2.43	3.29	3.99
Annual growth in livestock GDP (%)	-	7.31	4.92

Note: Per capita GDP and shares are average for the decade under consideration.

Inputs to crop sector

The contribution of livestock sector presented in Table 2 is underestimated because it does not reckon intermediate contributions of livestock. For example, draught power, which is an important intermediate contribution, is not reckoned while estimating livestock GDP. The contribution of animals to total available power to crop sector is presented in Table 3. In 1991, draught animals contributed about 23 percent to the total power availability to agriculture (Table 3). This has drastically come down from 61 percent in 1971. Though, its share has been declining, absolute contribution has remained almost unchanged at about 30000 megawatt. This indicates that livestock still continues to be an important source of draught power in Indian agriculture.

Table 3: Share of livestock in total energy available to Indian agriculture

Source of power	1971		1981		1991	
	Power (mw)	% in total	Power (mw)	% in total	Power (mw)	% in total
Human	8385	18.7	10951	12.4	12906	10.1
Draught animals	30426	60.5	31556	35.8	29840	23.3
Machines	10487	20.8	45699	51.8	85226	66.6

Source: Adapted from the Report of the Steering Group on National Livestock Policy Perspective, 1996, Department of Animal Husbandry, Ministry of Agriculture, Govt. of India.

Table 4 presents contribution of livestock in terms of dung manure. About half of the dung produced in India is used as manure and the rest is used as domestic fuel. In 1970-71, dung manure contributed 43 percent to the total value of manure and fertilizers used in agriculture. This declined drastically to 23 percent in 1980-81 and to 13 percent during 1990s. The rapid decline was mainly on account of higher growth in fertilizer use.

Table 4: Share of dung manure in total value of plant nutrients consumed, 1980-81 prices

	1970-71	1980-81	1990-91	1997-98
Value of dung (Rs million)	11730	13520	15230	18110
Dung used as manure (%)	49.5	51.2	47.3	48.2
Value of manure and fertilizers used in agriculture (Rs million)	13440	29840	60170	67510
Share of manure in value of manure and fertilizers (%)	43.2	22.7	12.1	12.9

Source: National Accounts Statistics, various issues, Central Statistical Organization, Ministry of Programme Planning and Implementation, Govt. of India.

Employment and poverty

Livestock sector has considerable potential to contribute towards alleviation of problems of unemployment and poverty. About three-fourth of country's population lives in rural areas, and more than one-fourth of it is below poverty line. Poverty is largely prevalent among the landless, marginal and small farm households. In 1991-92, these households comprised 84 percent of the total rural households and shared one-third of the cultivated land (Table 5). Average size of land holding is small, and has been declining continuously. On the contrary, distribution of livestock is more egalitarian. Bulk of the livestock population is owned by marginal and small landholders; 71 percent of cattle, 63 percent of buffaloes, 66 percent of small ruminants, 70 percent of pigs and 74 percent of poultry. This implies that marginal and small landholders derive a considerable proportion of their income from livestock. Evidences indicate that increase in income from livestock in rural areas reduces income inequality (Adams Jr. and He 1995, Birthal and Singh 1995).

Table 5: Size and distribution of land and livestock holdings, 1991-92

Size class of land holding	Percent of house-holds	Size of land holding (ha)	Size of livestock holding (numbers/household)				
			Cattle	Buffalo	Sheep and goat	Pig	Poultry
Landless	21.8	0.0	0.15 (2.4)	0.08 (2.8)	0.20 (5.1)	0.01 (7.7)	0.49 (6.4)
< 1.0 ha	48.3	0.35 (15.5)	1.35 (47.1)	0.44 (36.1)	0.81 (46.2)	0.04 (49.5)	1.90 (54.8)
1.0-2.0 ha	14.2	1.41 (18.6)	2.34 (24.0)	0.90 (26.7)	1.15 (19.3)	0.06 (20.4)	2.23 (19.0)
2.0-4.0 ha	9.7	2.69 (24.2)	2.38 (16.6)	1.23 (20.2)	1.31 (15.0)	0.06 (13.9)	2.47 (14.4)
4.0-10.0 ha	4.9	5.78 (26.4)	2.34 (8.3)	1.72 (14.4)	1.66 (9.7)	0.06 (7.1)	1.41 (4.2)
>10.0 ha	1.1	15.44 (15.3)	2.09 (1.6)	2.66 (4.8)	3.75 (4.7)	0.04 (1.0)	1.74 (1.1)
All	100.0	1.08 (100)	1.39 (100)	0.59 (100)	0.85 (100)	0.04 (100)	1.65 (100)

Figures in parentheses are shares in total population of a species.

Source: National Sample Survey Organization, Ministry of Programme Planning and Implementation, Govt. of India.

Though, the contribution of livestock to AgGDP has been rising continuously, its contribution to rural employment is not so encouraging. In terms of principal activity status livestock employs about 5 percent of the rural work force (Table 6). Its share however has declined to 3 percent in 1990s. Low share in rural employment is because livestock rearing in India is taken up as a subsidiary to crop production.

Table 6: Contribution of livestock to rural employment (million workers employed)

Source	1972-73	1977-78	1982-83	1987-88	1993-94
Agriculture	158.3	172.8	171.1	174.8	195.8
	(81.0)	(78.5)	(80.0)	(76.6)	(76.9)
Livestock	9.0	10.6	10.4	10.7	7.9
	(4.6)	(4.8)	(4.9)	(4.7)	(3.1)
Total	195.4	220.1	241.2	252.2	254.6

Figures in parentheses are percent to total number of workers by usual principal activity status.

Source: Basic Animal Husbandry Statistics, 1999, Department of Animal Husbandry, Ministry of Agriculture, Govt. of India.

Food and nutritional security

Diet of an average Indian is cereal based. Lack of diversification towards nutrient-rich foods is considered to be the main cause of malnutrition and under-nutrition. In 1993-94, 30 percent of the population was undernourished. The problem is more severe to the population having less access to land for crop and livestock production (Kumar and Joshi 1999).

Animal food is rich in protein and other vital nutrients, and has potential to contribute towards alleviation of nutrition related health impairments. Consumption of animal products is low (Table 7). In 1993-94, per capita annual milk consumption was 51 kg, and meat 1.7 kg. Consumption of eggs was less than one egg/capita/month. These figures are much below than in many developing and developed countries (Delgado et al. 1999).

Table 7: Consumption of livestock products in India and their share in food expenditure

Product	Consumption (kg/capita/annum)	Expenditure share (percent)	
	1993-94	1972-73	1993-94
Milk	50.96	10.01	15.03
Meat, egg and fish		3.43	5.22
Goat meat	0.74	-	-
Mutton	0.15	-	-
Beef	0.27	-	-
Buffalo meat	0.27	-	-
Chicken	0.27	-	-
Total meat	1.71	-	-
Eggs (No.)	10.46	-	-
Total	-	13.44	20.25

Source: Kumar (2000)

The demand for livestock products however is increasing as is indicated by the rising share of animal products in the food budget. In 1972-73, livestock products accounted for 14 percent of the food expenditure, and this gradually increased to 20 percent in 1993-94. (Table 7). This is expected to increase at a faster rate with sustained economic growth and attendant increases in per capita income (Kumar 1998, Delgado et al. 1999).

Trade

India has marginal presence in the world trade of livestock products. During triennium ending 1998, average export value of livestock products was Rs 13500 million. This comprised only 1 percent of the total export earnings and 6.2 percent of the agricultural export earnings (Table 8). Meat and meat products are the main livestock products of exports accounting for over 90 percent to the total export earnings from the livestock sector. The export performance of livestock sector has improved during 1990s.

During TE 1998, India imported livestock products worth Rs 1877 million, comprising 0.1 percent of total imports and 1.5 percent of agricultural imports. Hides and skins comprised main items of imports. The dependence on imports however has declined. For instance, almost the entire milk demand now is met from domestic supplies. The trend in imports of hides and skins also has weakened.

Table 8: Trade in livestock products (value in million rupees and share in percent)

	1980-82	1989-91	1996-98
Exports			
Value of exports of livestock products	761	1830	13505
Share of livestock exports in total exports	1.02	0.53	1.05
Share of livestock exports in agricultural exports	3.50	3.27	6.22
Imports			
Value of imports of livestock products	1824	910	1877
Share of livestock imports in total imports	1.41	0.10	0.10
Share of livestock imports in agricultural imports	14.27	4.79	1.52

Source: FAO Trade Year Book, various issues.

Growth in livestock sector is important on many counts. First, by augmenting income and employment opportunities it would benefit millions of small landholders and the landless labourers who possess a sizeable proportion of livestock wealth. Thus, the growth in livestock sector is considered to alleviate poverty and lessen interpersonal income disparities. Second, increase in outputs of livestock would lead to increased consumption of livestock products, contributing towards lessening of nutrition related problems. Third, the past experience has shown that the increase in livestock production has facilitated import substitution of many livestock products. Acceleration in growth would further reduce import dependence and facilitate export. Above all, being an integral part of agricultural economy, livestock would improve sustainability of the crop sector through provision of organic manure and draught power as inputs.

India has huge livestock population, but with poor productivity. Cattle milk yield is half of the world average. The same holds good for beef and pork. Goat and sheep meat yields are less by 20-25 percent. The milk as well meat productivity of Indian livestock is less compared to average of the Asian countries. The poor productivity is on account of scarcity of feeds and fodder, and poor animal health. Recent estimates indicate deficiency in dry fodder by 31 percent, green fodder by 23 percent, and concentrates by 47 percent. Further, a number of deadly diseases continue to occur frequently (Birthal 2000). Efforts to replace nondescript low yielding indigenous stock with high yielding crossbred stock too did not yield desired results. Only about 7.5 percent of cattle, 5 percent sheep, 14.5 percent pig and 32.9 percent poultry belonged to crossbred category in 1992. These figures indicate that technology would be a key factor in sustaining the growth of livestock sector in the decades to come.

Evolution of Livestock Research[2]

Historical background

Livestock research in India is more than a century old. During the latter half of the nineteenth century, cattle plague (rinderpest) was all pervasive and caused considerable loss to the livestock economy. The Government of India appointed the Indian Cattle Plague Commission (ICPC) in 1868 to report on the prevalence of rinderpest and other animal diseases, and to suggest measures for their prevention and control. The recommendation of this and another Commission functioning during 1882-83 culminated in establishment of Imperial Bacteriological Laboratory- the fore-runner of the Indian Veterinary Research Institute in 1889 at Pune, Maharashtra. In 1893, the Laboratory was shifted to Mukteshwar in Kumaon Hills, Uttranchal, and subsequently in 1913 to its current location at Izatnagar, Uttar Pradesh. Another landmark decision on the recommendation of the ICPC was the establishment of a veterinary college in Mumbai in 1883, and subsequently at Lahore (now in Pakistan), Kolkatta, Chennai and Patna.

For over the next four decades or so, research efforts at Imperial Bacteriological Laboratory remained concentrated to develop preventive and curative methods to overcome the rinderpest menace. In 1927, these efforts resulted into development of a highly efficacious vaccine for immunization of cattle and buffalo against rinderpest. The research portfolio of the Laboratory diversified gradually to include other animal diseases. Among other successes, a major breakthrough was development of a vaccine against Ranikhet disease of poultry in 1940.

The next important milestone towards strengthening livestock research was the establishment of Imperial Institute for Animal Husbandry and Dairying -the fore-runner of the Indian Dairy Research Institute at Banglore, Karnataka in 1923. The mandate of the Institute was to impart training in animal husbandry and dairying for development of the dairy sector. In 1936, the Institute was renamed as Imperial Dairy Institute. After Independence, the Institute was relocated at Karnal, Haryana in 1955.

The establishment of the Indian (then Imperial) Council of Agricultural Research in 1929 on the recommendations of the Royal Commission on Agriculture (1928) was the most important landmark in the history of Indian agricultural research. The Council was mandated to promote, guide and coordinate agricultural and veterinary research in the country. The mandate

[2] The historical background of livestock research system is drawn heavily from the National Commission on Agriculture (1976) and ICAR (1989, 2000).

precluded the Council to maintain its own institutions, but to determine the research needs at regional and all India level and to support ad hoc projects at research institutes and state departments.

The Royal Commission on Agriculture (RCA) had also made an in-depth analysis of the problems plaguing the growth and development of animal husbandry. The cattle were the main source of draught power for agriculture and milk for human consumption, but there was considerable imbalance between the two with a tilt in favor of the former. With due consideration to this duality, the RCA recognized the need to improve milk yield of bovines and recommended improving milk production traits of cattle as well as buffalo through genetic enhancement of indigenous breeds by selection. The RCA also emphasized on the importance of improved feeding and management practices. With these recommendations, the focus of research of the Imperial Dairy Institute shifted towards improving milk yield. It may be noted that the RCA did not favor crossbreeding research because of fear of non-acclimatization of crossbreeds to tropical climate of the country.

By late 1930s, artificial insemination (AI) technology has arrived in India. The isolated research efforts to try AI in cattle were started in 1939, but comprehensive studies on AI were initiated in 1942 at IVRI. It was found an effective tool to bring about genetic improvement in cattle and was recommended for extensive field application.

At the same time, the livestock research portfolio diversified to include other animal species, that is sheep and poultry. The focus was on improving their genetic potential through crossbreeding. Efforts to improve indigenous sheep through crossbreeding with exotic fine wool breeds had earlier been made in the beginning of the nineteenth century. These however could not sustain in the absence of proper organizations. Systematic efforts started in the late 1930s when ICAR initiated a number of pilot experiments for breeding superior sheep. Findings of these experiments evolved into a sheep breeding policy that emphasized improvement in indigenous breeds by selection in plains, and through crossbreeding in temperate Himalayan region and sheep tracts of Deccan plateau.

The beginning of poultry research in India can be credited to few Christian missionary organizations. Towards the end of nineteenth century, these organizations imported superior exotic breeds to improve the indigenous breeds through crossing. The organized efforts started in 1938 with the establishment of a Poultry Research Division in the Indian Veterinary Research Institute for undertaking research on poultry breeding, nutrition and health.

The animal science research in the pre-Independence era (pre-1947) was allocated fairly a good amount of funds (Jha 2001). In 1930s and 1940s, share of animal science research was about 30 percent of the total research funds of the ICAR. This laid a strong foundation for animal science research in the country. A review of research achievements by the ICAR towards the end of 1940s also revealed availability of a number of livestock technologies related to breeding, nutrition, dairy enterprise, sheep and wool, and poultry for field application. The research on many important species such as buffalo, goat, camel and pig was still lacking adequate attention.

Growth in infrastructure

No major initiatives were taken to strengthen agricultural research in the early post-Independence years. However, a number of committees were constituted to suggest ways and means to strengthen the agricultural research system. On their recommendation, the first agricultural university was established at Pantnagar in 1960 with the help of ICAR and support and grants from United States Agency for International Development. This was followed quickly in other states. At present, there are 28 agricultural universities, and most of these have faculty of animal sciences. There are two universities specifically meant for animal science research and education.

In 1950s, establishment of All India Coordinated Research Project (AICRP) on maize by ICAR was a major step towards strengthening agricultural research. During 1960s, 17 AICRPs were established but emphasis was on crop husbandry. However, during this period establishment of Central Sheep and Wool Research Institute at Avikanagar (Rajasthan) was a major step towards strengthening species specific research. Feed and fodder scarcity had repeatedly been pointed out to be the main limiting factor to improving animal productivity in the pre-Independence period. The problem persisted in the post-Independence years also. This led to the establishment of Indian Grassland and Fodder Research Institute in 1962 at Jhansi, Uttar Pradesh with the objective of identifying fodder problems in different regions and research and management solutions thereof.

Until 1966, agricultural research institutes were under the administrative and financial control of central Ministry of Food and Agriculture. ICAR was reorganized in 1966 and its mandate was revised to include ‘undertake research’ in the field of agriculture and animal husbandry. Thus, the research institutes under the Ministry of Food and Agriculture were brought under administrative, technical and financial control of ICAR.

Animal science research scenario changed drastically after mid-1960s. Milk production in the country had been stagnating around 20 million tons during the first two decades of post-Independence. By the end of 1960s, the Green Revolution technologies had resulted into tremendous success. Encouraged with this, a similar strategy was planned to increase milk production with emphasis on crossbreeding of indigenous cattle with exotic breeds and with simultaneous development of marketing facilities in the cooperative sector. The strategy culminated into initiation of the program 'Operation Flood' in early 1970s.

Animal science research infrastructure expanded considerably in 1970s and 1980s (Table 9). In early 1970s, a number of AICRPs were established. In late 1970s and 1980s, many species specific research institutes/centres were established by ICAR. At present, there are separate research institutes/ centres for cattle, buffalo, sheep, goat, poultry, mithun, yak, camel and equine. Besides, there are institutes to conduct research on animal genetic resources, physiology and nutrition. In all, there are 2 national institutes, 5 central institutes, 5 national research centres, 1 national bureau, 2 project directorates and 17 AICRPs dealing with animal science research in the country. The larger institutes have also their regional centres and sub-stations in different agroclimatic zones.

Table 9: Number of animal science research institutes/centres ICAR.

	Upto 1970	Upto 1980	Upto 1990	Upto 1998
National Institutes	2	2	2	2
Central Institutes	1	3	4	5
National Research Centres	0	0	4	5
National Bureaus	0	0	1	1
Project Directorates	0	0	2	2
AICRPs	18*	8	10	17

* Established during 1970/71.

Several other public sector agencies such as general universities, Council of Scientific and Industrial Research, Department of Biotechnology, Department of Science and Technology, Indian Council of Medical Research, Indian Institute of Immunology, etc. and private institutions like Bhartiya Agro-Industries Foundation also participate in livestock research directly or indirectly.

Financial resources

The institutions under ICAR and the AICRPs supported by it conduct bulk of the basic and applied research on livestock. ICAR also asserts considerable influence in deciding the research portfolio of state research systems through its funding and advisory roles. Therefore, an overview of ICAR's resource allocation pattern is of considerable interest. The story however remains incomplete in absence of a profile of allocation patterns of state research systems. Nonetheless, the pattern of resource allocation in ICAR acts as a trendsetter for state agricultural research systems. The financial outlay of ICAR during different five-year plans (FYP) is given in Table 10.

Table 10: Share of ICAR in total outlay for agriculture during different Five Year Plans

Plan	Outlay for agriculture and allied sectors (Rs million)	ICAR outlay (Rs million)	Share of ICAR in agricultural outlay (percent)
IV Plan (1969-74)	23200 (48525)	914 (1912)	3.94
V Plan (1974-78)	48650 (63481)	1535 (2003)	3.16
VI Plan (1980-85)	56950 (56950)	3399 (3399)	5.97
VII Plan (1985-90)	105240 (76581)	4250 (3093)	4.04
VIII Plan (1990-95)	224670 (84224)	13000 (4873)	5.79
IX Plan (1997-2002)*	375460 (85064)	33770 (7651)	8.99

Figures in parentheses are outlays at 1980-81 prices

*includes outlay of World Bank funded National Agricultural Technology Project.

Source: ICAR Five Year Plans

ICAR's outlay over the last three decades has increased considerably. In nominal terms, it increased from Rs 914 million in the IV FYP to Rs 33770 million in the IX FYP. However in real terms, ICAR outlay stagnated at around Rs 2000 million during the IV and V FYPs. It increased to Rs 3399 millions in the VI FYP and declined marginally in the VII FYP. It witnessed a quantum jump in the subsequent plans. In the on-going IX plan ICAR

outlay is 7651 million rupees. As percent of total outlay for agricultural sector ICAR's share has increased to 9 percent in the IX FYP from about 4 percent in the IV FYP.

Research claims about 70 percent of the ICAR resources (Table 11). Overtime, significant changes have occurred in pattern of ICAR resource allocation towards research. Its share in total ICAR outlay was around 60 percent in the IV and V FYPs. This increased to above 70 percent in the subsequent FYPs.

Table 11: Share of livestock research in total research outlay of ICAR (Rs million)

Plan	At current prices			At 1980-81 prices		
	Total outlay of ICAR	Research outlay of ICAR	Outlay for livestock research (ICAR)	Total outlay of ICAR	Research outlay of ICAR	Outlay for livestock research (ICAR)
IV Plan (1969-74)	914	579	152 (26.25)	1812	1111	318
V Plan (1974-78)	1535	932	259 (27.79)	2002	1215	338
VI Plan (1980-85)	3399	2497	356 (14.26)	3399	2497	356
VII Plan (1985-90)	4250	3172	446 (14.06)	3094	2309	325
VIII Plan (1990-95)	13000	9682	1738 (17.95)	4874	3630	652
IX Plan (1997-2002)	33770	24556	4710 (19.18)	7650	5562	1067

Figures in parentheses are percent of total research outlay

IX plan outlay also includes outlay on account of National Agricultural Technology Project.

Source: ICAR Five Year Plans

In relative terms, ICAR gives adequate emphasis on livestock research (Table 11). In the IV and V FYPs, ICAR allocated about 27 percent of its total research outlay to livestock research, which was about 1.5 times higher than the share of livestock in total value of agricultural output. It however fell drastically to 14 percent in the subsequent two FYPs. In the VII FYP, it increased to 18 percent and further to 19 percent in the IX FYP.

Table 11 also presents changes in ICAR allocations in real terms. In 1970s, there was marginal growth in ICAR's resources. During 1980s, there was a modest rise. It was only during 1990s that a sizeable expansion took place. Animal science research claimed considerable incremental resources during 1970s. During 1980s, it was almost stagnant. During 1990s, investment in livestock research stepped up considerably. This is an indication of intention of raising the level of resources for animal science research.

Impact of research

Livestock research has generated a number of technologies in the areas of animal breeding, nutrition, health and management. Adoption of these technologies has remained limited and sporadic. The value of output of livestock sector has however increased substantially since 1970. This could be attributed to the technological change as well as to improvements in efficiency of livestock production. The joint impact of technological change and technical efficiency can be captured by the growth in Total Factor Productivity (TFP) (Table 12). TFP index suggests that prior to 1970, growth in livestock output was input-driven. However since 1970, TFP index grew faster and accounted for about 37 percent of the output growth.

Table 12: Compound growth rates in output, input and total factor productivity index in livestock sector

	1950-51 to 1970-71	1970-71 to 1995-96	1950-51 to 1995-96
Output index	1.28	3.59	2.59
Input index	1.32	2.25	1.79
TFP index	-0.04	1.34	0.80

Source: Birthal et al. (1999)

TFP measures the joint impacts; it does not indicate explicit contribution of either technological change or technical efficiency. Considering the level and rate of adoption of crossbreeding technology[3], contribution of the former to output growth appears to be limited. Between 1982 and 1992, share of crossbred cattle in total cattle population increased from 4.7 percent to 7.4 percent, improved poultry from 21.7 percent to 32.9 percent, crossbred pig from 9.5 percent to 14.5 percent, and sheep 3.3 percent to 5.0 percent.

[3] Information on adoption level of technologies related to nutrition and health is not available.

Further, an examination of Table 13 suggests that TFP growth occurred mainly due to growth in productivity of cattle, buffalo and poultry[4]. Since early 1970s, milk output of cattle and buffalo has been growing at an annual rate of 5.2 and 4.4 percent respectively. The growth in milk yield was 3.2 percent in case of cattle, and 1.9 percent in case of buffalo.

Table 13: Annual compound growth (percent) in output and yield of different livestock species, 1972-1997

Commodity	1972-1997		1997	
	Output growth	Yield growth	Output (million tons)	Yield (kg/ animal/ annum)
Milk				
Cow	5.15	3.16	35.51	1085
Buffalo	4.41	1.94	35.33	1341
Meat				
Cattle	7.08	0.15	1.38	103
Buffalo	4.11	-0.01	1.40	137
Sheep	2.22	0.07	0.22	12
Goat	2.36	0.52	0.46	10
Pig	6.26	0.12	0.55	35
Poultry	5.65		0.53	-
Total meat	4.22		4.52	-
Eggs	5.58		28162*	190**

*Eggs in million numbers, and ** eggs in numbers/birds/annum

Source: Birthal (2000).

Meat output too grew at a rate above 4 percent a year. The rate of growth however varied across species; highest growth occurred in beef and veal, followed by pork, poultry meat, buffalo meat, goat meat and mutton. The growth has occurred due to growth in number of animals slaughtered. The yield growth was negligible in case of most of the species.

These trends indicate that technology has made limited contribution to the growth of livestock sector. Nonetheless, there exists considerable scope to raise productivity of livestock through focussed technological interventions.

[4] Growth in poultry productivity could not be estimated due to lack of information. However, rising share of improved poultry in total poultry population as well as egg production is pointer to this. About two-third of the total egg production in the country comes from improved layers that comprise about half of the total layers. The average egg yield of an improved layer is 232 eggs/annum, which is more than double the yield of an indigenous layer.

III METHODOLOGY

Livestock species are multi-functional in nature i.e. they generate multiple/ joint outputs. Each of the output has economic value, though its relative utility may vary over space and time. Multi-functionality is more pronounced in the subsistence oriented mixed crop livestock production systems as in India, where livestock is maintained not only to produce food but also to provide draught power and organic manure to agriculture. Mixed crop livestock production systems are dynamic, and possibilities of tradeoffs between crops and livestock as well as within the functions of livestock are quite high. For example, with the emergence of energy intensive cropping systems in India the emphasis of cattle breeding research is gradually shifting from dual-purpose breeds to milch breeds. The multi-functionality thus makes priority assessment exercise a complex process. Besides, livestock research is long-term, capital-intensive, uncertain and slow in producing benefits, which bring in elements of uncertainty in priority setting.

Over the last three decades, a number of priority setting methods have been developed. These differ widely in scope of analysis, degree of sophistication and applicability (Shumway 1973, Norton and Davis 1981, Anderson and Parton 1983, Parton et al. 1984, Norton and Pardey 1987, Fox 1987, Norton et al. 1992, Janssen 1994). The priority setting methods can be classified based on the objectives of priority setting (single or multiple objectives), measurement concepts (direct and indirect or qualitative and quantitative) and the time dimension (ex ante or ex post). Broadly, there are six methods of priority setting that have been widely applied in empirical research: (1) Scoring or weighted criteria model (Mahlstede 1971, Evension et al. 1979, Kirschke 1993, Moscardi 1987, CGIAR 1992, Franzel et al. 1995, Jha et al. 1995), (2) Economic surplus/benefit-cost models (Norton et al. 1987, Norton and Douglas 1989, Davis et al. 1987, Echeverria 1990, Mills 1997, Janssen and Waithaka 1998**)**, (3) Mathematical programming models (Russel 1977, De Wit 1988, Scobie and Jacobsen 1992), (4) Simulation models (Pinstrup-Anderson and Franklin 1977, Lu et al.1978), (5) Econometric methods, and (6) Analytical hierarchy process (Ramanujam and Satty 1981, Satty and Vargas 1994). Some investigators have also used a combination of scoring and economic surplus approaches in setting the research priorities (Kelly and Ryan 1995, Thornton et al. 2000). Each of these approaches has its advantages and limitations[5].

[5] For a detailed discussion on methods of priority setting and their advantages and limitations see, Norton (1987), Alston et al. (1995) and Jha et al. (1995).

Choice of Method: Multi-criteria Scoring Model

The choice of method depends on the objectives of research, level of priority assessment (national, institution or program), and its simplicity in application, data requirement and capacity to allow participation of stakeholders in priority assessment exercise.

Multi-criteria scoring model has been used in this exercise. This is often known as congruence method. This incorporates multiple objectives for making choices. The objectives included here are growth, equity, sustainability and participation in trade. These are complex and often argumentative in nature. Scoring model incorporates multiple objectives by modifying the simple and traditional measure of research evaluation - changes in value of production- to consider the concerns of equity, sustainability and trade. Given the relative importance of objectives, scoring model makes tradeoffs between objectives explicit. The approach is relatively transparent and allows extensive and active participation of stakeholders (CGIAR 1992). Finally, the approach is simple to apply and is not data intensive (McCalla and Ryan 1992). The model can be used to rank a long list of commodities, research alternatives and target domains.

Main limitation of this approach is its simplicity and flexibility. Often, there is a tendency to add in more and more criteria without checking for their internal logic and consistency. This gives rise to duplicating criteria. This happens as most of the criteria are directly or indirectly related with the efficiency criterion- the main objective of research (Alston et al. 1995).

Further, scoring model allocates research resources across regions or commodities in proportion to their contribution to the gross value of production. This implicitly assumes equal opportunities for research across commodities and regions. That means the value of new research generated is proportional to the value of output from the sector. The analysis is based on present values and presumes that relative contributions are constant. Thus, the results provide only the starting point for research priority setting. It also does not account for research spillovers and domestic and trade policies (Falconi 1999).

The results of scoring model however can be improved by combining them with other methods such as economic surplus and mathematical programming that consider probability of research success, adoption rate, research spillover effects and distribution of research benefits (Kelly and Ryan 1995, Thornton et al. 2000).

Basic steps in scoring model

Scoring model involves seven broad steps to arrive at a comprehensive assessment of the priorities. These are:

- Identification of research objectives and their indicators (extensity parameters)
- Assigning appropriate weights to research objectives
- Selection of research priority dimensions
- Construction of initial baseline (IBL)
- Modification of IBL
- Construction of final baseline (FBL)
- Assessment of research priorities

Identification of Research Objectives and Extensity Parameters

The first step is to identify research objectives that are consistent with the national or regional development goals. The goals often include growth acceleration, improvement in equity, sustainability of natural resources/ production systems and participation in international trade. The 'growth acceleration goal' suggests that research should enhance productivity in a cost-effective manner. Equity implies distribution of efficiency gains across regions, socioeconomic groups, farming systems and so forth. Sustainability is concerned with conservation and/or judicious use of natural resources. Participation in trade indicates that research needs to focus on commodities having potential for export promotion or import substitution.

These developmental goals have been the guiding principles for agricultural research system in defining the research objectives. The prominent research objectives corresponding to the national goals outlined above are: enhancing agricultural productivity, augmenting income of people living below poverty line and improving their nutritional status, increasing carrying capacity of land and accelerating export growth. The goals and objectives are shown in Table 14.

Table 14: Development goals, research objectives and extensity parameters for livestock research system

Goal	Research objective	Indicators/extensity parameters
Growth acceleration	Enhance productivity	Value of livestock production
Equity	Augment income of people below poverty line	Number of poor people
	Improve nutritional status	Undernourished population
Sustainability of livestock systems	Improve livestock carrying capacity of land	Land available for livestock (CPR)*
Participation in trade	Export promotion	Value of livestock exports

* CPR stands for common property resources.

The next step is to identify the indicators/extensity parameters reflecting the magnitude of the problems to be addressed by the research system. Accordingly, the research activities should target the regions where the magnitude of the problem is large. The extensity parameters reflecting the objectives of livestock research and used in this study are discussed below. The sources of these indicators are given in Annexure I.

Value of livestock production (VOP)

Research enhances production potential of livestock, and benefits of the research thus can be increased manifold by large-scale adoption of its outputs. That means value of research is proportionate to the value of production, and the latter therefore reflects the research objective of increasing productivity or production efficiency.

In this analysis, livestock species has been considered as the focus of research and thus we have included the triennium ending 1997-98 average value of the outputs of each species[6]. The species are cattle, buffalo, goat, sheep, pig, poultry, camel and equine. Other species such as mithun and yak could not be included in the analysis due to lack of information on their outputs and services. These species are important in certain agroecological regions, but are minor to the livestock sector.

[6] Value of the following outputs is available to estimate the value of contribution of a species: total milk (cattle+buffalo+goat), cattle meat, buffalo meat, goat meat, sheep meat, pig meat, poultry meat, eggs, cattle hide, buffalo hide, goat skin, sheep skin, sheep wool, goat hair, pig bristles, camel hair, total dung (cattle+buffalo). The value of some byproducts such as bones, blood etc. is also available but not by species. However, these comprise only a small fraction of total VOP of livestock and hence have not been considered to compute the contribution of individual species. In several cases, we had to apportion the values by species. For instance, total value of milk has been apportioned by species (cattle, buffalo and goat) taking into consideration the milk output and price of milk of different species. Similarly the total value of dung has also been disaggregated at the species level considering their populations and dung evacuation rates. Further, the values of draught services of different species were not available, so we had to estimate these values. The value of draught power contribution of livestock has been estimated using information on draught power utilisation from the Cost of Cultivation Studies. The Cost of Cultivation reports provide per ha value of animal draught power for major crops by states. A single estimate of value of animal draught power per ha was arrived at for major crops in different states. Thus the total value of animal draught power was arrived at by multiplying the per ha value with gross cropped area in a state. This was further disaggregated at species level in proportion of horsepower available from different draught species. For states not included in the Cost of Cultivation Studies, estimates of neighbouring states were used. The draught services of equine have been valued based on information on use of equines from the published and unpublished literature and their horse power (Birthal et al. 1999).

Number of poor and undernourished

The number of persons below poverty line and the number of undernourished persons are indicators of economic inequality and nutritional insecurity respectively. As distribution of livestock wealth is more equitably distributed compared to land, it is expected that strengthening livestock research in the regions having comparatively more number of the poor and undernourished[7] would help reduce interpersonal and interregional economic disparities and reduce incidence of malnutrition and under-nutrition.

Common property resources (CPRs)

Common property resources contribute significantly to the feed and fodder consumption and thus to the sustainability of livestock production (World Bank 1996). The contribution is higher in case of landless, marginal and small landholders who own bulk of the livestock wealth. The common grazing resources in India have however been deteriorating in quantity and quality. Therefore, conservation and management of CPRs is necessary to protect the interests of these households and to sustain the growth of livestock sector. The focus of livestock research thus should be relatively higher in the regions having more grazing and wastelands. In this analysis, we have considered area under barren and unculturable lands, permanent pastures and grazing lands, culturable wasteland, fallow lands and lands under miscellaneous tree crops to constitute the CPRs for the livestock sector. Triennium ending 1997-98 average of the CPR area has been used in the analysis.

Value of livestock exports

Livestock sector export constitutes around one percent of total export earnings. There is enormous scope to improve the contribution of livestock products in export. In the past, India has been a net importer of various livestock products particularly powdered milk. The dependence however has declined drastically in recent years on account of tremendous growth in milk production. Besides, India has the advantage of producing milk as well as other livestock products at lower costs because of availability of cheap labour. Further, trade liberalization is opening up opportunities for improving export performance of livestock products. Participation in trade therefore has been considered as one of the criteria for priority setting. The

[7] The information on the populations of poor and undernourished pertains to 1993-94. Incidence of poverty and under-nutrition seemingly appear to be significantly and positively correlated. The correlation coefficient between the two however is 0.32 and therefore we have included both of these as indicators of equity.

indicator for this is the mean value of livestock products exported[8] during triennium ending 1997-98.

These parameters quantify the magnitude of the problem to be addressed by the research system, and imply that if the research system has to be efficient in achieving specific objective(s) - enhancing productivity, alleviating poverty, improving nutritional security, improving sustainability or promoting exports, it should target regions having comparatively high value of the corresponding indicator.

Assigning Appropriate Weights to Research Objectives

The next step is to assign weights to the indicators of research objectives. This is needed to construct a composite index for priority ranking of regions, species and commodities. Each indicator is assigned an appropriate weight depending on the relative importance of the concerned research objective. There is no a priori information available on weights to different national developmental objectives. Thus, equal weights (0.25) have been assigned to each of the objective. In case of more than one indicator of an objective, each one has been given equal weight without altering the overall weighting structure. For example, the number of poor, and undernourished population, the two indicators of the equity, share half of the weight (0.125) assigned to the equity objective (0.25). The methodology however permits use of varying weights to reflect the relative importance of different objectives, and a sensitivity analysis has been done to assess the impact of differing weighting schemes.

Selection of Research Priority Dimensions

Livestock research prioritization has multiple dimensions. Priority indices can be developed for regions, livestock species and commodities or a combination of these. In this exercise, we have considered regional, species and commodity dimensions.

Regional dimensions ensure that benefits of research are equitably distributed across regions. Since R & D efforts are generally targeted to

[8] Export data at the state level is not available. The contribution of different states to national export earnings from an individual commodity has been assumed to be in proportion of the share of a state in the total value of the commodity under consideration at the national level. The shares of different commodities so obtained were added to compute the total contribution of a state in national export earnings. The apportioning of export earnings to different states by commodity takes into consideration the composition of export basket and attaches higher value to a state contributing more to the production of the commodity exported. This avoids double counting of VOP as is often presumed. The correlation coefficient between the VOP and percent of VOP exported by different states is – 0.19.

homogenous agroclimatic regions, priority assessment must consider regional dimensions. In India, agroclimatic regions cut across administrative boundaries and the necessary information for priority assessment is not available for the livestock sector at this level. Therefore, the state has been taken as the unit for analysis. All 25 states[9] and 7 union territories have been included in the analysis.

The regional research priorities can be translated into species priorities. Species included in this exercise are cattle, buffalo, goat, sheep, poultry, pig, camel and equine. As the animal in the mixed farming systems performs multiple functions, the priority for a species is further decomposed into functional priorities (products and services).

Construction of Initial Baseline (IBL)

Initial baseline (IBL) allocates research resources across regions in proportion of the weighted shares of extensity parameters reflecting different research objectives. This is constructed using state values of extensity parameters and their assumed weights. The procedure for construction of IBL is illustrated below:

Compute shares of states in each extensity parameter (S_{ij})

$$S_{ij} = \left(E_{ij} / \sum_{i=1}^{n} E_{ij}\right) \times 100;\ i = 1, \ldots n\ ;\ j = 1, \ldots, k$$

Where, S_{ij} is the share of i^{th} state in j^{th} extensity parameter, E_{ij} is the value of j^{th} extensity parameter in i^{th} state, n is the number of states and k is the number of extensity parameters.

On computation of the shares, assign weight (W_j) to each extensity parameter. It has already been mentioned that each extensity parameter has equal weight. Then, compute initial baseline (B_i) as:

$$B_i = \left(\sum_{j=1}^{k} W_j S_{ij} \right)$$

Where B_i is the IBL for i^{th} state, W_j and S_{ij} are as above.

[9] After carving out Jharkhand from Bihar, Chhattisgarh from Madhya Pradesh and Uttaranchal from Uttar Pradesh there are 28 states in the country. In this analysis, the new states have been retained with their mother states.

Modification of Initial Baseline

Value of IBL is a cumulative product of weights and shares of extensity parameters of research objectives. Research resource allocation based on IBL may not fully capture the major concerns of growth, equity, sustainability and exports, as this reflects size of the problem, but ignores its intensity. For example, a state might be ranking very high in terms of its share in the absolute number of the poor in the country it may not have the same ranking in terms of intensity of poverty. In research prioritization, intensity of the problem is also important. The effect of intensity of the problem cannot be captured in an analysis based on extensity parameters alone because of the problem of aggregation of values of intensity parameters across states. The intensity values are thus used to modify the IBL to arrive at the final baseline (FBL), which eventually reflects both the size and intensity of the problems. The intensity indicators are also known as modifiers.

Selection of modifiers

Eight intensity indicators were identified for modification of the initial baseline. These include scope for growth in milk production (yield gaps in indigenous cattle, crossbred cattle and buffalo), per capita state domestic product and combined share of landless, marginal and small farmers in total livestock population (adult cattle equivalent), per capita availability of milk and eggs, and livestock density (adult cattle units/ha of net cropped area plus land available for livestock). The modifiers corresponding to different extensity parameters are shown in Table 15 and discussed below.

Efficiency modifiers

There is considerable variation in milk yield across species and states. Yields of different breeds of cattle (indigenous as well as crossbred) and buffalo obtained under experimental conditions indicate possibilities of increasing milk yield. Due to lack of prior information on potential milk yield of the dominant breeds in different states it is assumed that the local breeds in a state would be replaced by the high yielding breeds of the same species. For this purpose, yield of Red Sindhi for indigenous cattle, of Haryana X Fresian for crossbred cattle and of Nili Ravi for buffalo are taken as yardsticks (Pundhir and Sahai 1997). The difference between the yield of these breeds obtained under experimental conditions and the mean of the realized yield of all breeds of the respective species provide estimates of yield gaps. This however is a crucial assumption as the performance of high yielding breeds varies across states depending on agroecological and socioeconomic conditions. Nonetheless, the gap between realized and potential yield exists even for the dominant breeds in different states.

Table 15: Intensity indicators used to modify IBL

Goal	Research objective	Modifier	Direction of influence on IBL
Growth acceleration	Enhance productivity	Scope for growth in milk production (yield gap in indigenous, crossbred and buffalo)	+
Equity	Augment income of people below poverty line	Per capita State Domestic Product	–
		Percent share of landless, marginal and small farmers in livestock population	+
	Improve nutritional security	Per capita availability of milk and eggs	–
Sustainability of production	Improve carrying capacity of land for livestock	Livestock density	+
Participation in trade	Export promotion	No modifier	

While yield gaps are attributed to differences in input use and management practices, magnitudes of such gaps are important determinants of strategic or applied research. Thus, greater the gap between potential and realized yield higher will be the scope for production growth through applied research. In such regions, the technology is available but its adoption is constrained due to biotic, abiotic and socioeconomic factors. Therefore, in such situations there is a greater need for socioeconomic research focussing on identification of constraints to adoption of improved technologies. In states like Punjab and Haryana where the realized yields are nearer to the potential yields, emphasis has to be on strategic research to break the biological yield barriers.

Equity modifiers

Four modifiers viz. per capita state domestic product, share of landless, marginal and small farmers in livestock population, per capita availability of milk and per capita availability of eggs have been used to address equity concerns. The first two address the economic equity concerns, while the

latter two address the issues related to nutritional equity. To improve income distribution more research resources are needed for the states with lower per capita income and higher concentration of livestock among landless, marginal and small landholders. This would help improve upon the interpersonal and interregional disparities.

Incidence of undernourishment is expected to be lower in states with higher per capita availability of livestock products. Diversification of food basket towards livestock products would help mitigate problem of undernourishment. Therefore, livestock research should target regions having higher incidence of undernourished population. Milk and eggs are the preferred livestock products in the daily diet of the majority population. Thus, per capita availability of these commodities as modifiers takes care of the intensity of nutritional insecurity.

Sustainability modifiers

With an annual growth rate of about 5 percent livestock sector is one of the fastest growing sub-sectors of Indian agriculture. It is however unclear whether this trend will sustain considering the growing number of livestock, declining per capita land availability, slow growth in area under fodder crops and quantitative and qualitative deterioration of common grazing lands. In other words, land and other natural resources available for livestock would come under heavy pressure, threatening the sustainability of natural resources as well as livestock output growth. This calls for emphasis on yield-enhancing research that would help optimize livestock population commensurate with available resources. Livestock density (per unit of net cropped area plus land available for livestock) during the triennium ending 1997-98 is used as a modifier to address the sustainability issues in livestock production.

Selection of weights and signs of modifiers

Having identified modifiers, the next step is to assign weight to modifiers (in concurrence with their relative importance) and determine their signs as to quantify their individual or joint impact on IBL. The magnitude of the weight of the modifier directly influences the relative emphasis of each concern, and this is the explicit weight of the modifier. Besides, the variability in distribution of a modifier across states exerts indirect influence, which is termed as the implicit weight of the modifier. Recognizing the role of implicit weight of the modifier in impacting the IBL we have not introduced varied explicit weights. Evidences indicate that higher weights to the modifiers bring in considerable distortions in relative ranking of regional priorities (CGIAR 1992). Thus, equal weights are assigned to all the modifiers. The methodology however is flexible to accommodate varying weights.

A modifier will have either a positive or negative impact on initial baseline. For instance, higher the per capita domestic product in a state, lower should be the research emphasis there to reduce interregional disparities in income distribution. Therefore, a negative sign is attached to this modifier. On the other hand, inter-household distribution of livestock (share of landless, marginal and small holders) would carry a positive sign as this helps improve interpersonal equity in distribution of benefits of livestock research. Modifiers of nutritional equity (per capita availability of milk and egg) would have negative signs as the states having less per caput availability would need more research resources to enhance the production potential of livestock and thereby the availability of different livestock products. Positive signs are attached to efficiency modifiers (yield gaps) as the states with higher yield gaps need more emphasis to enhance the yield level nearer to the potential yield. The livestock density variable, which addresses sustainability concerns, carries a positive sign.

Thus, signs of the modifiers should be appropriately decided to quantify their impact on IBL, as the selection of signs involves logical judgements. The methodology enables use of different signs to different modifiers to evaluate their impacts and tradeoffs involved in priority setting with multiple objectives.

Impact of modifiers

The impact of selected modifiers on the initial baseline can be quantified as follows.

Modified baseline

$$B'_i = [\, 1 + \{M_{ij} / \text{Max}\,(M_{ij})\} \times W_j \,]\, B_i$$

New priority distribution

$$B''_{ij} = \left(B'_i \Big/ \sum_{i=1}^{n} B'_j \right) \times 100$$

Where, B_i is the IBL for i^{th} state, M_{ij} is the data for j^{th} modifier for i^{th} state, W_j is the weight for j^{th} modifier, B_i' is the modified baseline for regional distribution of research resources, B_{ij}'' is the new priority distribution for i^{th} state based on impact of j^{th} modifier, and i refers to number of states (1 to n) and j refers to number of modifiers (1 to m).

The above procedure applies when modifiers have positive signs. Impact of modifiers with negative signs is obtained by subtracting $\{M_{ij}/\text{Max}\,(M_{ij})\}$ from unity.

Construction of the Final Baseline (FBL)

The impact of individual modifiers is summed up to get the net aggregate impact of all modifiers. The IBL is then modified using the aggregate impact to obtain the FBL, indexed to sum up to 100 across states.

Assessment of Research Priorities

Priority by states

The FBL indexed to 100 across states generates shares of different states in total research resources available at the national level. The states can be ranked based on their shares in order of priority.

Priority by species

For operational purposes, regional priorities need to be translated into species and/or commodity priorities. This is done by adjusting the VOP of each species in each state by an adjustment factor. The adjustment factor for each state is obtained by multiplying the VOP by the ratio of priority distribution based on FBL and priority distribution based on VOP (FBL/VOP). A ratio greater than one implies an upward adjustment in allocation reinforced by concerns of equity, sustainability or trade or all. A ratio less than one implies otherwise. The same procedure can be applied to get functional (commodity) priorities for an individual species.

Priority by species and states

The VOP of each species adjusted to the FBL/VOP ratio is used to generate the relative priorities by species across states and the country as a whole.

IV REGIONAL PRIORITIES IN LIVESTOCK RESEARCH

Livestock sector accounts for nearly one-fourth of the gross value of agricultural output in the country (Table 16). This however varies widely across states. In Punjab, Jammu & Kashmir and Meghalaya, livestock contributes more than one-third to the total value of output of agricultural sector. The states in which the contribution of livestock ranges between one-fourth to one-third to the gross value of agricultural output are Bihar, Haryana, Himachal Pradesh, Rajasthan and Nagaland. In other states, except Goa, Orissa, Arunachal Pradesh, Assam and Tripura, it ranges between 20 to 25 percent.

Estimates by Jha et al. (1995) suggested an allocation of 23 percent of the agricultural research resources for animal science research (last col. of Table 16). Across states, this varied from 16 percent in Assam to 34 percent in Rajasthan, which was largely in conformity with the contribution of livestock to gross value of agricultural output in these states.

Distribution of Extensity Parameters

Distribution of extensity parameters viz. value of production (VOP), poverty (POOR), undernourished population (UNUR), sustainability (CPR) and exports (EXPO) across states is shown in Table 17.

Value of output of livestock (VOP)

VOP is the initial indicator of research resource allocation across regions when the sole objective of research is to improve the efficiency of research. This means distribution of research resources should be in proportion of their shares in total value of output produced in the country. The distribution of VOP shown in Table 17 suggests highest allocation for Uttar Pradesh (14.7%), followed by Maharashtra (8.8%), Punjab (8%), Madhya Pradesh (7.7%), West Bengal (7.5%), Andhra Pradesh (7.4%), Rajasthan (7.3%) and Bihar (7.2%).

Poverty (POOR)

The distribution of poor people across states shows their highest concentration (18.9%) in Uttar Pradesh (Table 17). Bihar ranks second with a share of 15.2 percent, and is followed by Maharashtra (10.3%),

Table 16: Share of livestock sector in gross value of output of agricultural sector, TE 1997-98.

State	Value of output of agricultural sector	Contribution of livestock sector		Suggested share of livestock research in agricultural research resources*
	(Rs billion)	(Rs billion)	(Percent)	(Percent)
North				
Haryana	162.6	47.9	29.5	30.5
Himachal Pradesh	27.2	8.0	29.5	32.0
Jammu & Kashmir	43.5	14.6	33.6	27.0
Punjab	239.4	79.8	33.3	30.1
Uttar Pradesh	599.1	139.5	23.3	23.1
South				
Andhra Pradesh	338.8	71.7	21.2	19.8
Karnataka	251.6	52.5	20.9	18.5
Kerala	162.6	39.4	24.2	14.5
Tamil Nadu	223.8	46.1	20.6	23.1
West				
Goa	5.0	0.9	17.1	17.8
Gujarat	230.4	50.0	21.7	23.1
Madhya Pradesh	299.6	62.3	20.8	25.4
Maharashtra	381.2	89.9	23.6	23.0
Rajasthan	247.8	69.8	28.2	33.6
East				
Bihar	257.8	77.3	30.0	25.6
Orissa	120.6	12.3	10.2	10.7
West Bengal	342.8	75.6	22.1	22.0
North east				
Arunachal Pradesh	4.0	0.8	19.7	-
Assam	92.4	17.1	18.5	12.6
Manipur	7.2	1.7	23.1	-
Meghalaya	7.4	2.6	34.6	-
Mizoram	3.3	0.7	21.0	-
Nagaland	5.3	1.4	26.9	-
Sikkim	2.1	0.5	22.2	-
Tripura	12.3	1.5	12.2	-
India	4083.5	971.1	23.8	22.7

Source: Central Statistical Organization, Ministry of Programme Planning and Implementation, Govt. of India.

* Jha ,et al. (1995)

Madhya Pradesh (8.2%), West Bengal (8.1%) and Tamilnadu (6.6%). This indicates that emphasis on poverty alleviation would favor more allocation of resources to these states.

Table 17 : Percent distribution of value of output (VOP), poverty (POOR), undernourished population (UNUR), sustainability (CPR) and exports (EXPO) by states

State	VOP	POOR	UNUR	CPR	EXPO
North					
Haryana	4.94	1.06	1.44	0.52	0.39
Himachal Pradesh	0.81	0.51	0.47	2.23	0.09
Jammu & Kashmir	1.44	0.59	0.25	1.03	0.37
Punjab	7.99	0.80	1.66	0.18	1.04
Uttar Pradesh	14.72	18.95	12.17	6.89	18.39
South					
Andhra Pradesh	7.37	4.45	9.40	11.77	12.92
Karnataka	4.82	4.92	6.20	5.59	2.61
Kerala	3.96	1.56	5.06	0.36	4.77
Tamil Nadu	4.81	6.58	10.10	4.35	3.65
West					
Goa	0.09	0.06	0.23	0.11	0.29
Gujarat	5.52	4.47	6.05	9.04	1.16
Madhya Pradesh	7.70	8.22	7.59	10.59	1.58
Maharashtra	8.76	10.28	12.14	8.79	21.35
Rajasthan	7.32	4.12	2.87	19.60	1.94
East					
Bihar	7.17	15.23	9.69	6.88	12.14
Orissa	1.60	5.52	3.11	4.11	0.63
West Bengal	7.49	8.14	6.07	0.72	3.66
North east					
Arunachal Pradesh	0.09	0.11	0.16	0.23	0.02
Assam	1.82	2.76	3.09	3.17	0.52
Manipur	0.19	0.19	0.17	0.23	1.36
Meghalaya	0.23	0.21	0.28	1.43	0.15
Mizoram	0.08	0.06	0.07	1.02	0.07
Nagaland	0.15	0.14	0.10	0.62	0.81
Sikkim	0.06	0.05	0.08	0.37	0.16
Tripura	0.16	0.34	0.48	0.05	0.18
India	100.00	100.00	100.00	100.00	100.00

Undernourished population (UNUR)

Uttar Pradesh has highest undernourished population (12.2%) in the country. This is closely followed by Maharashtra (12.1%). Tamilnadu, Bihar, Andhra Pradesh and Madhya Pradesh are other states having sizeable share in undernourished population. Concerns for nutritional security/equity would favor higher resources for these states.

Common property resources (CPR)

The regional distribution of CPRs shown in Table 17 indicates their highest concentration in Rajasthan (19.6%). Andhra Pradesh, Gujarat, Maharashtra, Uttar Pradesh and Bihar too account for substantial share in total CPRs. Thus, these states should receive higher priority if the emphasis of research were to improve sustainability of livestock systems through conservation and management of CPRs.

Exports (EXPO)

This indicator is designed to address the trade-related issues in priority assessment. It is defined as the share of a state in national export earnings from the livestock sector. The export portfolio includes live animals, dairy products, meat, and poultry products. With export as a criterion of allocation of research resources, bulk of the resources are shared by Maharashtra, Uttar Pradesh, Andhra Pradesh and Bihar in that order.

Initial Baseline (IBL)

The distribution of extensity parameters indicate that research emphasis should be on the regions having comparatively higher share in value of output, poor and undernourished population, grazing resources and exports. The shares of the states however vary for each extensity parameter. A composite index of allocation of research resources (weighted sum of extensity parameters) has been generated by assigning equal weight to each specified objective. In case of equity objective, the weight is shared equally between its two indicators, i.e. population of the poor and the undernourished. Thus, a baseline for research resource allocation has been arrived (indexed to sum up to 100 at all India level), and is shown in Table 18.

VOP based allocation assigns high priority to Uttar Pradesh, Maharashtra, Punjab, Madhya Pradesh, West Bengal, Andhra Pradesh, Rajasthan and Bihar. When poverty is superimposed on VOP index, Uttar Pradesh consolidates its position and Bihar gains considerably by moving to second

place in the priority ranking. Maharashtra, Madhya Pradesh and West Bengal gain in priority order, while Punjab, Andhra Pradesh and Rajasthan lose their positions.

Table 18: Initial base line (IBL) with different research objectives

State	VOP	VOP and POOR	VOP, POOR and UNUR	VOP, POOR, UNUR and CPR	All (IBL)	IBL/ VOP
North						
Haryana	4.94	3.64	3.09	2.23	1.77	0.36
Himachal Pradesh	0.81	0.71	0.65	1.18	0.90	1.11
Jammu & Kashmir	1.44	1.16	0.93	0.96	0.81	0.57
Punjab	7.99	5.60	4.61	3.14	2.61	0.33
Uttar Pradesh	14.72	16.13	15.14	12.39	13.89	0.94
South						
Andhra Pradesh	7.37	6.40	7.15	8.69	9.75	1.32
Karnataka	4.82	4.86	5.19	5.32	4.64	0.96
Kerala	3.96	3.16	3.63	2.54	3.10	0.78
Tamil Nadu	4.81	5.40	6.58	5.84	5.29	1.10
West						
Goa	0.09	0.08	0.12	0.11	0.16	1.78
Gujarat	5.52	5.17	5.39	6.61	5.24	0.95
Madhya Pradesh	7.70	7.87	7.80	8.73	6.94	0.90
Maharashtra	8.76	9.26	9.98	9.58	12.52	1.43
Rajasthan	7.32	6.25	5.40	10.14	8.09	1.11
East						
Bihar	7.17	9.86	9.82	8.84	9.66	1.35
Orissa	1.60	2.91	2.96	3.34	2.66	1.66
West Bengal	7.49	7.71	7.30	5.11	4.75	0.63
North east						
Arunachal Pradesh	0.09	0.10	0.11	0.15	0.12	1.32
Assam	1.82	2.13	2.37	2.64	2.11	1.16
Manipur	0.19	0.19	0.18	0.20	0.49	2.62
Meghalaya	0.23	0.23	0.24	0.64	0.51	2.21
Mizoram	0.08	0.07	0.07	0.39	0.39	3.71
Nagaland	0.15	0.15	0.14	0.30	0.43	2.84
Sikkim	0.06	0.06	0.07	0.17	0.16	2.65
Tripura	0.16	0.22	0.29	0.21	0.20	1.23
India	100.00	100.00	100.00	100.00	100.00	

VOP : Value of output, POOR : Poverty, UNUR : Undernourished
CPR : Common property resources, Expo : Export

With addition of nutritional security dimension, Uttar Pradesh continues to rank first but loses marginally. Maharashtra reverts to its original ranking to second place and Bihar slides to the third place. Madhya Pradesh, West Bengal and Andhra Pradesh are other states in the priority order. Punjab loses considerably and is replaced by Tamilnadu. The concerns for equity thus bring in considerable trade off in regional research resource allocation.

The priority ranking of the states is further reshuffled on incorporation of sustainability considerations. Uttar Pradesh maintains its position, but with considerable decline in its share in research resources. Rajasthan emerges second in the priority list, and is followed by Maharashtra, Bihar, Madhya Pradesh, Andhra Pradesh, Gujarat and Tamilnadu. The final iteration with all the extensity parameters (including exports) suggests that nearly three-fourths of the livestock research resources would be claimed by Uttar Pradesh (13.9%), Maharashtra (12.5%), Andhra Pradesh (9.7%), Bihar (9.6%), Rajasthan (8.1%), Madhya Pradesh (6.9%), Tamilnadu (5.3%) and Gujarat (5.2%).

The IBL/VOP ratio indicates that in the IBL based allocation all the states in eastern (except West Bengal) and northeastern regions improve their shares over VOP based allocation. Among the western states, Maharashtra and Rajasthan gain considerably, and Madhya Pradesh and Gujarat lose marginally. In the southern region, Andhra Pradesh and Tamilnadu improve their shares over the VOP based allocation, and the shares of Kerala and Karnataka get reduced at the margin. In the northern regions, Punjab, Haryana, Jammu & Kashmir lose considerably, while Uttar Pradesh loses marginally over their VOP shares. It is only Himachal Pradesh in this region that gains marginally over its VOP based share. The considerations of poverty, nutritional security, sustainability and exports help these states to gain over simple VOP based allocation.

Final Baseline (FBL)

The IBL has been modified to accommodate the intensity of the problem[10] to be addressed by the research system. The impact of the modifiers on the IBL, and modified base line i.e. FBL are shown in Table 19.

The distribution pattern of livestock research resources changes when extensity indicators and their modifiers are considered together. Shares of Haryana, Punjab and Gujarat, Andhra Pradesh, Karnataka, Tamilnadu, Goa, Maharashtra and Rajasthan further decline, while other states consolidate their positions over IBL based allocations. This implies that neglect of intensity dimensions may lead to sub-optimal allocation of research resources.

[10] The values of the intensity indicators are given in Annexure II.

Table 19: Impact of modifiers on IBL

State	VOP	IBL	FBL	FBL/IBL	FBL/VOP
North					
Haryana	4.94	1.77	1.56	0.88	0.32
Himachal Pradesh	0.81	0.90	0.94	1.04	1.16
Jammu & Kashmir	1.44	0.81	0.85	1.05	0.59
Punjab	8.00	2.61	2.25	0.86	0.28
Uttar Pradesh	14.72	13.89	14.36	1.03	0.98
South					
Andhra Pradesh	7.37	9.75	9.63	0.99	1.31
Karnataka	4.82	4.65	4.57	0.98	0.95
Kerala	3.96	3.10	3.16	1.02	0.80
Tamil Nadu	4.81	5.29	5.216	0.99	1.08
West					
Goa	0.09	0.16	0.15	0.98	1.74
Gujarat	5.52	5.24	4.87	0.93	0.88
Madhya Pradesh	7.70	6.94	7.03	1.01	0.91
Maharashtra	8.76	12.53	12.04	0.96	1.37
Rajasthan	7.32	8.09	7.73	0.96	1.06
East					
Bihar	7.17	9.66	10.33	1.07	1.44
Orissa	1.60	2.66	2.95	1.11	1.84
West Bengal	7.49	4.75	4.88	1.03	0.65
North east					
Arunachal Pradesh	0.09	0.12	0.12	1.04	1.38
Assam	1.82	2.11	2.33	1.10	1.28
Manipur	0.19	0.49	0.54	1.10	2.89
Meghalaya	0.23	0.51	0.52	1.00	2.22
Mizoram	0.08	0.31	0.31	1.01	3.74
Nagaland	0.15	0.43	0.47	1.09	3.10
Sikkim	0.06	0.16	0.17	1.04	2.75
Tripura	0.16	0.20	0.23	1.14	1.40

VOP : Value of output, IBL : Initial base line, and FBL : Final base line

These tradeoffs become more pronounced when FBL based allocation scheme is compared with VOP based allocation scheme. The FBL/VOP ratios reflect these. In the absence of tradeoffs among research objectives, FBL/VOP ratio would be closer to unity (say 0.95-1.05). A ratio greater than unity for a state implies that concerns for equity, sustainability and exports favor more allocation of resources for the state. Vice versa, a ratio less than unity implies less research emphasis for the state.

The tradeoffs in research resource allocation are more explicitly shown in Table 20. The FBL/VOP ratio lies between 0.95 and 1.05 for Karnataka and Uttar Pradesh. This implies that their shares in total livestock research resources remain almost same whether resources are allocated based on economic efficiency criterion alone or in combination with equity, sustainability and export criteria.

Table 20: Tradeoff in regional research priorities

Ratio (FBL/VOP)	States
>1.50	Goa, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Orissa
1.25-1.50	Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Maharashtra, Tirpura
1.05-1.25	Himachal Pradesh, Tamilnadu, Rajasthan
0.95-1.05	Karnataka, Uttar Pradesh
0.75-0.95	Gujarat, Kerala, Madhya Pradesh
<0.75	Haryana, Jammu & Kashmir, Punjab, West Bengal

The FBL/VOP ratios for other states indicate that concerns for equity, sustainability and export lead to considerable regional tradeoffs in resource allocation. With these concerns, northeastern and eastern states (except West Bengal) gain over the VOP based allocation. In the southern region, Andhra Pradesh and Tamilnadu consolidate their positions in the FBL based scheme, while Kerala loses. In the western region, Goa, Maharashtra and Rajasthan would receive higher priority in allocation of incremental research resources, while Gujarat and Madhya Pradesh would lose. In the north, Himachal Pradesh would be benefited in the FBL scheme, while Punjab, Haryana and Jammu & Kashmir would lose.

The tradeoffs are quite large for some states (Table 19). The FBL based readjustments in resource allocation indicate considerable reduction in shares of Punjab (72%), Haryana (68%), Jammu & Kashmir (41%), West Bengal (35%) and Kerala (20%); and a moderate reduction in shares of Gujarat (12%) and Madhya Pradesh (9%). The shares of northeastern states however increase considerably. The increase is 28 percent for Assam, 40 percent for Arunachal Pradesh and Tripura, 122 percent for Meghalaya, 174 percent for Sikkim, 188 percent for Manipur, 210 percent for Nagaland and 274 percent for Mizoram. Orissa, Goa, Bihar, Maharashtra and Andhra Pradesh too gain 30 percent or more in the FBL based allocation. It may be noted that most of the states that gain in FBL allocation are backward

or are in the development stage of agriculture, while those lose or maintain their shares in incremental allocations are in the fairly advanced stage of development. Further, in the former group of states contribution of livestock is less compared to the latter.

The results imply that though improving production efficiency is the main emphasis of research, ignoring long-term social and environmental goals in allocation of livestock research resources might aggravate regional disparities in livestock development. Unfortunately, no reliable information is available on the investments made in animal science research at the state level to verify the readjustments suggested by this analysis.

V SPECIES PRIORITIES IN LIVESTOCK RESEARCH

The main objective of the animal science research is to accelerate the growth of livestock sector by improving the productive potential of the species. A species therefore is the unit of research, and allocation of research resources at this level has operational significance. Since an animal species has the characteristic of producing multiple/joint outputs, it is also important to bear in mind the relative utility of different products and services provided by a species while assessing research priorities. In this exercise, we have first assessed species priorities, and then identified priorities for different functions (outputs and services) of the species.

Priorities by Species: All India

The pattern of distribution of research resources across species at the national level is shown in Table 21. The FBL calculations accord highest priority to buffalo research with a share of 40.2 percent in the total research resources. Cattle with a share of 37.6 percent follow closely. Though, buffaloes are considerably less in number than cattle, higher priority to buffalo research is due to their higher milk yield and premium price on milk due to higher fat content. Poultry, goat, sheep, equine, pig and camel are other species in the priority order. Small ruminants and poultry demand 10 and 9.6 percent of the research resources respectively.

Table 21: Allocation of research resources with extensity and intensity parameters by livestock species

Species	Efficiency	Efficiency and equity	Efficiency, equity and sustainability	All objectives (FBL)	FBL/ VOP
Cattle	37.48	38.68	39.04	37.62	1.03
Buffalo	41.23	39.31	39.39	40.20	0.95
Goat	7.53	8.21	7.66	7.86	1.07
Sheep	1.74	1.81	1.82	1.76	1.04
Pig	0.79	0.88	0.98	1.03	1.38
Poultry	9.65	9.59	9.60	10.05	1.05
Camel	0.02	0.02	0.03	0.02	0.91
Equine	1.57	1.51	1.50	1.46	0.92
Total	100.00	100.00	100.00	100.00	

Note: Efficiency =VOP; Equity = POOR and UNUR; Sustainability =CPR; Export =EXPO.

Table 21 also shows how the concerns for equity (economic and nutritional), sustainability and export influence relative species priorities. Within the dairy sector, priority towards cattle promotes equity and sustainability, and towards buffalo efficiency and export. In case of small ruminant sector, priority towards goats promotes equity, and towards sheep improves equity as well as sustainability. Higher priority to poultry and pig research promotes exports. Priority towards equine promotes efficiency, and towards camel improves sustainability. These seem to be in tune with their biological efficiency, the environments in which these are reared and their relative economic importance.

No significant tradeoffs in resource allocation are observed when all objectives are taken together. The FBL/VOP ratio reflects this. A ratio of greater than unity for a species indicates additional emphasis on this at the cost of the species for which FBL/VOP ratio is less than unity. Thus, FBL/VOP ratio suggests added emphasis on pig, goat and poultry (FBL/VOP ratio > 1.05). The FBL/VOP ratio for cattle, buffalo and sheep lies between 0.95 and 1.05, and implies little tradeoffs in resource allocation due to objectives other than efficiency. With considerations of equity and sustainability, the share of poultry remains almost the same as in VOP based allocation. While consideration for export make poultry research gain a little. Camel and equine however lose their share (8-9 percent) in the FBL based scheme.

Since dairy animals rank higher in the prioritization, so are their products/services in commodity prioritization (Annexure III). Milk production research claims 68.3 percent of the livestock research resources, followed by draught power (8.7%), poultry meat (7.2%), small ruminant meat (6.3%), eggs (3.6%) and beef and buffalo meat (2.4%). The research on other products and byproducts (hides, skins, wool and hair) does not demand much of the resources.

Having decided species priority, we determine priorities for products and services that a species provides. Figure 4 shows that 77.8 percent of resources for cattle research should be earmarked for milk production and 16.9 percent for draught power research. Meat and byproducts should receive the rest. In case of buffalo, most of the resources should be spent on milk production research (Figure 5). Draught power, meat and hides share the rest.

Meat production emerges as the priority research area for small ruminant sector. The relative commodity shares however are different for sheep and goat. More than half of the goat research resources need to be allocated for meat and followed by milk (Figure 6). While in case of sheep, three-fourths of the research resources should be earmarked for meat research (Figure 7). Wool research claims only 11.4 percent.

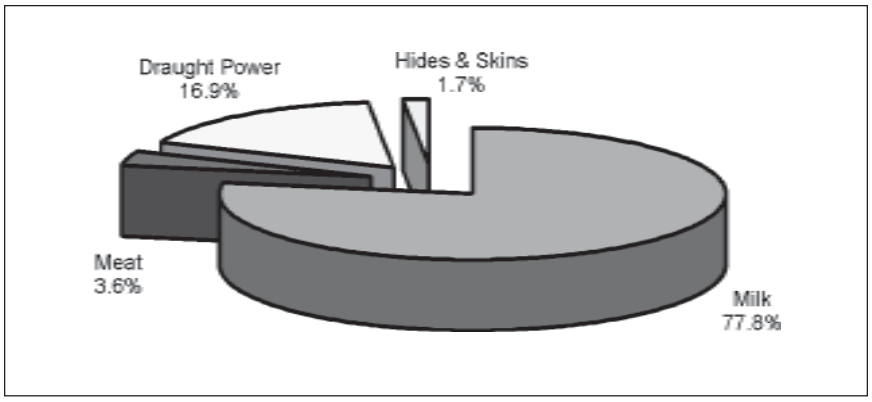

Fig. 4: Priorities in cattle research

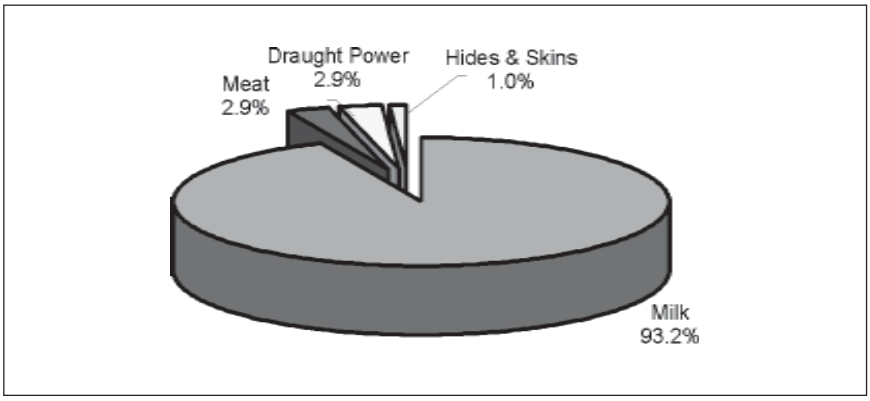

Fig. 5: Priorities in buffalo research

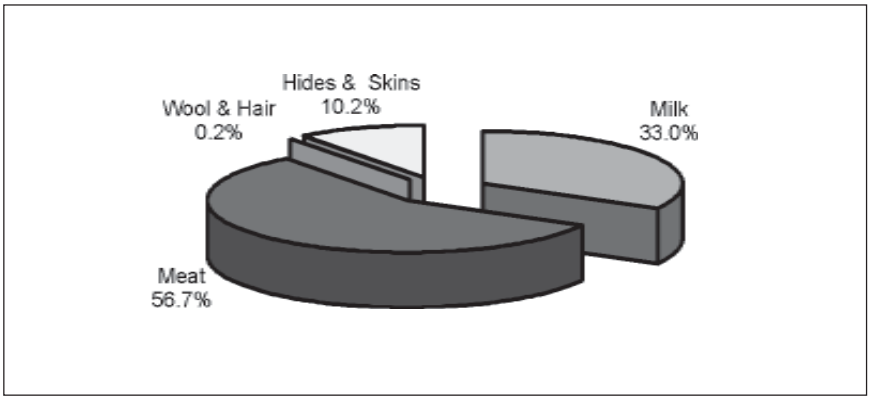

Fig. 6: Priorities in goat research

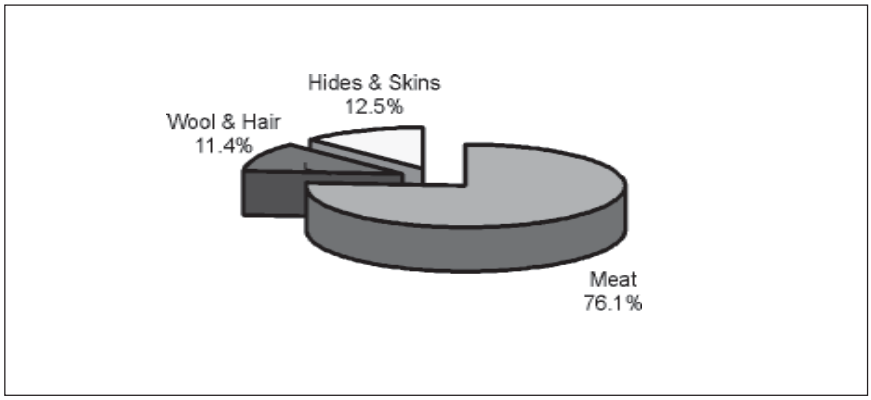

Fig. 7: Priorities in sheep research

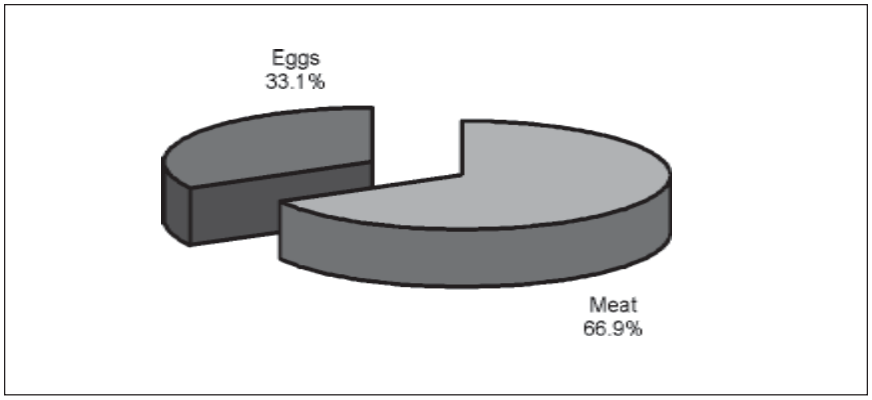

Fig. 8: Priorities in poultry research

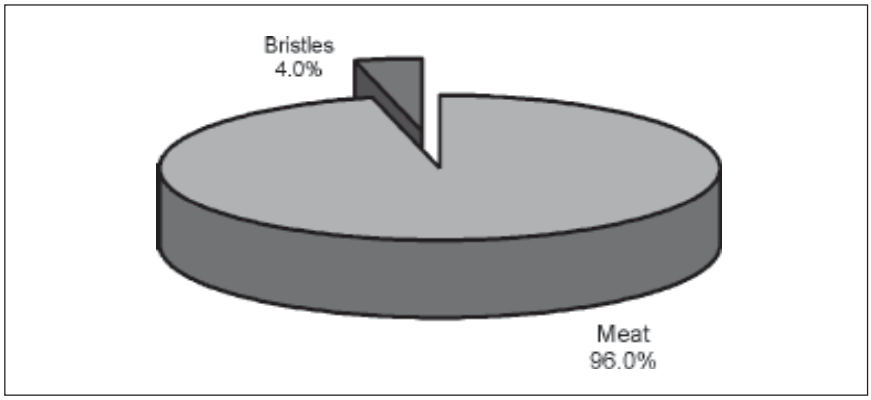

Fig. 9: Priorities in pig research

Poultry research resources should be earmarked for meat and egg research in the ratio of 2:1 (Figure 8). Improving pork production constitutes the main focus of pig research (Figure 9). Camel and equine research should be exclusively for improving their draughtability.

Species Priorities in States

Economic contribution of different species varies across states. So are their shares in research resources. Table 22 shows species priorities in different states. In northern states (except Himachal Pradesh and Jammu & Kashmir), buffalo research emerges as the main priority. In Haryana and Punjab, cattle and poultry are next to buffalo in priority order, while in Uttar Pradesh it is the cattle and goat. Cattle and buffalo are equal candidates for incremental research resources in Himachal Pradesh. Priorities in Jammu & Kashmir favor cattle, buffalo, sheep and poultry.

In southern region, species priorities vary considerably across states. For example, in Andhra Pradesh buffalo and poultry appear as the main priority species for livestock research. Cattle, sheep, goat, equine and pig are next in priority ranking. In Kerala, on the other hand, cattle research claims bulk of the livestock research resources, and is followed by poultry, buffalo and goat. Cattle and buffalo demand almost equal attention (41% each) in Karnataka, and poultry with a share of about 8 percent comes next in priority.

In western region, cattle and buffalo research should receive almost equal priority, with the exception of Gujarat where the buffalo research needs to receive almost twice the resources allocated to cattle research. Poultry research is important in Goa and Maharashtra. Issues related to goat too constitute an important research agenda in Rajasthan, Gujarat and Madhya Pradesh.

In eastern region too, species priorities vary considerably across states. In Bihar, buffalo and cattle claim 34 and 31 percent of the total livestock research resources respectively. Goat research also demands considerable resources (21%), and is followed by poultry (8%). Cattle research is important in Orissa (59%). Buffalo, poultry and small ruminants need equal emphasis (13-14 %) here. In West Bengal also, cattle receives highest priority, and goat and poultry follow in the order.

In northeastern region, highest priority should be accorded to cattle research (53-76 %). Poultry is the next most important priority in some states (Assam, Arunachal Pradesh, Manipur and Tripura), while pig is in others.

These results indicate that dairy animals (cattle and buffalo) would continue to attract significant attention in the livestock research cutting across regional

Table 22: Research priorities by livestock species in different states (% of total research resources in a state).

State	Cattle	Buffalo	Goat	Sheep	Pig	Poultry	Camel	Equine	Total
North									
Haryana	9.66	81.59	1.13	0.48	0.12	3.84	0.08	3.09	100.00
Himachal Pradesh	44.49	42.97	5.52	2.64	0.11	2.93	0.00	1.33	100.00
Jammu & Kashmir	52.79	17.42	3.41	12.07	0.00	10.78	0.00	3.53	100.00
Punjab	17.13	66.24	0.73	0.22	0.05	14.27	neg	1.36	100.00
Uttar Pradesh	22.86	61.54	8.76	0.51	1.57	0.76	neg	4.00	100.00
South									
Andhra Pradesh	19.09	44.60	1.86	3.06	0.10	31.17	0.00	0.12	100.00
Karnataka	42.28	40.96	3.56	4.70	0.26	7.71	0.00	0.53	100.00
Kerala	71.46	7.13	5.46	0.00	0.25	15.68	0.00	0.00	100.00
Tamil Nadu	54.93	28.75	2.37	2.91	0.06	10.27	0.00	0.71	100.00
West									
Goa	37.73	32.63	5.48	0.00	3.14	21.01	0.00	0.00	100.00
Gujarat	32.15	58.09	3.19	0.50	0.01	4.70	0.03	1.33	100.00
Madhya Pradesh	48.49	41.29	4.64	0.23	0.03	3.66	neg	1.64	100.00
Maharashtra	38.63	37.97	6.52	1.74	0.17	14.20	0.00	0.77	100.00
Rajasthan	43.19	42.33	7.90	1.45	0.17	2.33	0.22	2.42	100.00
East									
Bihar	30.95	33.92	21.32	1.71	2.41	7.77	0.00	1.92	100.00
Orissa	58.68	13.76	8.49	5.25	0.70	13.11	0.00	0.00	100.00
West Bengal	54.29	5.52	22.81	3.41	1.17	12.65	0.00	0.14	100.00
North east									
Arunachal Pradesh	74.79	0.37	1.82	2.02	5.36	13.41	0.00	2.22	100.00
Assam	70.46	9.26	4.33	0.06	1.38	14.12	0.00	0.40	100.00
Manipur	52.94	15.31	0.95	0.27	13.34	17.19	0.00	0.00	100.00
Meghalaya	58.12	2.49	3.97	0.01	20.01	14.82	0.00	0.58	100.00
Mizoram	57.98	3.08	0.98	0.00	26.24	10.12	0.00	1.60	100.00
Nagaland	57.07	7.35	2.57	0.00	16.34	15.32	0.00	1.34	100.00
Sikkim	76.33	7.94	4.59	0.56	3.43	4.99	0.00	2.17	100.00
Tripura	64.46	1.45	7.12	0.21	8.65	18.10	0.00	0.00	100.00
India	37.62	40.20	7.86	1.76	1.03	10.05	0.02	1.46	100.00

boundaries though the relative emphasis varies across states. Buffalo is the main priority species in most of the northern states; cattle in majority of the eastern and northeastern states; and both cattle and buffalo in the western states. In southern region, cattle should constitute the main research agenda. Further, livestock research agenda need to take care of the emerging diversification trends in the livestock sector. For instance, poultry and pigs in the northeastern regions, poultry in the western region and goat in the eastern region contribute substantially to the gross value of livestock production and should receive adequate attention in the process of research resource allocation.

Product Priorities by Species and States

After deciding the pattern of research resource allocation by species in different states, we assess the commodity priorities in the species research. The distribution of functional priorities for different species would vary across states due to differences in the functional utilities of a species. A regional comparison of the suggested allocation of cattle research resources shows emphasis on milk production research in most of the states (Annexure IV.1). The emphasis however varies across states. Except in Andhra Pradesh, Goa, Gujarat, Madhya Pradesh, Orissa and most of the northeastern states milk production research claims more than three-fourths of resources allocated to cattle research. In Andhra Pradesh, Gujarat, Madhya Pradesh, Rajasthan, Orissa, Arunachal Pradesh, Assam, Mizoram, Sikkim and Tripura, draught power research also needs considerable emphasis. Beef research is important in most of the northeastern states.

For buffalo research, a pattern of commodity prioritization similar to that at all India level is observed for most of the states (Annexure IV.2). At all India level, the analysis indicates research concentration on milk. In Kerala, Orissa, West Bengal and few northeastern states draught power and/or meat research is also important.

The allocation of goat research resources shown in Annexure IV.3 indicates higher priority to milk production research in northern and western states. While in other regions, meat research gets precedence over milk research. Sheep research in most of the states should concentrate on meat production (Annexure IV.4). Exceptions are Himachal Pradesh and Rajasthan where wool research emerges as the main priority.

Poultry has been emerging as an important sub-sector of livestock in India. This is in response to growing demand for poultry products. At the national level, poultry research resources should be allocated in the ratio of 2:1 between meat and egg research. This however varies across states (Annexure IV.5). The priority in Haryana, Himachal Pradesh, Jammu and

Kashmir, Kerala, Goa, Rajasthan, Bihar, Orissa, West Bengal and northeastern states by and large corresponds to the national priority. In Punjab, Andhra Pradesh, Gujarat and Maharashtra the ratio approximates to 3:1. Egg production research gets precedence over meat production research in Uttar Pradesh, Karnataka, Tamilnadu, Madhya Pradesh and Sikkim.

Meat and bristles are two important outputs of pig, the former however should comprise the focus of pig research in all the states (Annexure IV.6). In Jammu & Kashmir, Tamilnadu, Gujarat, Madhya Pradesh, Andhra Pradesh, Orissa and Haryana research on bristles too demands attention.

Besides males of cattle and buffalo, camel and equine are other important sources of draught power. Camel population is concentrated largely in Rajasthan, Gujarat, Haryana, Uttar Pradesh and Madhya Pradesh where it is used for both farm and non-farm activities. Camel also provides hairs, which are used in carpet industry. The main emphasis of camel research however should be on improving draughtability (Annexure IV.7). Equines (donkey and mules) are found mainly in Uttar Pradesh, Rajasthan Haryana, Himachal Pradesh and Punjab, and provide draught services mainly to the non-farm sector.

The analysis indicates considerable regional variation in priorities for outputs and services of a species. In irrigated states, improving milk yield of cattle and buffalo is the main research agenda, while in rainfed states research on draught bovines also demands considerable attention. In case of other species too, there are marked regional differences in preferences for their outputs/services. These aspects should not be ignored while designing species specific research programs.

Regional Priorities by Species

Another important issue in determining research priorities is the distribution of species specific research resources across states. In other words, if 100 rupees are available for research in the country on a particular species, how this should be allocated to different states. This is shown in Table 23.

Bulk of the cattle research resources should be allocated to the western states of Madhya Pradesh, Rajasthan and Maharashtra, which together claim for over 30 percent of the resources. Uttar Pradesh, Bihar, West Bengal, Orissa, Tamilnadu, Assam and Gujarat are other important candidates. It may be noted that many of these states are rainfed, where cattle is an important species to cater to the milk and draught power demand of the households. This distribution takes care of the agroecological targeting of the cattle research.

Table 23: Regional priorities by livestock species (percent)

State	Cattle	Buffalo	Goat	Sheep	Pig	Poultry	Camel	Equine
North								
Haryana	0.40	3.16	0.22	0.43	0.18	0.60	5.88	3.29
Himachal Pradesh	1.12	1.01	0.66	1.42	0.10	0.28	0.00	0.86
Jammu & Kashmir	1.20	0.37	0.37	5.86	neg	0.91	0.00	2.06
Punjab	1.03	3.71	0.21	0.28	0.10	3.20	0.45	2.10
Uttar Pradesh	8.72	21.97	16.00	4.14	21.83	1.08	1.70	39.27
South								
Andhra Pradesh	4.89	10.68	2.27	16.77	0.95	29.86	0.00	0.80
Karnataka	5.13	4.65	2.07	12.24	1.15	3.50	0.00	1.65
Kerala	6.00	0.56	2.19	neg	0.78	4.93	0.00	0.00
Tamil Nadu	7.62	3.73	1.57	8.67	0.30	5.33	0.00	2.53
West								
Goa	0.16	0.13	0.11	0.00	0.47	0.32	0.00	0.00
Gujarat	4.16	7.04	1.97	1.38	0.05	2.28	7.92	4.42
Madhya Pradesh	9.07	7.22	4.15	0.94	0.24	2.56	0.93	7.89
Maharashtra	12.36	11.37	9.98	11.94	1.96	17.01	0.00	6.29
Rajasthan	8.88	8.14	7.77	6.41	1.26	1.79	83.12	12.77
East								
Bihar	8.50	8.72	28.01	10.05	24.18	7.98	0.00	13.56
Orissa	4.61	1.01	3.19	8.84	2.02	3.85	0.00	0.00
West Bengal	7.04	0.67	14.16	9.49	5.55	6.15	0.00	0.47
North east								
Arunachal Pradesh	0.25	neg	0.03	0.14	0.65	0.17	0.00	0.19
Assam	4.36	0.54	1.28	0.07	3.12	3.27	0.00	0.64
Manipur	0.76	0.21	0.07	0.08	7.04	0.93	0.00	0.00
Meghalaya	0.80	0.03	0.26	neg	10.03	0.76	0.00	0.20
Mizoram	0.48	0.02	0.04	neg	7.90	0.31	0.00	0.34
Nagaland	0.71	0.09	0.15	neg	7.38	0.71	0.00	0.42
Sikkim	0.35	0.03	0.10	0.06	0.57	0.08	0.00	0.25
Tripura	0.39	0.01	0.21	0.03	1.90	0.41	0.00	0.00
India	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Research on buffalo should target Uttar Pradesh (21.2%), Madhya Pradesh (10%), Rajasthan (9.4%), Andhra Pradesh (9.1%), Maharashtra (8.5%) Bihar (8.3%), Punjab (5.7%) and Karnataka (5.6%). The wide dispersion of buffalo research resources indicates adaptability of buffalo to varied climatic conditions in the country.

Goat research should target eastern region mainly Bihar and West Bengal. These two states together demand about 43 percent of national goat research resources. Uttar Pradesh, Rajasthan, Maharashtra and Madhya Pradesh are other important target domains. Sheep research should have more focus in southern region (Karnataka, Andhra Pradesh and Tamilnadu). Other target domains include Orissa, West Bengal and Bihar in the east, Maharashtra and Rajasthan in the west and Jammu & Kashmir in the north.

Andhra Pradesh and Maharashtra are the priority states for poultry research with a share of 26.5 percent and 13.2 percent in national research resources respectively. The other important states in priority are Bihar, West Bengal, Tamilnadu, Orissa, Punjab and Assam.

Northeastern states, Bihar and Uttar Pradesh constitute the main target domains for pig research. Camel research should target mainly Rajasthan. For equine research Uttar Pradesh ranks first in priority, followed by Bihar, Rajasthan, Madhya Pradesh, Gujarat and Maharashtra.

This pattern of allocation of regional research resources might be in congruence with the existing pattern of allocation. It is however difficult to comment on this due to lack of state level and species level information on research investment.

VI SENSITIVITY ANALYSIS

The assumption of equal weights to all research objectives in setting priorities is liable to criticism especially when the objectives are argumentative in nature. For instance, efficiency and equity objectives are often in conflict with each other. The main objective of research is to improve production efficiency, and therefore it is presumed that the benefits of research trickle down on its large-scale application benefiting the majority landless and small landholders who possess sizeable proportion of livestock wealth. The emphasis of research thus may vary over time and space, so are weights attached to different research objectives. In this chapter, we examine the sensitivity of priority ranking/resource allocation to changes in weights to the specified research objectives. This would provide information on the robustness of the results of the priority setting exercise. This is also important from the point of view of designing suitable research strategies consistent with the role of livestock in socioeconomic development. Sensitivity of regional and species priorities is tested with different weighting schemes presented in Table 24.

The results in the previous chapters were based on equal weights to all the objectives (scheme I). In schemes II, weight to efficiency is doubled (0.50), weight to equity is kept unchanged (0.25), and the weights to sustainability and trade are reduced to 0.15 and 0.10 respectively. Higher weight to efficiency is due to emphasis of research on improving the productive potential of livestock. In scheme III, weight to equity is increased to 0.35, as livestock in India is more equitably distributed than land. The emphasis on efficiency is retained though the weight is reduced to 0.40. Weights to other objectives are kept same as in scheme II.

Table 24: Weighting schemes for sensitivity analysis for research resource allocation

Objective	Weighting scheme		
	I	II	III
Extensity parameters			
Efficiency	0.25	0.50	0.40
Equity	0.25	0.25	0.35
Sustainability	0.25	0.15	0.15
Exports	0.25	0.10	0.10
Intensity parameters			
Efficiency	0.25	0.50	0.40
Equity	0.25	0.25	0.35
Sustainability	0.25	0.15	0.15
Exports	0.25	0.10	0.10

Regional Priorities

The impact of changes in weights to research objectives on regional priorities is shown in Table 25. Higher weight to efficiency (scheme II) causes marginal changes in relative ranking of states[11] . Amongst the top ten states appearing in the priority with equal weights, Uttar Pradesh, Maharashtra, Bihar, Andhra Pradesh, Gujarat and Karnataka retain their relative positions as with the equal weights (scheme I). Madhya Pradesh and West Bengal improve their ranking while Tamilnadu and West Bengal lose their positions.

Table 25: Impact of changes in weights to research objectives on regional research priorities

State	FBL			FBL/VOP		
	Weighing scheme			Weighing scheme		
	I	II	III	I	II	III
North						
Haryana	1.56	2.46	2.17	0.32	0.50	0.44
Himachal Pradesh	0.94	0.93	0.89	1.16	1.15	1.09
Jammu & Kashmir	0.85	1.06	0.95	0.59	0.73	0.66
Punjab	2.25	3.56	3.08	0.28	0.45	0.39
Uttar Pradesh	14.36	14.53	14.64	0.98	0.99	1.00
South						
Andhra Pradesh	9.63	8.58	8.42	1.31	1.16	1.14
Karnataka	4.57	4.88	4.20	0.95	1.01	1.02
Kerala	3.16	3.47	3.37	0.80	0.88	0.85
Tamil Nadu	5.22	5.48	5.80	1.08	1.14	1.21
West						
Goa	0.15	0.13	0.13	1.74	1.43	1.46
Gujarat	4.87	5.11	5.11	0.88	0.93	0.93
Madhya Pradesh	7.03	7.82	7.76	0.91	1.02	1.01
Maharashtra	12.04	10.39	10.53	1.38	1.19	1.20
Rajasthan	7.33	7.40	7.00	1.06	1.01	0.96
East						
Bihar	10.33	9.53	10.11	1.44	1.33	1.41
Orissa	2.95	2.96	3.21	1.85	1.85	2.00
West Bengal	4.88	6.02	6.04	0.65	0.80	0.81
North east						
Arunachal Pradesh	0.12	0.12	0.13	1.38	1.34	1.38
Assam	2.33	2.44	2.54	1.28	1.34	1.40
Manipur	0.54	0.35	0.35	2.89	1.86	1.84
Meghalaya	0.52	0.42	0.42	2.22	1.79	1.78
Mizoram	0.31	0.22	0.22	3.74	2.68	2.63
Nagaland	0.46	0.32	0.31	3.10	2.15	2.07
Sikkim	0.17	0.13	0.13	2.75	2.09	2.06
Tripura	0.23	0.24	0.27	1.40	1.47	1.64

[11] There is a high degree of correlation between ranking of states with different schemes. The correlation coefficients between scheme I and II, I and III and II and III are 0.986, 0989 and 0.996 respectively, and are significant at 1 percent level.

Though the ranking of states by and large remains unaffected, shares of some states change significantly with higher emphasis on efficiency. This is indicated by the FBL/VOP ratios of different schemes. With higher weight to efficiency at the cost of sustainability and exports (scheme II), Haryana, Punjab, Jammu & Kashmir and West Bengal gain considerably, while most of the northeastern states, Maharashtra and Goa lose enormously. Shares of other states are not affected much. With emphasis on equity and efficiency together (scheme III) most of the states that gain with higher emphasis on efficiency (scheme II) suffer a loss, yet receive more than that with equal weights. Shares of other states largely remain unaffected.

Variation in weights to research objectives does not seem to cause significant tradeoffs in regional research resource allocation except in extreme cases. For instance, relatively higher emphasis on efficiency favors those states, which are fairly in advanced stage of livestock development (Haryana and Punjab) or are in developing stage (Gujarat, Karnataka, Tamilnadu and West Bengal). While emphasis on efficiency and equity together favors higher allocations to the backward states (Orissa, Bihar and northeastern states).

Species Priorities

Table 26 presents the sensitivity of species research priorities to the changes in weights to research objectives. The ranking of species remains unaffected under different weighting schemes. However, marginal changes are observed in their shares in total research resources. Higher emphasis on efficiency at the cost of sustainability and exports (scheme II) causes marginal increase in shares of cattle, sheep and equine over the equal

Table 26: Impact of changes in weights on species priorities

Species	FBL			FBL/VOP		
	Weighing scheme			Weighing scheme		
	I	II	III	I	II	III
Cattle	37.62	38.02	38.23	1.03	1.04	1.05
Buffalo	40.20	40.20	39.79	0.95	0.95	0.95
Goat	7.86	7.81	7.94	1.07	1.06	1.08
Sheep	1.76	1.77	1.79	1.04	1.05	1.06
Pig	1.03	0.93	0.95	1.38	1.25	1.28
Poultry	10.05	9.81	9.79	1.05	1.03	1.03
Camel	0.02	0.02	0.02	0.91	0.91	0.87
Equine	1.46	1.50	1.49	0.92	0.95	0.94

emphasis scheme. Allocations to buffalo and camel remain unaffected, while other species lose. Higher emphasis on efficiency and equity together at the cost of sustainability and exports (scheme III) favors marginal increase in resources for cattle, goat, sheep and equine research, and a marginal decline in shares of buffalo, poultry and pig over scheme I.

The analysis suggests that regional pattern of allocation of research resources is not much sensitive to changes in weights to research objectives. So is the pattern of resource allocation across species.

Existing and Suggested Allocation of Resources

Whether the proposed pattern of allocation of livestock research resources is in congruence with the existing pattern is difficult to comment upon in the absence of reliable information on research investment by states and species. Location of a livestock research entity could however provide some subjective judgement of regional pattern of investment in livestock research. But, this kind of subjectivity is liable to criticism because of differences in the size and functions of different entities as well as in the quality of research. Nevertheless, an assessment of pattern of investment in species research at the national level has been undertaken using investments made by ICAR in research on different species. One needs to note the limitation imposed by absence of state level data.

The information on investment in livestock research has been compiled from the Budget Books of the ICAR for the period 1995-96 to 1997-98. Total investment includes expenditures in the livestock research institutes, research centres and All India Coordinated Research Projects (AICRP). Besides, expenditure on account of the adhoc research projects funded by the Council in the area of animal science under AP Cess scheme is also included.

Most of the research centres, AICRPs and AP Cess schemes have species or commodity focus. Expenditures of commodity/ species specific research entities and projects have been allocated to the species under consideration. Expenditures of multi-species research entities (National Dairy Research Institute, Indian Veterinary Research Institute, National Bureau of Animal Genetic Resources, National Institute of Animal Nutrition and Physiology) have been allocated to different species in proportion of the published research articles on different species[12]. Investment on a species so estimated has been added to the sum total of the expenditure of species specific research to arrive at total research investment on a species.

[12] The information on research articles was compiled from the Annual Reports of these institutes.

Table 27 presents the pattern of existing and proposed allocations of research resources by species. Though, the ranking of the species based on existing and proposed allocation is in congruence[13], there is a considerable scope for reallocation of research resources. The proposed allocation suggests considerably higher research resources to the dairy sector. Resources for cattle research need to be enhanced from the existing 29.9 percent to 37.6 percent, and for buffalo research from 21.2 percent to 40.2 percent.

Table 27: Existing and suggested allocation of research resources by species (percent)

Species	Existing	Suggested	Deviation
Cattle	29.87	37.62	7.75
Buffalo	21.15	40.20	19.05
Goat	14.21	7.86	-6.35
Sheep	11.89	1.76	-10.13
Pig	1.95	1.03	-0.92
Poultry	12.90	10.05	-2.85
Camel	2.21	0.02	-2.19
Equine	4.22	1.46	-2.76
Others*	1.60	-	
Total	100	100	

Species such as goat, sheep, pig and equine are considered to be important for landless, marginal and small landholders. About 71 percent of the small ruminant and 78 percent of pig population is concentrated among these households. On this ground more investment is often demanded for research on these species. Contrary to the general belief, our results suggest that these species already command more research resources compared to their relative contributions to the gross value of livestock sector. Existing allocation to goat research is almost double than the proposed allocation. Investment in sheep research is 6.7 times more than the proposed one. For pig and equine, it is respectively 1.9 and 2.9 times more than proposed ones. However, there is some congruence between the existing and proposed allocations for poultry research.

These findings indicate that there is considerable subjectivity in the existing allocation decisions. It has been often been perceived that livestock research in India is biased towards cattle at the cost of species such as buffalo, small ruminants and poultry (World Bank, 1990). The situation appears to

[13] The correlation between the rankings is 0.93 and significant at less than 5 percent level.

have changed; cattle receives less research resources than its relative contribution. The bias against buffalo research is enormous and needs to be corrected.

Most of the so-called neglected and pro-poor species claim proportionately higher shares in research resources than their relative economic contributions. The evolution pattern of livestock research as discussed in Chapter II suggests that in the past many of these species such as goat, equines, camel and pig did not receive adequate attention in the animal science research. It is only recently that ICAR has established research institutes for most of these species to strengthen research and development efforts. That means higher initial capital investment in the fixed assets such as buildings, laboratories and equipment. Research on sheep is comparatively old, and a breakthrough in research is yet to take place, as the productivity of sheep in terms of meat as well as wool has been stagnating for quite some time.

Whatever might be the reasons for imbalances in allocation of research resources across regions and species there is a need to have a fresh look at the livestock research resource allocation process keeping in view the relative importance of different species, their past performance and the potential in meeting the socioeconomic, ecological and policy goals. However, it should be kept in mind that livestock research is complex, capital-intensive, long-term and slow in producing benefits. The nature and cost of research vary from species to species, so would be the rates of return on investment in research. For instance, compared to small ruminants and monogastrics, large ruminant research is complex, time taking and capital-intensive, and thus might yield low rates of returns.

VII CONCLUSIONS AND POLICY IMPLICATIONS

The robust growth in the livestock sector in recent years indicates that if managed properly, livestock could be a driving force in the growth of agricultural sector in the coming decades. Apart from its immense and rising contributions to agricultural gross domestic product and food and nutritional security, livestock has the capacity to reduce interpersonal and interregional economic disparities, as there exists considerable scope to enhance its income and employment contributions. But, there are apprehensions. The current trends in livestock production may not sustain for long due to various operating constraints. Increasing livestock population, chronic feed and fodder scarcity, deterioration of common grazing lands, frequent occurrence of diseases and rising competition for land between man and animal would strain the livestock production. Productivity of livestock is low, and is not showing any sign of growth particularly of sheep, goat and pig. Growth in productivity of indigenous cattle is also not encouraging. Adoption of improved technologies is low. Further, there is considerable interregional variation in productivity and technology adoption. These call for revisiting livestock research priorities across regions, species and commodities.

In a seminal attempt to prioritize research for Indian agriculture, Jha et al. (1995) indicated that expenditure on livestock research is more or less in line with livestock sector's relative contribution to gross output of agricultural sector. This however varied over time. In 1970s, livestock research accounted for more resources than the relative contribution of livestock sector to AgGDP. It fell down drastically in the eighties. In recent years, realizing the growth potential of livestock sector and its impact on equity and nutritional security efforts have been made to restore livestock research's share commensurate with the relative contribution of the livestock sector to AgGDP. During ninth five year plan, animal science research received 19 percent of ICAR's research resources, which by and large is in congruence with livestock sector's share in AgGDP.

Thus, considering the growing realization of the importance of livestock sector in socioeconomic development this study has identified regional and species priorities for allocation of limited research resources in a multi-criteria framework with efficiency, equity, sustainability and trade participation as research objectives. The study began with assessing regional priorities with the sole criterion of efficiency and subsequently examined the effects of other criteria on the pattern of research resource

allocation. It came out that ignoring social and sustainability dimensions in deciding priorities leads to sub-optimality in regional allocation of research resources.

In a pure economic efficiency framework, northeastern states together receive about 3 percent of the national livestock research resources. Their share almost doubles when the equity, nutritional security, sustainability and trade issues are superimposed on economic efficiency criterion. The other states that stand to gain significantly with inclusion of equity and sustainability dimensions are Himachal Pradesh, Andhra Pradesh, Goa, Maharashtra, Bihar and Orissa. Most of these states are agriculturally backward or are developing slowly. A larger proportion of incremental research resources should therefore flow into these states to accelerate the growth of livestock sector and to improve upon interregional and interpersonal disparities.

Regional pattern of allocation of livestock research resources varies from species to species. Cattle research should target western states of Madhya Pradesh, Rajasthan and Maharashtra. Uttar Pradesh, Bihar, West Bengal, Orissa, Tamilnadu, Assam and Gujarat are other important target domains for cattle research. Buffalo research activities should be concentrated mainly in Uttar Pradesh, Madhya Pradesh, Rajasthan, Andhra Pradesh, Maharashtra and Bihar. Target domain for goat research includes mainly eastern states of Bihar and West Bengal. Focus on sheep research should be in southern states viz. Karnataka, Andhra Pradesh and Tamilnadu. Andhra Pradesh and Maharashtra are the main claimants for poultry research resources. Northeastern region, Bihar and Uttar Pradesh appear as the priority states for pig research. Camel research should by and large be confined to Rajasthan. For equine research, Uttar Pradesh should receive the highest priority.

Concerns for equity, sustainability and trade shift emphasis towards animals that have short life span, generate quick returns, improve equity and require less initial investment and recurring costs. These include goat, sheep and pig. Cattle also fall in this group. Priority towards buffalo, equine and camel promotes efficiency. With all objectives in consideration, buffalo demands highest attention in livestock research (40.2 %) and followed by cattle (37.6%), poultry (10%) and goat (7.9%). Sheep, equine, pig and camel follow in the priority order.

In mixed crop livestock systems, an animal is maintained to provide a number of products and services. Thus, multi-functionality of a species demands a balanced allocation of research resources among its different functions/commodities. Bulk of the bovine (cattle and buffalo) research at the national level should target milk production, followed by draught power

and meat. Research on goats should focus on meat, followed by milk and skins. Sheep research should target mainly meat production. Wool production and skins rank next in the order. In case of poultry, meat research demands two-third of the resources and the rest should be earmarked for egg production research. Improving efficiency of meat production should be the main concern of pig research. For camel and equine, the research should exclusively address the draughtability concerns.

The functional distribution of research resources however varies across regions depending on the utility of products and services derived from a species. Bovine research in most of the states should concentrate on milk and followed by draught power. However, in northeastern states beef research is also important. Focus of goat research in western and northern states should be on milk, while in most of the southern, eastern and northeastern states meat research gets precedence over milk research. Functional distribution of sheep research resources exhibits a varied pattern across states; both meat and wool research demand considerable attention in northern and western states. In southern, eastern and northeastern states meat appears as the agenda for sheep research. Poultry research should give high priority to meat production in most of the states, except Uttar Pradesh, Karnataka and Madhya Pradesh where egg research demands comparatively more resources.

Whether the proposed allocation is in congruence with the existing pattern of allocation is rather difficult to comment upon in absence of research investment data at regional level. However, an examination of existing allocation by species at the national level indicates considerable deviations from the proposed allocation. Our results call for greater emphasis on buffalo and cattle research. This needs to be viewed in terms of their long generation interval compared to small ruminants and monogastrics. *Ceteris paribus,* this means that the rates of return to successful productivity enhancing research on the former will be lower than the latter, especially for breeding.

The study has generated indices for allocation of livestock research resources across regions, species and commodities. It suggests target domains, species and commodities for livestock research. The study does not propose the research agenda in terms of breeding, nutrition, health and management. This also does not provide the alternative research strategies to address these issues in a cost-effective manner. These issues concern the demand-side aspects of animal science research and require considerable amount of information from the livestock owners and scientific community. The next phase of this study targets development of the demand-driven agenda for animal science research.

REFERENCES

Adams, Jr. R.H. and Jane, J. He.1995. Sources of income inequality and poverty in rural Pakistan. International Food Policy Research Institute, Washington, D.C.

Alston, J.M., G.W. Norton and P.G. Pardey. 1995. Science under scarcity: Principles and practices for agricultural research evaluation and priority setting. Cornell University Press, Ithaca and London.

Anderson, J.R. and K.A. Parton.1983. Techniques for guiding the allocation of resources among rural research projects. Prometheus 1(1): 180-201.

Birthal, P.S. 2000. Technological change in India's livestock sector and its impact. Presented at the VIII annual conference on Livestock in different farming systems in India. Agricultural Economics Research Association (India), Indian Agricultural Research Institute, New Delhi.

Birthal, P.S. and M.K. Singh.1995. Structure of rural income inequality: A study in western Uttar Pradesh. Indian Journal of Agricultural Economics 50(2):168-175.

Birthal, P.S., Anjani Kumar, A. Ravishankar and U.K. Pandey.1999. Sources of growth in the livestock sector. Policy Paper 9. National Centre for Agricultural Economics and Policy Research, New Delhi.

CGIAR. 1992. Review of CGIAR priorities and strategies (part I). TAC Secretariat, FAO, Rome, Italy.

Contant, R.B. 2001. Priority setting. *In* Planning agricultural research (G. Gijsbers, W. Janssen, H.H. Odame and G. Meijerink, eds.). CAB International, Wallingford, U.K. and ISNAR, The Hague, Netherlands.

Davis, J.S., P. Oram and J.G. Ryan. 1987. Assessment of agricultural research priorities: an international perspective. Australian Centre for International Agricultural Research, Canberra and International Food Policy Research Institute, Washington, D.C.

Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. Livestock to 2020: The next food revolution. Food, Agriculture, and the Environment Discussion Paper 28. International Food Policy Research Institute, Washington, D.C.

De Wit, C.T. 1988. The use of interactive multiple goal programming in the resource allocation process of the CGIAR system. TAC/CGIAR, Rome, Italy.

Echeverria, R.G. 1990. Assessing the impact of agricultural research. *In* Methods for diagnosing research system constraints and assessing the impact of agricultural research (R.G. Echeverria, ed.).

Evension, R.E., P.E. Waggoner and V.W. Ruttan. 1979. Economic benefits from research: an example from agriculture. Science 205: 1101-1107.

Fox, G. 1987. Models of resource allocation in public agricultural research: A survey. Journal of Agricultural Economics 37: 449-462.

Falconi, C.A. 1999. Methods of priority setting in agricultural biotechnology research. *In* Managing agricultural biotechnology: Addressing research program needs and policy implications (J.I. Cohen, ed.). CAB International.

Franzel, S., H. Jaenicke and W. Janssen. 1995. Priority setting for MPT improvement research. The Hague, The Netherlands.

Gaddi, G.M. and L.B. Kunal.1996. Sources of output growth in new milk production technology and some implications to research investment. Indian Journal of Agricultural Economics 51(3): 389-395.

Hann, C. de, H.Steinfeld and H. Blackburn. 1997. Livestock and the environment: Finding a balance. FAO/USAID/World Bank. WRENmedia, Eye, U.K.

ICAR. 1989. 40 years of agricultural research and education in India. Indian Council of Agricultural Research, New Delhi.

ICAR. 2000. Handbook of ICAR research institutes. Indian Council of Agricultural Research, New Delhi.

GOI. 1976. Report of the National Commission on Agriculture, Part VII, Animal husbandry. Ministry of Agriculture and Irrigation, Government of India, New Delhi.

GOI. 1976. Report of the National Commission on Agriculture, Part XI, Research, education and extension. Ministry of Agriculture and Irrigation, Government of India, New Delhi.

Janssen, W. 1994. Priority setting as a practical tool for research management. ISNAR Discussion Paper. ISNAR, The Hague, Netherlands.

Janssen, W. and M. Waithaka. 1998. Priority setting for livestock research: The case of KARI's dairy program. International Livestock Research Institute, Addis Ababa, Ethiopia.

Jha, D. 2001. Agricultural research and small farms. Indian Journal of Agricultural Economics 56 (1): 1-23.

Jha, D., P. Kumar, Mruthyunjaya, S. Pal, S. Selvarajan, and Alka Singh. 1995. Research priorities in Indian agriculture. Policy Paper 3. National Centre for Agricultural Economics and Policy Research, New Delhi.

Kelly, T.G. and J.G. Ryan. 1995. Applied participatory priority setting in international agricultural research: Making trade-offs transparent and explicit. Agricultural Systems 49: 177-216.

Kirschke, D.1993. Research priority setting for livestock development in developing countries. Paper presented in the International conference on Livestock development in developing countries. Weilheim, Germany.

Kumar, A. 2000. Performance of livestock sector in India: Implications for food security. Afro-Asian Journal of Rural Development 14(2): 77-90.

Kumar, A. and P.S. Birthal. 2001. Economic impact of crossbreeding research on cattle in India. Paper presented at the ICAR-ICRISAT workshop on Documentation, adoption and impact of livestock technologies in the mixed crop livestock systems in India. ICRISAT, Patancheru, India.

Kumar, A. 2000. Trade in livestock products: Trend, performance and competitiveness. Presented at the VIII annual conference on Livestock in different farming systems in India. Agricultural Economics Research Association (India), Indian Agricultural Research Institute, New Delhi.

Kumar. P. 1998. Food demand-supply projections. Indian Agricultural Research Institute, New Delhi.

Kumar, P., C.C. Maji and R.K. Patel. 1977. Returns on investment in research and extension: A study on Indo-Swiss cattle improvement project, Kerala. Indian Journal of Agricultural Economics 32(3).

Kumar P. and P.K. Joshi.1999. Socioeconomic factors contributing to nutritional security of rural households. Paper presented at the workshop on Diversification of agriculture for human nutrition. National Academy of Agricultural Sciences, New Delhi and National Institute of Nutrition, Hyderabad.

Lu, Y., L. Quance and C.L. Liu. 1978. Projecting agricultural productivity and its economic impact. American Journal of Agricultural Economics 60: 976-980.

Mahlstede, J.P. 1971. Long range planning at the Iowa agricultural and home economics experiment stations. *In* Resource allocation in agricultural research (W.L. Fishel, ed.). University of Minnesota Press, Minneapolis, Minnesota.

McCalla, A.F. and J.G. Ryan. 1992. Setting agricultural research priorities: Lessons from CGIAR study. American Journal of Agricultural Economics 74(5): 1095-1100.

Mills, B. 1997. Ex ante research evaluation and regional trade flows: Maize in Kenya. ISNAR, The Hague, Netherlands.

Moscardi, E.R. 1987. Allocating resources for agricultural research and extension in Argentina: Experiences of INTA. Paper presented at the conference on Allocating Resources for developing country agricultural research. Bellagio, Italy.

Norton, G.W. 1987. Priority setting methods for agricultural research: Recent experiences in the Dominican Republic, Ecuador and Uruguay. Project Paper No. 6. ISNAR, The Hague, Netherlands.

Norton. G. W. and C. Douglas. 1989. Analysis of net economic benefits of agricultural research and extension in eastern Caribbean. SP 89-8. Virginia Polytechnic Institute and State University.

Norton, G.W. and J.S. Davis. 1981. Evaluating returns to agricultural research: a review. American Journal of Agricultural Economics 63(4): 685-99.

Norton, G.W. and P.G. Pardey.1987. Priority setting mechanisms for national agricultural research systems: Present experience and future needs. Working Paper No. 7. ISNAR, The Hague, Netherlands.

Norton, G.W., P.G. Pardey and J.M. Alston. 1992. Economic issues in agricultural research priority setting. American Journal of Agricultural Economics 74(5): 1089-1094.

Parton, K.A., J.R. Anderson and J.P. Makeham. 1984. Evaluation methods for Australian wood production research. Agricultural Economics Bulletin No. 29. University of New England, Armidale.

Pinstrup-Anderson, P. and D. Franklin .1977. A system approach to agricultural research resource allocation in developing countries. *In* Resource allocation and productivity in national and international research (C.T.M. Arndt, D.G. Dalrymple, and V. W. Ruttan, eds.). University of Minnesota Press, Minneapolis, Minnesota.

Pundhir, R.K. and R. Sahai.1997. Conservation of indigenous cattle breeds. Dairy India, 1997. Gupta Publishers, New Delhi.

Ramanujam, V. and T. Satty. 1981. Technological choice in the less developed countries: An analytical hierarchy approach. Technological Forecasting and Social Change, 19: 81-98.

Russell, D.G. 1977. Resource allocation in agricultural research using socio-economic evaluation and mathematical models. Canadian Journal of Agricultural Economics 23 : 29-52.

Satty, T. and L. Vargas. 1994. Decision making in economic, political, social and technological environments with the AHP. University of Pittsburgh.

Scobie, G.M. and V. Jacobsen. 1992. Allocation of R&D funds in the Australian wool industry. University of Waikato, Hamilton, New Zealand.

Sere, C. and H. Steinfeld. 1996. World livestock production systems: Current status, issues and trends. FAO Animal Production and Health Paper 127. FAO, Rome, Italy.

Sharma, V.P. and P. Sharma. 2000. The implications of agricultural trade liberalization for Indian dairy industry. Presented at the VIII annual conference on Livestock in different farming systems in India. Agricultural Economics Research Association (India), Indian Agricultural Research Institute, New Delhi.

Shumway, C.R. 1973. Allocation of scarce resources to agricultural research: Review of methodology. American Journal of Agricultural Economics 55(4):547-558.

Singh, P. and A. B. Majumdar.1992. Current status of feed and fodder management of livestock. Agricultural Situation in India, (August): 375-382.

Thornton, P.K., T.F. Randolph, P.M. Kristjanson, W.S. Omamo, A.N. Odero and J.G. Ryan. 2000. Priority assessment for the International Livestock Research Institute, 2000-2010. ILRI Impact Assessment Series No. 6. International Livestock Research Institute, Nairobi, Kenya.

World Bank. 1990. Agricultural research in India: Prologue, performance and prospects. The World Bank, Washington D.C.

World Bank. 1996. India livestock sector review: Enhancing growth and development. The World Bank, Washington D.C.

ANNEXURES

Annexure I: Sources of information on extensity and intensity parameters

Parameters	Reference year	Source
Extensity parameters		
Value of livestock outputs	Triennium ending average, 1997-98	Central Statistical Organization (CSO) Ministry of Statistics and Programme Implementation, Govt. of India
Number of poor people	1993-94	Planning Commission, Govt. of India
Undernourished population	1993-94	Kumar and Joshi (1999)
Common property lands	Triennium ending average, 1997-98	Indian Agricultural Statistics, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India
Value of livestock exports	Triennium ending average, 1997-98	FAO Trade Yearbook
Modifiers/ Intensity parameters		
Livestock yields	Triennium ending average, 1993-94	Basic Animal Husbandry Statistics, Department of Animal Husbandry and Dairying, Ministry of Agriculture, Govt. of India
Per capita state domestic product	Triennium ending average, 1997-98	National Accounts Statistics, CSO
Share of landless, marginal and small landholder in livestock units	1991-92	Report on Land and Livestock Holdings, National Sample Survey Organization, Ministry of Statistics and Programme Implementation, Govt. of India
Per capita availability of milk and eggs	Triennium ending average, 1993-94	Basic Animal Husbandry Statistics
Livestock density	Triennium ending average, 1997-98	Livestock Census, 1982 and 1992

Annexure II: Values of modifiers used for construction of FBL

State	Per capita availability		Share of LMS in ACU (%)	Per capita SDP (Rs/ annum)	Yield (kg/day)			Livestock density (ACU/ha)
	Milk (g/day)	Egg (no./annum)			Nondescript cattle	Crossbred cattle	Buffalo	
Andhra Pradesh	165	79	67	8896	4.5	2.9	3.3	1.1
Arunachal Pradesh	119	27	64	10168	4.7	2.1	3.9	2.6
Assam	86	19	87	6323	5.0	5.3	3.9	2.6
Bihar	97	15	84	3699	4.2	4.6	2.4	2.5
Goa	78	80	99	18469	4.0	6.0	2.2	0.6
Gujarat	269	11	60	12526	3.0	1.4	2.1	0.8
Haryana	610	35	46	14000	1.8	3.0	0.3	1.9
Himachal Pradesh	330	13	83	8447	4.2	6.1	3.0	1.4
Jammu & Kashmir	282	45	68	5820	4.1	4.7	2.3	3.5
Karnataka	199	34	54	9327	4.0	4.0	2.3	1.3
Kerala	198	65	94	8329	4.1	3.9	3.5	1.3
Madhya Pradesh	196	17	49	6624	4.6	3.7	2.8	1.4
Maharashtra	160	31	53	15316	4.4	2.6	2.5	1.0
Manipur	80	29	82	6790	5.0	5.3	3.9	2.8
Meghalaya	80	39	81	7579	5.1	0.8	3.8	0.5
Mizoram	41	26	82	7743	5.2	1.0	3.9	0.1
Nagaland	86	32	83	6638	5.4	7.4	3.9	1.0
Orissa	51	19	80	5994	5.4	6.2	4.4	1.6
Punjab	856	123	50	16261	2.5	0.7	0.0	4.7
Rajasthan	306	10	45	7282	3.1	4.1	1.9	0.7
Sikkim	196	35	84	9271	5.0	5.3	3.9	0.6
Tamil Nadu	183	52	81	10088	3.4	4.1	2.4	1.3
Tripura	36	16	97	4961	5.0	5.3	3.9	3.3
Uttar Pradesh	225	5	74	5980	3.8	4.1	2.2	2.3
West Bengal	125	35	89	8429	4.0	3.8	1.1	3.1
A&N island	170	142	49	10933	3.2	4.0	3.3	1.0
Chandigarh	140	35	44	19134	2.8	0.9	0.4	10.5
D&N Haveli	74	24	85	9730	4.4	2.6	2.5	2.2
Daman & Diu	24	36	94	9730	3.0	1.4	2.1	0.6
Delhi	64	6	76	19134	1.8	4.5	0.0	3.7
Lakshadweep	48	90	100	9730	4.0	4.6	1.8	1.9
Pondicherry	103	8	91	11064	4.0	4.6	1.8	2.4
India	201	30	66	9730	4.1	3.6	2.2	1.5

Note: LMS= Landless, marginal and small landholders. ACU= Adult cattle units. SDP= State Domestic Product.

Annexure III: Research priority by commodity in different states (percent)

State	Cattle Milk	Buffalo milk	Goat Milk	Cattle meat	Buffalo meat	Goat meat	Sheep meat	Pig Meat	Poultry meat	Eggs	Cattle hide
North											
Haryana	6.57	81.41	0.71	0.00	0.00	0.47	0.26	0.12	2.75	1.47	0.09
Himachal Pradesh	40.02	43.57	3.69	0.00	0.00	1.70	0.83	0.11	1.83	1.31	0.49
Jammu & Kashmir	44.75	16.27	4.17	0.00	0.00	0.00	10.37	0.00	9.01	4.59	0.27
Punjab	16.24	65.72	0.45	0.00	0.00	0.28	0.14	0.05	11.47	3.46	0.05
Uttar Pradesh	17.93	60.40	3.79	0.00	0.93	5.17	0.43	1.61	0.24	0.57	0.15
South											
Andhra Pradesh	11.44	41.74	0.00	0.83	1.17	1.66	2.54	0.09	24.29	8.05	0.18
Karnataka	32.93	40.41	0.28	0.35	0.24	2.90	3.90	0.26	3.86	4.18	0.25
Kerala	59.77	3.43	3.53	5.72	0.92	2.64	0.00	0.30	11.45	7.61	1.25
Tamil Nadu	42.83	28.75	0.00	0.64	0.41	2.14	2.64	0.03	4.20	7.20	0.40
West											
Goa	19.59	29.09	0.00	14.36	2.01	4.62	0.00	2.94	12.20	9.15	0.61
Gujarat	19.72	57.28	2.78	0.00	0.12	0.37	0.24	0.01	3.76	1.04	0.41
Madhya Pradesh	25.53	41.83	4.48	0.05	0.09	0.61	0.16	0.02	1.83	2.27	0.33
Maharashtra	34.61	36.27	3.16	1.38	1.83	3.26	1.54	0.17	11.19	3.72	0.67
Rajasthan	29.77	42.20	8.53	0.00	0.19	1.73	0.65	0.21	2.16	0.92	0.39
East											
Bihar	21.27	30.26	6.15	0.95	1.21	14.83	1.44	2.72	5.50	3.39	1.43
Orissa	31.09	7.57	0.13	0.27	0.00	7.71	4.96	0.61	7.79	5.82	1.33
West Bengal	41.92	4.01	0.14	3.68	0.00	19.71	2.95	1.18	8.56	4.67	1.55
North east											
Arunachal Pradesh	35.10	0.00	0.00	4.50	0.00	1.53	1.43	4.74	9.46	4.25	4.42
Assam	53.87	7.38	2.37	0.87	0.07	1.28	0.04	1.33	9.84	4.72	0.88
Manipur	32.37	7.47	0.00	12.18	5.65	0.88	0.25	13.27	12.68	5.05	1.11
Meghalaya	22.02	1.30	0.00	31.52	0.29	3.54	0.00	20.31	10.02	5.28	1.43
Mizoram	19.69	0.00	0.00	27.50	0.48	0.82	0.00	26.02	6.62	3.58	0.63
Nagaland	30.47	0.00	0.00	18.73	4.14	2.26	0.00	15.65	11.58	4.14	1.49
Sikkim	44.71	6.13	1.97	7.25	1.87	2.47	0.10	3.35	0.25	4.82	0.29
Tripura	31.33	0.00	0.00	3.04	0.64	6.80	0.21	8.55	12.92	5.93	0.98
India	27.21	38.15	2.92	1.24	1.17	4.87	1.44	1.06	7.21	3.59	0.59

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Annexure III: Research priority by commodity in different states (Percent)

State	Buffalo Hide	Goat hide	Sheep Hide	Cattle draught power	Buffalo draught power	Camel draught power	Equine draught power	Sheep wool	Goat hair	Pig bristles	Camel Hair
North											
Haryana	0.29	0.04	0.03	0.81	1.22	0.08	3.40	0.24	0.03	0.02	neg
Himachal Pradesh	0.56	0.13	0.09	1.97	0.01	0.00	1.42	1.90	0.38	neg	0.00
Jammu & Kashmir	0.10	0.07	2.15	0.94	0.09	0.00	4.46	2.70	0.06	neg	0.00
Punjab	0.32	0.03	0.02	0.18	0.09	neg	1.43	0.08	neg	neg	neg
Uttar Pradesh	0.33	0.43	0.05	2.48	1.06	neg	4.29	0.06	neg	0.07	neg
South											
Andhra Pradesh	0.35	0.27	0.48	5.35	1.26	0.00	0.13	0.16	neg	0.02	0.00
Karnataka	0.28	0.52	0.68	7.43	0.64	0.00	0.55	0.33	0.01	0.02	0.00
Kerala	0.19	0.47	Neg	0.76	1.95	0.00	0.00	0.00	neg	0.01	0.00
Tamil Nadu	0.17	0.41	0.57	8.62	0.07	0.00	0.79	0.02	0.07	0.04	0.00
West											
Goa	0.19	0.95	0.00	2.70	1.35	0.00	0.00	0.00	0.00	0.25	0.00
Gujarat	0.79	0.09	0.07	11.54	0.19	0.03	1.35	0.19	0.01	neg	0.00
Madhya Pradesh	0.21	0.10	0.01	19.42	1.11	neg	1.84	0.09	neg	0.01	0.00
Maharashtra	0.51	0.40	0.17	0.14	0.02	0.00	0.80	0.12	0.03	0.00	0.00
Rajasthan	0.41	0.16	0.10	7.61	0.25	0.29	3.20	1.17	0.03	0.01	neg
East											
Bihar	0.88	3.41	0.25	0.38	3.42	0.00	2.20	0.26	0.01	0.03	0.00
Orissa	0.28	0.96	0.49	24.90	5.96	0.00	0.00	0.00	neg	0.12	0.00
West Bengal	0.12	3.99	0.59	5.43	1.28	0.00	0.15	0.02	neg	0.04	0.00
North east											
Arunachal Pradesh	0.03	0.32	0.11	30.26	0.32	0.00	2.27	0.52	0.01	0.73	0.00
Assam	0.11	0.81	0.01	14.22	1.67	0.00	0.42	0.00	0.01	0.10	0.00
Manipur	0.41	0.09	0.03	6.28	1.79	0.00	0.00	0.00	0.01	0.49	0.00
Meghalaya	0.03	0.55	0.01	2.02	0.77	0.00	0.59	0.00	neg	0.33	0.00
Mizoram	0.03	0.17	Neg	9.94	2.52	0.00	1.62	0.00	0.00	0.40	0.00
Nagaland	0.25	0.38	Neg	5.54	2.86	0.00	1.37	0.00	0.01	1.13	0.00
Sikkim	0.05	0.23	0.02	23.72	0.00	0.00	2.20	0.45	0.00	0.13	0.00
Tripura	0.07	0.60	0.01	27.73	0.70	0.00	0.00	0.00	0.02	0.47	0.00
India	0.42	0.88	0.24	5.88	1.18	0.03	1.63	0.23	0.02	0.04	neg

Annexure IV.1: Commodity priorities in cattle research in different states (percent)

State	Milk	Meat	Hides & Skin	Draught Power	Total
North					
Haryana	87.94	0.00	1.24	10.82	100.00
Himachal Pradesh	94.22	0.00	1.15	4.63	100.00
Jammu & Kashmir	97.38	0.00	0.58	2.03	100.00
Punjab	98.61	0.00	0.30	1.09	100.00
Uttar Pradesh	87.20	0.00	0.74	12.07	100.00
South					
Andhra Pradesh	64.27	4.68	1.03	30.03	100.00
Karnataka	80.40	0.87	0.61	18.13	100.00
Kerala	88.54	8.47	1.86	1.13	100.00
Tamil Nadu	81.61	1.21	0.76	16.42	100.00
West					
Goa	52.58	38.55	1.64	7.24	100.00
Gujarat	62.28	0.00	1.29	36.43	100.00
Madhya Pradesh	56.32	0.10	0.74	42.84	100.00
Maharashtra	94.03	3.76	1.82	0.39	100.00
Rajasthan	78.82	0.00	1.04	20.14	100.00
East					
Bihar	88.47	3.97	5.96	1.60	100.00
Orissa	53.98	0.48	2.31	43.23	100.00
West Bengal	79.73	7.00	2.94	10.34	100.00
North east					
Arunachal Pradesh	47.26	6.05	5.95	40.74	100.00
Assam	77.14	1.25	1.25	20.36	100.00
Manipur	62.32	23.45	2.13	12.10	100.00
Meghalaya	38.64	55.30	2.51	3.55	100.00
Mizoram	34.10	47.62	1.08	17.20	100.00
Nagaland	54.19	33.31	2.65	9.85	100.00
Sikkim	58.85	9.54	0.39	31.22	100.00
Tripura	49.67	4.82	1.55	43.96	100.00
India	77.76	3.63	1.69	16.93	100.00

Annexure IV.2: Commodity priorities in buffalo research in different states (percent)

State	Milk	Meat	Hides & skin	Draught Power	Total
North					
Haryana	98.18	0.00	0.35	1.47	100.00
Himachal Pradesh	98.72	0.00	1.27	0.02	100.00
Jammu & Kashmir	98.88	0.00	0.60	0.52	100.00
Punjab	99.38	0.00	0.49	0.13	100.00
Uttar Pradesh	96.29	1.48	0.52	1.70	100.00
South					
Andhra Pradesh	93.77	2.62	0.78	2.83	100.00
Karnataka	97.21	0.57	0.68	1.54	100.00
Kerala	52.93	14.17	2.88	30.01	100.00
Tamil Nadu	97.78	1.41	0.58	0.24	100.00
West					
Goa	89.13	6.15	0.58	4.13	100.00
Gujarat	98.12	0.20	1.36	0.32	100.00
Madhya Pradesh	96.74	0.20	0.48	2.58	100.00
Maharashtra	93.89	4.74	1.32	0.06	100.00
Rajasthan	98.02	0.45	0.95	0.58	100.00
East					
Bihar	84.63	3.37	2.45	9.55	100.00
Orissa	54.81	0.00	2.06	43.12	100.00
West Bengal	74.19	0.00	2.17	23.64	100.00
North east					
Arunachal Pradesh	0.00	0.00	7.42	92.58	100.00
Assam	79.87	0.79	1.23	18.12	100.00
Manipur	48.75	36.89	2.65	11.71	100.00
Meghalaya	54.50	12.01	1.07	32.42	100.00
Mizoram	0.00	15.82	0.90	83.28	100.00
Nagaland	0.00	57.05	3.50	39.45	100.00
Sikkim	76.16	23.18	0.66	0.00	100.00
Tripura	0.00	45.33	5.19	49.48	100.00
India	93.21	2.90	1.02	2.88	100.00

Annexure IV.3: Commodity priorities in goat research in different states (percent)

State	Milk	Meat	Hides & skin	Hair	Total
North					
Haryana	56.84	37.46	3.44	2.26	100.00
Himachal Pradesh	62.44	28.80	2.25	6.51	100.00
Jammu & Kashmir	97.01	0.00	1.56	1.42	100.00
Punjab	59.00	36.45	4.07	0.49	100.00
Uttar Pradesh	40.35	55.08	4.53	0.04	100.00
South					
Andhra Pradesh	0.00	85.97	13.90	0.13	100.00
Karnataka	7.62	78.10	13.91	0.37	100.00
Kerala	53.14	39.81	7.05	0.00	100.00
Tamil Nadu	0.00	81.53	15.74	2.73	100.00
West					
Goa	0.00	82.95	17.05	0.00	100.00
Gujarat	85.66	11.38	2.80	0.16	100.00
Madhya Pradesh	86.37	11.71	1.83	0.08	100.00
Maharashtra	46.20	47.58	5.84	0.37	100.00
Rajasthan	81.64	16.55	1.54	0.26	100.00
East					
Bihar	25.19	60.78	13.98	0.05	100.00
Orissa	1.51	87.56	10.91	0.03	100.00
West Bengal	0.59	82.65	16.75	0.01	100.00
North east					
Arunachal Pradesh	0.00	82.16	17.23	0.61	100.00
Assam	53.12	28.68	18.09	0.12	100.00
Manipur	0.00	89.87	9.56	0.57	100.00
Meghalaya	0.00	86.38	13.51	0.11	100.00
Mizoram	0.00	83.03	16.97	0.00	100.00
Nagaland	0.00	85.44	14.30	0.26	100.00
Sikkim	42.17	52.93	4.90	0.00	100.00
Tripura	0.00	91.59	8.14	0.26	100.00
India	32.98	56.67	7.16	0.20	100.00

Annexure IV.4: Commodity priorities in sheep research in different states (percent)

State	Meat	Hides & skins	Wool	Total
North				
Haryana	48.72	6.36	44.92	100.00
Himachal Pradesh	29.48	3.29	67.23	100.00
Jammu & Kashmir	68.11	14.12	17.76	100.00
Punjab	59.45	6.74	33.81	100.00
Uttar Pradesh	79.97	9.58	10.45	100.00
South				
Andhra Pradesh	79.99	15.12	4.89	100.00
Karnataka	79.55	13.81	6.64	100.00
Kerala	0.00	100.00	0.00	100.00
Tamil Nadu	81.68	17.56	0.76	100.00
West				
Goa	0.00	0.00	0.00	0.00
Gujarat	47.69	14.25	38.06	100.00
Madhya Pradesh	59.38	4.75	35.86	100.00
Maharashtra	84.22	9.40	6.39	100.00
Rajasthan	33.82	5.32	60.86	100.00
East				
Bihar	73.82	12.99	13.19	100.00
Orissa	90.96	9.04	0.00	100.00
West Bengal	82.66	16.64	0.70	100.00
North east				
Arunachal Pradesh	69.23	5.48	25.29	100.00
Assam	74.41	25.59	0.00	100.00
Manipur	90.35	9.65	0.00	100.00
Meghalaya	0.00	100.00	0.00	100.00
Mizoram	0.00	100.00	0.00	100.00
Nagaland	0.00	100.00	0.00	100.00
Sikkim	17.45	3.06	79.49	100.00
Tripura	93.29	6.71	0.00	100.00
India	76.10	12.50	11.41	100.00

Annexure IV.5: Commodity priorities in poultry research in different states (percent)

State	Meat	Eggs	Total
North			
Haryana	65.12	34.88	100.00
Himachal Pradesh	58.26	41.74	100.00
Jammu & Kashmir	66.26	33.74	100.00
Punjab	76.82	23.18	100.00
Uttar Pradesh	30.08	69.92	100.00
South			
Andhra Pradesh	75.10	24.90	100.00
Karnataka	47.98	52.02	100.00
Kerala	60.07	39.93	100.00
Tamil Nadu	36.86	63.14	100.00
West			
Goa	57.14	42.86	100.00
Gujarat	78.43	21.57	100.00
Madhya Pradesh	44.57	55.43	100.00
Maharashtra	75.02	24.98	100.00
Rajasthan	70.11	29.89	100.00
East			
Bihar	61.88	38.12	100.00
Orissa	57.24	42.76	100.00
West Bengal	64.70	35.30	100.00
North east			
Arunachal Pradesh	69.01	30.99	100.00
Assam	67.60	32.40	100.00
Manipur	71.54	28.46	100.00
Meghalaya	65.50	34.50	100.00
Mizoram	64.91	35.09	100.00
agaland	73.68	26.32	100.00
Sikkim	4.92	95.08	100.00
Tripura	68.54	31.46	100.00
India	66.94	33.06	100.00

Annexure IV.6: Commodity priorities in pig research in different states (percent)

State	Meat	Bristles	Total
North			
Haryana	87.87	12.13	100.00
Himachal Pradesh	94.19	5.81	100.00
Jammu & Kashmir	0.00	100.00	100.00
Punjab	95.24	4.76	100.00
Uttar Pradesh	95.75	4.25	100.00
South			
Andhra Pradesh	81.44	18.56	100.00
Karnataka	94.35	5.65	100.00
Kerala	96.29	3.71	100.00
Tamil Nadu	41.43	58.57	100.00
West			
Goa	92.04	7.96	100.00
Gujarat	51.25	48.75	100.00
Madhya Pradesh	61.36	38.64	100.00
Maharashtra	98.76	1.24	100.00
Rajasthan	96.47	3.53	100.00
East			
Bihar	98.78	1.22	100.00
Orissa	84.13	15.87	100.00
West Bengal	96.75	3.25	100.00
North east			
Arunachal Pradesh	86.63	13.37	100.00
Assam	93.20	6.80	100.00
Manipur	96.46	3.54	100.00
Meghalaya	98.39	1.61	100.00
Mizoram	98.48	1.52	100.00
Nagaland	93.28	6.72	100.00
Sikkim	96.19	3.81	100.00
Tripura	94.81	5.19	100.00
India	96.03	3.96	100.00

Annexure IV.7: Commodity priorities in camel research in different states (percent)

State	Draught power	Hair	Total
North			
Haryana	94.81	5.19	100.00
Punjab	75.76	24.24	100.00
Uttar Pradesh	88.89	11.11	100.00
West			
Gujarat	100.00	0.00	100.00
Madhya Pradesh	100.00	0.00	100.00
Rajasthan	99.26	0.74	100.00
India	98.78	1.22	100.00