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Macro Level Priorities for Livestock Research and Development for Bihar

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Abstract

The study has revealed macro-level priorities for livestock research and development for the state of Bihar. Considering equity as the single most important criterion for resource allocation, the North-West Alluvial Plains should receive highest priority in resource allocation, followed by the South-West Alluvial Plains, the North-East Alluvial Plains and the South-East Alluvial Plains. However, sustainability is the core of any development programme. After incorporation of sustainability considerations, the North-West Alluvial Plains (Zone-I) maintained its prime position for share in resources, followed by the South-West Alluvial Plains (Zone-IIIB). The distribution of species-specific allocations across regions has revealed that the higher proportion of total resources (more than two-thirds) should be allocated to South-West Alluvial Plains and North-West Alluvial Plains for cattle development. Again, North-West Alluvial Plains should be targeted for buffalo development, followed by the South-West Alluvial Plains. Sheep development efforts should concentrate in the South-West Alluvial Plains, goat development in North-West Alluvial Plains and North-East Alluvial Plains and piggery development in Gaya, Nawada, Jamui, Jahanabad and Katihar districts of south Bihar. North-West Alluvial Plains should get priority for poultry development in Bihar.

Key words: Livestock, research & development, priorities, Bihar

JEL Classification: Q1

Introduction

Livestock constitute an integral component of India's rural economy and contribute significantly to the social and economic development of the rural people. The role of livestock in provision of nutritionally rich foods like milk, meat and eggs for human consumption is well-recognized. They are important productive assets as well a source of income for the rural households (Birthal and Negi, 2012). They generate almost continuous flow of outputs and services and hence are a regular source of income for rural people and provide a cushion against crop production risks. It is increasingly recognized that livestock production is more sustainable in the mixed farming systems characterized by a strong interaction between crop and livestock production activities.

The sustained economic growth and rapid urbanization are causing substantial changes in food consumption pattern, away from staples towards animal food products. Projections indicate that by 2020 India's demand for milk and meat (including fish and eggs) will increase to 143 million tonnes (Mt) and 19 Mt, respectively (Joshi and Kumar, 2011). So far, the country has been successful in meeting the growing demand for different animal food products through domestic production. However, the sustainability of livestock production in the future is questionable, as the past growth in livestock production occurred largely

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through increase in animal numbers than their productivity (Birthal and Taneja, 2012). Livestock productivity is low in India, but more worrisome is the deceleration in its growth (Birthal and Taneja, 2012).

At a similar rate of growth, the livestock production proves to be more pro-poor than the growth in crop production (Birthal and Negi, 2012). However, for maintaining the pro-poor nature of livestock, the key lies in improving the efficiency and sustainability of livestock production systems by way of enhanced investment in livestock research and development, and appropriate targeting thereof.

Evidence indicates that there are very high payoffs to investments on livestock research (Birthal *et al*., 1999). Unfortunately, resources allocated to livestock research in India have not been commensurate with the contribution of livestock to agricultural gross domestic product (Birthal and Negi, 2012). To operationalise the pro-poor potential of livestock there is a need to rationalize the allocation of R&D resources and invest in generation and dissemination of technologies related to genetic enhancement, breeding, health and nutrition.

Livestock Sector of Bihar

In Bihar, the livestock sector grew at a rate of around 8 per cent per annum during the period 2000-01 to 2010-11, which is more than double the rate of growth in their agricultural sector. It is worth mentioning that the rate of growth in the livestock sector in Bihar was also double than that at the national level during this period. The share of livestock in the value of output of the agricultural sector in Bihar increased to 37.4 per cent in 2010-11 from 25.4 per cent in 2000-01.

In Bihar, the agriculture economy is dominated by small landholders. Close to 60 per cent of the rural households in the state possess landholdings of less than one hectare, often termed as marginal landholders. Their corresponding share in land is merely 28 per cent. Their share in livestock, however, is much more. About two-thirds of the cattle and buffaloes, and more than three-fourths of the small ruminants, pigs and poultry are controlled by the marginal farm households. This distribution pattern of land and livestock implies that growth in livestock sector is likely to have a larger impact on poverty reduction than the growth in crop sector.

Productivity of livestock in Bihar is low compared to that in many other states, such as Punjab and Haryana and is also less than the national average. However, the milk yields of cows and buffaloes are closer to their national averages. On the other hand, meat yields of most species in Bihar are much less than their corresponding national averages. Low animal productivity is due to numerous biotic and abiotic constraints including dominance of poor quality breeds, poor animal health and feed and fodder scarcity. Besides, many socio-economic and institutional factors such as a lack of access to animal health and breeding services, markets and credit, and tiny holdings, shrinking common lands, etc. restrict farmers realize the potential yield of different livestock species.

Bihar still lags behind on account of livestock infrastructure. Animal health as well as breeding infrastructure has remained poor in the state, as is indicated by the number of livestock units served per veterinary institution, and the proportion of breedable population of cows and buffaloes covered with artificial insemination. The number of livestock units served per livestock institution in Bihar is 2.5-times more than the national average. Likewise, the breedable population artificially inseminated is 24 per cent in Bihar compared to the national average of 41 per cent.

Feed resources in Bihar are inadequate and of poor quality (Singh *et al*., 2011). Landholdings are too small to allow farmers to allocate any land to fodder crops. Area under grazing and pastures is extremely small. Infrastructure for marketing and processing of livestock products is also underdeveloped. Dairy cooperatives in Bihar procure only about 6 per cent of the milk produced in the states as compared to the national average of 8.2 per cent.

As evident, Bihar is one of the Indian states, which has high dependency on agriculture. About 81 per cent of the workforce in Bihar depends on agriculture and livestock play an anchoring role in sustainability of the agrarian economy of the state. In recent years, the government of Bihar ahs accorded considerable priority to the animal husbandry (GoB, 2012). It is evident from the fact that the Agricultural Road Map of Bihar identifies livestock, particularly dairying, as a vehicle to promote inclusive growth and income augmentation in the state.

Table 1. Development goals, R&D objectives and their extensity parameters

Goal	R&D objective	Indicators/extensity parameters
Accelerate growth	Improve animal productivity	Value of livestock production
Improve equity	Enhance income of the poor	Number of poor people
Improve sustainability of the livestock production system	Improve carrying capacity of land for enhanced growth of livestock	Land available for livestock

It is, therefore, imperative to analyze and set the macro-priorities for livestock R&D and to allocate resources in accordance with the priorities for increasing the efficacy and efficiency of available resources. The present study assesses research and development priorities for livestock sector of Bihar at the macro level to meet the economic and social objectives.

Method for priority assessment

Over the past few decades, a number of methods have been developed for assessment of the priorities or allocation of resources across regions and commodities[1]. We have used multi-criteria scoring model to assess the regional and species priorities. This model incorporates multiple objectives of efficiency, equity and sustainability by modifying traditional measure of efficiency. Given the relative importance of different objectives, the scoring model makes tradeoffs between different objectives explicitly. The method is transparent, easy to apply and not data-intensive. The scoring model can be used to rank commodities, research alternatives and target domains.

The scoring model has its limitations too. The main limitation is its simplicity and flexibility. Often, there is a tendency to incorporate more and more criteria without checking for their internal logic and consistency. This gives rise to duplication of the criteria as most of the criteria are directly or indirectly related with the efficiency criterion - the main objective of R&D (Alston *et al*., 1995). Further, the 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 that the impact of new R&D is proportion to the value of output of the commodities. It also does not account for research spillovers and domestic and trade policies (Falconi, 1999).

The scoring model involves five main steps in the process of assessing priorities. These are: (i) identification of R&D objectives and their indicators or extensity parameters, (ii) assigning appropriate weights to the objectives, (iii) selection of R&D priority dimensions, (iv) construction of initial baseline (IBL) for resource allocation, and (v) modification of IBL to obtain final baseline (FBL) for assessment of R&D priorities.

Identification of R&D Objectives and their Extensity Parameters

The first step is to identify R&D objectives that are consistent with the development goals, which are: enhancing growth, improving equity, and promoting sustainable use of natural resources. The 'growth acceleration goal' suggests that R&D efforts should improve productivity in an efficient manner. Equity implies that efficiency gains should be shared among regions and socioeconomic groups; and the sustainability is concerned with conservation and management of the natural resources. The R&D objectives corresponding to these goals are: enhancing animal productivity, increasing income of the poor, and increasing carrying capacity of land or natural resources (Table 1).

Having identified R&D objectives it is important to identify the indicators or extensity parameters that reflect magnitude of the problems to be addressed by the R&D institutions. These indicators are discussed below.

Value of Livestock Production (VOP) — Research and development efforts enhance production potential of livestock, and therefore benefits of R&D can be

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

increased manifold if implemented on a large-scale. That means that the value of R&D should be proportional to the value of production, and this reflects the objective of increasing productivity or production efficiency. In this study, 'animal species' are the focus of R&D; therefore the value of main output[2] of cattle, buffalo, goat, sheep, pig and poultry in a district has been taken in assessing the priority. Other species could not be included in the analysis due to lack of information on their outputs and services.

Number of Rural Poor (POOR) — The population below poverty line being an indicator of the economic inequality, it is expected that a greater R&D focus on regions having comparatively more number of poor would help reduce interpersonal and interregional disparities. We have taken the number of rural poor in a district as an indicator of equity.

Land Available for Livestock Production (LLP) — Livestock are raised in the mixed farming systems, and derive their feed and fodder requirement from crop residues and byproducts. In subsistence-oriented systems, as in Bihar, animals to a large degree depend on common lands for their feed and fodder requirements. Further, the dependence of livestock on common lands are more in case of landless and small landholders who dominate the rural sector. Conservation and management of common lands are thus important to sustain livestock production for the benefit of the poor. The focus of livestock R&D thus should be relatively high in the regions with larger common land resources. Barren and non-culturable lands, permanent pastures and grazing lands, culturable wastelands, fallow lands, lands under miscellaneous tree crops and land under fodder crops are taken to constitute the land available for livestock production.

Assigning Weights to R&D Objectives

The next step is to assign appropriate weights to the indicators of R&D objectives as to construct a composite index for priority ranking of districts/regions and species. Since, prior information on weights to different R&D objectives is not available; equal weights were assigned to each objective. For an objective with more than one extensity indicator, each indicator was assigned equal weight without altering the overall weighting structure.

Selection of R &D Priority Dimensions

Prioritization has multiple dimensions. Priority indices can be developed for regions/districts and livestock species/commodities. In this exercise, we have considered regional and species dimensions. Regional dimensions ensure that R&D efforts are appropriately targeted to regions or districts and priority assessment must consider regional dimensions. In this study, a district has been taken as a unit for analysis, and aggregated district priorities at agro-ecological zone level. Note that the regional R&D priorities can be translated into species priorities.

Construction of Initial Baseline (IBL)

The initial baseline (IBL) allocates research resources across regions in proportion of the weighted shares of the extensity parameters reflecting different R&D objectives. The IBL is constructed using values of the extensity parameters and their assumed weights as illustrated by Equation (1):

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

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

Having computed shares, each extensity parameter is assigned a weight (W_j) to construct the initial base line (IBL or B_i) as given by Equation (2):

$$B_i = \left(\sum_{j=1}^{k} W_j S_{ij} \right) \qquad \ldots(2)$$

[2] The value of main output of a species in a district was estimated by multiplying the main product by its price. Production of different products was obtained from the Integrated Sample Survey reports conducted by the Department of Animal Husbandry and Dairying of the concerned state. For Bihar, district-level information on meat production of different species was not available. We generated this information by multiplying the number of meat producing animals by their respective slaughter rates. National slaughter rates of 10 per cent for buffaloes, 40 per cent for small ruminants and 95 per cent for pig were used to estimate meat production.

Table 2. Intensity indicators used to modify Initial Base Line

Goal	R&D objective	Modifier	Direction of influence on IBL
Growth acceleration	Enhance productivity	Milk yield gap in indigenous, crossbred and buffalo	+
Equity	Augment income of people below poverty line	Per capita State Domestic Product	–
Sustainability	Improve carrying capacity of land for livestock	Livestock density	+

Modification of Initial Baseline for Final Allocation

The IBL is a cumulative product of weights and shares of extensity parameters. This, however, reflects only size of the problem and ignores intensity of the problem. For example, a region/district may be ranking high in terms of its share in poor, but it may not have the same ranking in terms of intensity of the poverty. Hence, it is important to consider intensity of the problem in priority assessment. The intensity parameters were used to modify IBL to arrive at the final baseline (FBL) which eventually reflected both size and intensity of the problem.

Intensity indicators, also known as modifiers, for each objective were identified for modification of the IBL. We have used yield gap (deviation from the highest yielding district in the state) that reflects the scope for accelerating growth in livestock production (Table 2). Yield gaps are attributed to differences in the input-use and management practices. Thus, larger the yield gap higher will be the scope for enhancing growth by targeting R&D efforts and investment. The per capita district domestic product and/or share of landless, marginal and small farmers were used to address the equity concerns. To improve income distribution more resources are needed for the regions/ districts with lower per-capita income or higher concentration of landless, marginal and small landholders.

Land and other natural resources available for livestock may come under a confluence of pressure, threatening sustainability of the livestock sector. This calls for emphasis on yield-enhancement that would help optimize livestock population commensurate with available feed resources. The livestock units per hectare of net cropped area plus land available for livestock are used as modifiers to address the sustainability concern in priority assessment.

Having identified modifiers, the next step was to assign weights to modifiers (in accordance with their relative importance) and determine their signs so 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. Equal weights were assigned to all the modifiers. A modifier will have either a positive or negative impact on IBL. For example, higher the per capita income in a district, lower should be the R&D emphasis there so as to reduce the interregional disparities in income distribution. Therefore, a negative sign is attached to this modifier. On the other hand, the distribution of rural population would carry a positive sign. Positive sign is attached to the efficiency modifier (yield gap) as districts with lower yield need more resources. The livestock density variable, which addresses sustainability concerns, carries a positive sign. The impact of selected modifiers on the initial baseline can be estimated as modified baseline ($B'_{i),}$ as given in Equation (3), which shows a new priority distribution.

$$B_i^{'} = \left[1 + \left\{M_{ij} / Max(M_{ij})\right\} \times W_j\right] B_i \qquad \ldots(3)$$

New priority distribution:

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

where, M_{ij} is the data for j^{th} modifier for i^{th} district, W_j is the weight for the j^{th} modifier, B_i' is the modified baseline for regional distribution of research resources, B_{ij}'' is the new priority distribution for the i^{th} region/ district based on impact of j^{th} modifier, and i refers to the number of districts (1 to n) and j refers to number of modifiers (1 to m). The above procedure is applicable in case of modifiers with positive signs. The impact of

modifiers with negative signs is obtained by subtracting $\{M_{ij}/\text{Max}\ (M_{ij})\}$ from 1.

The impact of individual modifiers was summed up to get the aggregate net impact of all the modifiers. The IBL was then modified using the aggregate impact to obtain the FBL, indexed to sum up to 100 across districts. The FBL indexed to 100 provided the shares of different districts in total R&D resources available with the state. The districts could be ranked based on their shares in order of priority. For operational purposes, regional priorities are to be translated into species priorities. This was done by adjusting the VOP of each species in each district by an adjustment factor. The adjustment factor for each state was obtained by multiplying the actual VOP by the ratio of priority distribution based on FBL and priority distribution based on VOP (FBL/VOP). A ratio greater than one implied an upward adjustment in allocation reinforced by the concerns of equity and sustainability.

Regional and Species Priorities in Bihar

The main objective of R&D is to accelerate and sustain growth in livestock production by way of improving productive potential of animals. Thus, an animal species is the basic unit for targeting R&D efforts and investment. For the purpose, we have considered only main products generated by different species in all the districts of the state. Following the methodology described in the previous section, we first assessed regional priorities and then the species priorities.

The first step in priority assessment was to examine the distribution of the problem across regions/districts. Table 3 presents the regional distribution of extensity parameters, viz. value of production (VOP), number of rural poor (POOR) and land available for livestock production (LAND) across the four major zones of the state. The distribution of these parameters together with the initial and final allocation of resources across the districts is presented in Annexure Table 1.

The distribution of VOP revealed that allocation of resources to livestock R&D was highest for the South-East Alluvial Plains (33.4%), followed by the North-West Alluvial Plains (31.3%). The South-West Alluvial Plains and North-East Alluvial Plains should receive 19 per cent and 16 per cent of the total resources, respectively. Across districts, Patna, Rohtash, Bhojpur and Bhagalpur ranked higher in priority order (Annexure Table 1). If equity were to be the single most important criterion for resource allocation, then the North-West Alluvial Plains should receive higher priority in resource allocation (51.3%), followed by South-West Alluvial Plains (24.9%), North-East Alluvial Plains (13.7%) and South-East Alluvial Plains (10.1%). Amongst districts, Muzaffarpur, East Champaran, Madhubani, Sitamarhi and Saran need more resources because of higher concentration of the poor.

Table 3. Distribution of extensity parameters, initial base line (IBL) and final base line (FBL) for resource allocation in Bihar, 2008-2010

Zone	Distribution of extensity parameters (%)			Initial base line with different objectives (%)		Final baseline (%)		
	VOP	POOR	LAND	VOP and POOR	IBL= VOP, POOR and LAND	IBL/ VOP	FBL	FBL/ VOP
North-West Alluvial Plains (Zone I)	31.29	51.32	24.53	41.30	35.71	1.14	35.22	1.13
North-East Alluvial Plains (Zone II)	15.86	13.67	17.28	14.76	15.60	0.98	16.91	1.07
South-East Alluvial Plains (Zone IIIA)	19.48	10.11	21.49	14.79	17.03	0.87	17.05	0.88
South-West Alluvial Plains (Zone IIIB)	33.37	24.90	36.70	29.14	31.66	0.95	30.82	0.92
Bihar	100.00	100.00	100.00	100.00	100.00	1.00	100.00	1.00

The regional distribution of land available for livestock production shown in Table 3 suggests a similar priority ranking as equity, that is South-West Alluvial Plains and North-West Alluvial Plains should receive higher resources. Across districts, based on sustainability criterion more resources should be allocated to Gaya, Jamui, Patna and Banka. The distribution of extensity parameters suggests that R&D efforts and investments should be targeted on regions/ districts having comparatively higher share in VOP, rural poor and land available for livestock production. The shares of the districts or zones, however, varied considerably for each of the extensity parameter. A composite index of allocation of resources (weighted sum of extensity parameters) was generated by assigning equal weights to each of the specified objective. Thus, an initial baseline (IBL) for resource allocation was arrived (indexed to sum up to 100 at state level), and is shown in Table 3.

With efficiency (VOP based allocation) and equity considerations, North-West Alluvial Plains zone would rank higher in priority order, followed by the South-West Alluvial Plains. Except for Begusarai, Samastipur and Sheohar, all other districts in the North-West Alluvial Plains would gain with equity considerations in the resource allocation process, while most districts in the South-West Alluvial Plains (except Aurangabad and Nalanda) would lose their shares. The priority ranking of regions remains almost the same on incorporation of the sustainability indicators in resource allocation exercise. North-West Alluvial Plains (Zone-I) maintains its position in share in resources, and was followed by the South-West Alluvial Plains (Zone-IIIB). The IBL/VOP ratio indicates that without considering the intensity of the problem, all the districts in the North-West Alluvial Plains (except Begusarai, Samastipur and Sheohar) would improve their shares in resources over the efficiency-based allocation. In the South-West Alluvial Plains, except the districts of Arwal, Aurangabad, Gaya and Nawada, all other districts would lose their share considerably. In South-East Alluvial Plains, only Jamui district would gain its share in the IBL allocation over the efficiency-based allocation. In North-East Alluvial Plains, districts of Araria, Katihar, Madhepura and Purnia would gain while others would lose their share of resources.

The IBL has been modified to incorporate the intensity of the problem to be addressed through technology, investment and infrastructure. The modified or final base line (FBL) is also shown in Table 3. The distribution pattern of resources undergoes a change when both size of the problem and intensity of the problem are considered together in resource allocation. At the zone level, the difference between IBL and FBL based allocations is marginal. The difference, however, becomes substantial at a more disaggregated level that is at the district level. This indicates that neglect of the intensity of the problem may lead to sub-optimal allocation of the resources.

These tradeoffs between different R&D objectives become more pronounced when the FBL-based allocations are compared with the VOP - based allocations. This is reflected by the FBL/VOP ratios. In the absence of tradeoffs among objectives, the FBL/ VOP ratio should be closer to unity (say 0.95-1.05). A ratio of greater than unity for a district implies that concerns for equity and sustainability favour more allocation of resources to the concerned district or vice versa. The tradeoffs in resource allocation are shown in Table 4. The FBL/VOP ratio lies between 0.95 and 1.05 only for a few districts, viz. Banka, Nalanda, Jahanabad and Darbhanga. It means that the share of

Table 4. Tradeoff in regional research priorities in Bihar

Ratio (FBL/VOP)	Districts
>1.50	Arwal, Sitamarhi, Katihar, Gaya, East Champaran
1.25-1.50	Siwan, Gopalgunj, Saran, Purnia
1.05-1.25	Darbhanga, Khagria, Nawada, Muzaffarpur, Kisangunj, Madhepura, Araria, Aurangabad, West Champaran, Vaishali, Jamui, Madhubani
0.95-1.05	Banka, Nalanda, Jahanabad
0.75-0.95	Buxar, Lakhisarai, Patna, Bhagalpur, Supaul, Bhabhua
< 0.75	Bhojpur, Sheohar, Samastipur, Rohtash, Shekhpura, Saharsa, Begusarai, Munger

Table 5. Allocation of research resources to different livestock species in Bihar, 2008-2010

(in per cent)

Species	Efficiency	All objectives (FBL)	FBL/ VOP
Cattle	40.45	39.78	0.98
Buffalo	49.29	47.97	0.97
Sheep	0.12	0.12	0.98
Goat	5.80	6.87	1.18
Pig	2.39	2.94	1.23
Poultry	1.94	2.33	1.20

these districts in the total resources for livestock R&D would remain unchanged whether these are allocated based on economic efficiency criterion alone or in combination with equity and sustainability criteria.

The FBL/VOP ratios for districts other than these indicate that concerns for equity and sustainability lead to considerable regional tradeoffs in resource allocation. With these concerns, Sheohar, Samastipur and Begusarai districts in the North-West Alluvial Plains, and Saharsa and Supaul districts in the North-East Alluvial Plains would lose their shares over efficiency-based allocation. The districts of Gaya, Arwal, Jahanabad, Nawada and Aurangabad in the South-West Alluvial Plains and Jamui in the South-East Alluvial Plains would gain over efficiency-based allocation. In the South-East Alluvial Plains, only Jamui would gain when intensity parameters are taken into consideration in the resource allocation process. It may be noted that most of the districts 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 more developed.

The pattern of distribution of research resources across species in the state level is shown in Table 5. In the final allocation (FBL-based allocation), buffalo with a share of 49 per cent in the total resources ranks higher in priority order of R&D and is followed by cattle (40%). Small ruminants (mainly goat), pig and poultry receive 7.0 per cent, 2.9 per cent and 2.3 per cent, respectively of the total resources available for livestock development in the state. When compared with VOP- based allocation, there is a marginal reduction in resources allocation for buffalo and cattle, and a higher allocation for development of pigs, goats and poultry.

An important dimension of the research prioritization is the distribution of species-specific allocations across regions/districts. This means, that if there is ₹ 100 available for a species at state level, how these should be allocated across different regions/ districts. This is shown in Table 6. For cattle development, south-west alluvial plains and north-west alluvial plains should be allocated 39 per cent and 36 per cent of the total resources, respectively. Amongst districts, Gaya, Rohtash, Madhubani, Patna, East Champaran and Muzaffarpur are the important candidates for resources for cattle development (Annexure Table 2). Again, the North-West Alluvial Plains should be targeted for buffalo development (34.6%), followed by the South-West Alluvial Plains (25.1%). The districts of Jamui, Banka, Gaya, Muzaffarpur, Bhagalpur and Patna should receive priority for buffaloes than any other district in the state.

The R&D efforts for sheep should concentrate in the South-West Alluvial Plains. The districts of Aurangabad, Bhabua, Jamui, Buxer and Rohtash are important for targeting development of sheep husbandry. Of the total resources allocated for development of goat, about 39 per cent should be allocated to North-West Alluvial Plains and North-East Alluvial Plains. The districts of West Champaran, East Champaran, Araria, Katihar and Purnia should each receive around 6 per cent of the total resources allocated

Table 6. Distribution of livestock species-specific resources across zones in Bihar, 2008-2010

(in per cent)

Zone	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	All
North-West Alluvial Plains	36.37	34.57	14.72	38.92	21.39	36.40	35.22
North-East Alluvial Plains	14.82	15.56	5.42	33.18	15.62	34.97	16.91
South-East Alluvial Plains	9.93	24.77	13.24	11.04	9.30	7.05	17.05
South-West Alluvial Plains	38.88	25.10	66.62	16.86	53.69	21.58	30.82

Table 7. Allocation of resources across livestock species in different zones of Bihar, 2008-2010

(per cent)

Zone	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
North-West Alluvial Plains	41.08	47.09	0.05	7.59	1.78	2.41
North-East Alluvial Plains	34.85	44.12	0.04	13.47	2.71	4.81
South-East Alluvial Plains	23.18	69.72	0.10	4.45	1.60	0.96
South-West Alluvial Plains	50.17	39.06	0.26	3.75	5.11	1.63
Bihar	39.78	47.97	0.12	6.87	2.94	2.33

for the goat R&D in the state. Almost half of the resources for piggery development should be earmarked for the South-West Alluvial Plains, followed by North-West Alluvial Plains (21.4%). Of all the districts receiving priority for piggery development, Gaya alone requires 28 per cent of the resources followed by Nawada, Jamui, Jahanabad and Katihar districts.

The North-West Alluvial Plains should be the priority for poultry development with a share of 36 per cent in the total resources earmarked for the poultry sector in the state. In this zone, Sitamarhi, Saran, East Champaran, West Champaran and Madhubani districts should receive higher priority for poultry development. North-East Alluvial Plain zone follows closely, with a share of 35 per cent in the total investment for poultry development in the state. Interestingly, the districts of Purnea, Katihar, Kisanganj and Araria, that rank higher in priority for poultry development resources, fall in this zone.

The relative importance of livestock species varies across regions/districts; hence it is important to examine the share of different species in the total resources available for livestock development in a particular region/district. Table 7 shows the species-wise priorities in different zones. The results indicate that buffalo will attract significant attention in the livestock R&D in three out of the four zones, except in the South-West Alluvial Plains, where cattle appears to be the main candidate for developmental resources. Small animals, particularly goat, pig and poultry, though are important to the poor, their share in total resources in any of the zones hardly exceeds 20 per cent.

Priority ranking of livestock species in different districts, shown in Annexure Table 3, suggests that more than 80 per cent of the resources will have to be allocated to the development of buffalo and cattle. Buffaloes remain important in most of the districts. However, cattle compete with buffalo in some of these districts, viz. Goapalgunj, Siwan, Vaishali, Sahrasha, Arwal, Aurangabad, Gaya and Nawada.

Goat development should receive a higher priority in the districts of Katihar, Purnia, West Champaran, Kisangunj and Araria — each requiring 15 per cent or more share in the resources. Pig and poultry both require around 2 per cent to 3 per cent of the resources with Gopalgunj, Jahanabad, Nawada and Gaya being the districts higher in priority ranking. Kisanganj, Katihar and Araria districts are important for poultry development.

Conclusions and Policy Implications

The livestock sector plays a significant role in the small and marginal farmers dominated agrarian economy of Bihar. The sector is growing at a rate of around 8 per cent. However, the momentum of growth may succumb to acute deceleration in future if the sector is not supported by technologies, investments, institutions and infrastructure. It is imperative to have a well-set priority prescription to target efforts and resources in a way to improve efficiency and efficacy of livestock research and development. This study has generated regional and species priorities for the development of livestock sector in the state of Bihar and has also provided research agenda for different livestock species.

The results of the prioritization exercise for Bihar have suggested a higher allocation of R&D resources to the North-West Alluvial Plains (Zone I) (35.2%), followed by the South-West Alluvial Plains (Zone IIIB) (30.8%). Rest of the resources are to be shared almost equally between the North-East Alluvial Plains (Zone II) and the South-East Alluvial Plains (Zone IIIA). Amongst districts, higher priority should be accorded

to Gaya, followed by Patna, Muzzafarpur, Jamui, East Champaran, Banka, Madhubani, Bhagalpur and Saran and therefore, the R&D resources should be allocated accordingly.

Buffalo should continue to receive a higher priority with a share of 48 per cent in the total R&D resources. Cattle ranks next (40%), followed by goat, pig and poultry. Species-specific distribution has suggested accordingly high priority to cattle development in the South-West Alluvial Plains (Zone IIIB) and the North-West Alluvial Plains (Zone I), as these zones offer a greater opportunity for dairy development by allocating R&D resources on cattle development. The North-West Alluvial Plains (Zone I) and South-West Alluvial Plains (Zone IIIB) are crucial for buffalo development and thus, these zones should receive top priority for the development of buffaloes. The North-East Alluvial Plains (Zone II) has been found to be important for the development of goat, while the North-West Alluvial Plains (Zone I) should receive the highest priority for poultry development.

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APPENDICES

Annexure Table1. Initial and final base lines for resource allocation across districts of Bihar, 2008-2010

Districts	VOP	POOR	LAND	VOP and POOR	IBL=VOP, POOR and LAND	IBL/VOP	FBL	FBL/VOP
North-West Alluvial Plains (Zone I)								
Begusarai	2.98	1.17	1.69	2.08	1.95	0.65	2.05	0.69
Darbhanga	2.07	3.11	1.33	2.59	2.17	1.05	2.17	1.05
East Champaran	1.97	7.38	2.68	4.67	4.01	2.04	3.67	1.86
Gopalgunj	1.55	2.78	1.33	2.16	1.89	1.22	1.97	1.27
Madhubani	2.27	6.31	2.24	4.29	3.61	1.59	3.36	1.48
Muzaffarpur	3.85	7.66	2.11	5.75	4.54	1.18	4.38	1.14
Samastipur	3.84	1.60	1.40	2.72	2.28	0.59	2.34	0.61
Saran	2.44	4.58	3.25	3.51	3.42	1.40	3.22	1.32
Sheohar	2.65	0.81	0.50	1.73	1.32	0.50	1.57	0.59
Sitamarhi	1.76	4.71	1.45	3.24	2.64	1.50	2.84	1.61
Siwan	1.87	3.72	1.48	2.80	2.36	1.26	2.35	1.25
Vaishali	1.83	3.64	2.35	2.73	2.61	1.42	2.57	1.40
West Champaran	2.21	3.84	2.72	3.03	2.93	1.32	2.75	1.24
North-East Alluvial Plains (Zone II)								
Araria	1.77	2.21	1.92	1.99	1.97	1.11	2.09	1.18
Katihar	1.64	2.69	3.69	2.17	2.67	1.63	2.65	1.62
Khagaria	1.22	0.38	1.51	0.80	1.03	0.85	1.31	1.08
Kisanganj	1.84	1.63	1.85	1.74	1.77	0.96	2.12	1.15
Madhepura	1.50	2.16	1.00	1.83	1.56	1.04	1.75	1.17
Purnia	1.80	1.98	3.47	1.89	2.42	1.35	2.45	1.36
Saharsa	3.12	1.13	1.35	2.12	1.87	0.60	2.09	0.67
Supaul	2.97	1.49	2.48	2.23	2.31	0.78	2.45	0.82
South-East Alluvial Plains (Zone- IIIA)								
Banka	3.62	2.13	5.18	2.88	3.64	1.01	3.45	0.95
Bhagalpur	4.07	2.85	3.37	3.46	3.43	0.84	3.29	0.81
Jamui	2.95	2.68	7.48	2.82	4.37	1.48	4.16	1.41
Lakhisarai	3.17	0.95	2.68	2.06	2.27	0.72	2.38	0.75
Mungher	2.87	0.97	1.91	1.92	1.92	0.67	1.99	0.69
Shekhpura	2.79	0.52	0.86	1.66	1.39	0.50	1.78	0.64
South-West Alluvial Plains (Zone-IIIB)								
Arwal	0.61	0.29	0.95	0.45	0.62	1.01	0.97	1.58
Aurangabad	2.28	3.17	3.05	2.72	2.83	1.24	2.75	1.21
Bhabhua	2.86	1.93	3.25	2.40	2.68	0.94	2.65	0.93
Bhojpur	4.58	1.96	1.01	3.27	2.52	0.55	2.55	0.56
Buxer	2.75	2.00	0.94	2.38	1.90	0.69	2.05	0.75
Gaya	3.68	3.56	13.77	3.62	7.00	1.90	6.17	1.67
Jahanabad	1.36	0.46	1.62	0.91	1.15	0.84	1.41	1.03
Nalanda	2.65	3.45	1.52	3.05	2.54	0.96	2.52	0.95
Nawada	1.89	1.01	2.86	1.45	1.92	1.02	2.11	1.12
Patna	5.72	4.23	5.55	4.98	5.17	0.90	4.47	0.78
Rohtash	4.97	2.83	2.19	3.90	3.33	0.67	3.17	0.64

Note: VOP = Value of Livestock Production, POOR = Number of Rural Poor, LAND = Land Available for Livestock Production, IBL = Initial Base Line, and FBL = Final Base Line

Annexure Table 2. Species-specific allocation across districts of Bihar, 2008-2010

Districts	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	All
Northwest Alluvial Plains (Zone I)							
Begusarai	1.14	3.19	0.03	0.72	0.18	0.38	2.05
Darbhanga	3.00	1.55	0.15	1.94	1.08	2.77	2.17
East Champaran	4.37	2.67	1.73	6.47	3.12	4.79	3.67
Gopalgunj	2.16	1.69	0.59	2.09	3.60	1.93	1.97
Madhubani	4.79	2.22	0.35	3.83	1.72	3.51	3.36
Muzaffarpur	4.02	4.98	3.71	3.77	1.91	2.83	4.38
Samastipur	1.90	3.07	1.13	1.12	0.24	1.01	2.34
Saran	3.11	3.41	4.30	2.02	2.72	5.07	3.22
Sheohar	1.45	1.97	0.00	0.44	0.54	0.15	1.57
Sitamarhi	2.62	2.58	0.15	5.47	2.08	5.45	2.84
Siwan	2.63	2.29	1.75	1.51	1.78	1.90	2.35
Vaishali	2.78	2.55	0.65	2.40	0.36	2.76	2.57
West Champaran	2.40	2.40	0.17	7.15	2.08	3.84	2.75
North-East Alluvial Plains (Zone II)							
Araria	1.63	1.65	0.38	6.44	2.13	6.14	2.09
Katihar	1.04	3.10	0.75	6.13	4.59	8.37	2.65
Khagaria	0.89	1.64	0.03	1.77	0.69	0.95	1.31
Kisangunj	2.60	1.03	0.04	5.55	1.19	7.72	2.12
Madhepura	1.93	1.38	0.05	3.24	2.56	1.23	1.75
Purnia	1.56	2.35	0.63	6.04	2.63	8.76	2.45
Saharsa	2.53	2.00	0.06	1.30	0.78	0.62	2.09
Supaul	2.63	2.40	3.46	2.71	1.06	1.18	2.45
South-East Alluvial Plains (Zone-IIIA)							
Banka	1.81	5.14	3.10	2.39	1.59	1.96	3.45
Bhagalpur	1.78	4.88	0.00	2.59	0.73	1.95	3.29
Jamui	2.05	5.90	9.85	4.24	5.27	2.19	4.16
Lakhisarai	1.21	3.81	0.11	0.65	0.68	0.31	2.38
Mungher	2.05	2.27	0.16	0.88	0.54	0.48	1.99
Shekhpura	1.03	2.77	0.02	0.31	0.49	0.17	1.78
South -West Alluvial Plains (Zone-IIIB)							
Arwal	1.10	0.91	2.21	0.64	0.81	1.08	0.97
Aurangabad	3.11	2.48	16.33	2.63	2.65	2.00	2.75
Bhabhua	3.88	2.14	14.66	0.49	0.60	0.49	2.65
Bhojpur	3.62	2.14	5.45	0.50	1.08	0.52	2.55
Buxer	3.51	1.17	7.64	0.44	1.15	0.94	2.05
Gaya	5.84	5.14	5.46	5.98	28.06	6.02	6.17
Jahanabad	2.02	0.83	1.93	0.64	4.67	0.90	1.41
Nalanda	3.90	1.52	2.66	1.23	3.31	2.56	2.52
Nawada	2.01	1.75	1.56	2.37	8.20	2.80	2.11
Patna	4.76	4.90	2.18	1.05	2.52	3.41	4.47
Rohtash	5.14	2.11	6.52	0.87	0.66	0.86	3.17

Annexure Table 3. Species priorities in different districts of Bihar, 2008-2010

(in per cent)

Districts	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
North-West Alluvial Plains (Zone I)						
Begusarai	22.07	74.83	0.00	2.41	0.25	0.43
Darbhanga	55.07	34.36	0.01	6.13	1.46	2.97
East Champaran	47.41	34.89	0.06	12.10	2.50	3.04
Gopalgunj	43.69	41.31	0.04	7.29	5.37	2.29
Madhubani	56.57	31.67	0.01	7.81	1.50	2.43
Muzaffarpur	36.56	54.63	0.10	5.92	1.28	1.51
Samastipur	32.33	63.03	0.06	3.28	0.30	1.00
Saran	38.50	50.87	0.16	4.32	2.48	3.67
Sheohar	36.81	60.05	0.00	1.92	1.00	0.23
Sitamarhi	36.65	43.53	0.01	13.21	2.15	4.46
Siwan	44.66	46.72	0.09	4.42	2.23	1.88
Vaishali	43.04	47.59	0.03	6.42	0.41	2.50
West Champaran	34.73	41.92	0.01	17.86	2.22	3.25
North-East Alluvial Plains (Zone II)						
Araria	31.00	37.95	0.02	21.20	2.99	6.85
Katihar	15.61	56.09	0.03	15.86	5.07	7.34
Khagaria	27.20	60.25	0.00	9.30	1.56	1.70
Kisangunj	48.70	23.25	0.00	17.95	1.64	8.46
Madhepura	43.73	37.67	0.00	12.68	4.28	1.63
Purnia	25.40	46.14	0.03	16.94	3.16	8.33
Saharsa	48.17	45.77	0.00	4.28	1.09	0.69
Supaul	42.76	47.09	0.17	7.59	1.27	1.12
South-East Alluvial Plains (Zone IIIA)						
Banka	20.90	71.56	0.11	4.75	1.36	1.32
Bhagalpur	21.51	71.06	0.00	5.40	0.65	1.38
Jamui	19.66	68.11	0.29	7.00	3.72	1.22
Lakhisarai	20.23	76.76	0.01	1.87	0.84	0.30
Mungher	40.96	54.66	0.01	3.02	0.79	0.56
Shekhpura	22.96	74.82	0.00	1.19	0.81	0.23
South-West Alluvial Plains (Zone- III B)						
Arwal	45.04	45.07	0.28	4.56	2.47	2.58
Aurangabad	44.95	43.25	0.73	6.57	2.83	1.69
Bhabhua	58.20	38.75	0.68	1.28	0.66	0.43
Bhojpur	56.40	40.27	0.26	1.36	1.24	0.47
Buxer	67.98	27.37	0.46	1.47	1.65	1.07
Gaya	37.64	39.97	0.11	6.66	13.35	2.27
Jahanabad	57.10	28.41	0.17	3.10	9.73	1.49
Nalanda	61.40	28.90	0.13	3.36	3.85	2.36
Nawada	37.91	39.79	0.09	7.72	11.40	3.09
Patna	42.38	52.53	0.06	1.60	1.65	1.78
Rohtash	64.61	32.01	0.25	1.89	0.61	0.63