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Can Livestock Sector be the Game Changer in Enhancing the Farmers' Income? Reinvesting Thrust with Special Focus on Dairy Sector[§]

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Abstract

The livestock sector provides promising opportunities and is assumed to bring desired growth in farmers' income, especially in less and poor endowed regions. The present study has delineated the entire country into four zones, viz. Least Performing Zone (LPZ), Average Performing Zone (APZ), Good Performing Zone (GPZ) and Well Performing Zone (WPZ) based on district level livestock income for effective policy formulation and implementation. The drivers of livestock income were identified through multiple regression framework for regional interventions. Crossbred adoption and crossbred milk yield with elasticity of 0.09 and 0.42, respectively, are found to significantly contribute to enhancing livestock income. Thus, crossbreeding should be geared up especially in LPZ as an income enhancement strategy. The buffalo farming has emerged as an important contributor in raising farmers' income through meat production. The productivity enhancement strategy for buffaloes along with indigenous cattle will be a win-win situation as these animals are well adapted to tropical climate of the country. Further, special attention is required for strengthening marketing network through co-operatives for better procurement and prices with utmost priority in LPZ, as only 12 per cent of milk produced is sold to the co-operatives. The state governments in conjunction with all stakeholders, including research institutions and private players have to play a catalytic role in mainstreaming the livestock development, especially in the identified disadvantageous regions/zone as an entry point for the socio-economic upliftment of the region as well as the nation as a whole.

Key words: Livestock income, income zones, crossbred adoption, milk yield, milk marketing, dairy sector, farmers' income

JEL Classification: Q13, Q18

Introduction

Animal husbandry has been an integral component of Indian agriculture since time immemorial due to its multifarious contributions to the society in the form of nutrient-rich food products, clothing, drought power,

income and employment. The gross value added (GVA) from livestock sector contributed 4 per cent to the total GVA and 26.7 per cent to the agricultural GVA in 2014-15 (at 2011-12 prices) (BAHS, 2016). During the recent decade (2004-05 to 2014-15), crop, livestock and fisheries registered growth of 2.93 per cent, 6.11 per cent and 5.13 per cent per annum, respectively. The pattern indicates that overall growth in agriculture moves parallel with the crop sector growth. The same

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is also confirmed from the year-on-year fluctuations in different sub-sectors. The livestock sector is growing at an appreciable and sustainable rate and is ahead among all sub-sectors of agriculture.

It is remarkable to mention that the livestock sector has never attained a negative growth in any of the years during the span of past 34 years; the lowest growth rate attained in the sector was just one per cent in the year 2003-04. Thus, the livestock sector is likely to emerge as an engine of growth of agricultural sector and can be relied upon for risk mitigation and loss minimization for the farmers in case of even worst outcomes from other sub-sectors. The Previous studies have unanimously reported that livestock is the best insurance against agrarian distress as the sector is the source of sustained income and generates income more frequently than the crop sector.

The livestock sector is being considered as one of the promising sectors for enhancing farmers' incomes. As many pockets/clusters in the country largely rely on this sector as one of the major sources of income, it is important to delve out how the livestock incomes in different regions could be enhanced. Dairying contributes significantly to the livestock sector in terms of share in gross value added and animal population. Milk production in India has grown at more than 4 per cent compounded annually during 1981-2011, surpassing the growth rates in the global dairy output and India's own food grain production (Birthal and Negi, 2012). Among the various species of livestock, cattle and buffalo account for around 60 per cent of the livestock population in the country. India possesses about 118.59 million milch dairy animals (2012 Livestock Census) producing 155.5 million tonnes of milk (BAHS, 2016). As dairying has a predominant share in livestock production and population, this paper has looked into its potential for enhancing farmers' income by providing a special focus on the dairy sector.

Data and Approach

Data

The study is primarily based on the data of agricultural households published in Situation Assessment Survey (SAS) 2014, which provides information on the key characteristics like socio-economic dimensions of agricultural households,

particularly cost and receipts from crop cultivation and animal husbandry, income from non-farm sources, wages & salaries, etc. The study relied on the district level estimates of farm income from different sources, viz., crop, livestock, wages & salaries, and non-farm business, which were arrived at from unit record household data for 2012-13. Data regarding district level milk yield for the year 2012-13 (or the latest available year) were sourced from Integrated Sample Survey (ISS) report of Department of Animal Husbandry of different states. The district level milch population of cattle (crossbred and indigenous) and buffaloes were collected from Livestock Census, 2012. The information regarding smallholders (including marginal and small farmers) was obtained from the Agricultural Census, 2010-11.

Delineation of Livestock Income Zones

The district level livestock income varies significantly across regions and states; it was presumed that different strategies and plans for boosting the livestock sector would be required based on its existing performance. Considering this, an effort was made to delineate income zones based on district level livestock income. For this, K means clustering technique was used and four broad zones were identified (Annexure 1). These were given nomenclature as: (i) Least performing zone (LPZ), (ii) Average performing zone (APZ), (iii) Good/Moderate performing zone, and (iv) Well performing zone.

The zoning was done so as to minimize within cluster sum of square (i.e., variance). The algorithm followed for the clustering is given in Equation (1):

$$\operatorname{argmin}_Z \sum_{i=1}^k \sum_{X \in Z_i} \|X - \mu_i\|^2 = \operatorname{argmin}_Z \sum_{i=1}^k |Z_i| \operatorname{Var} Z_i \quad \dots(1)$$

where, Z indicates i^{th} zone ($i=1,2,3,4$), X is livestock income, μ_i is the mean of points in Z_i and $\operatorname{Var} Z_i$ indicates variance within the i^{th} zone.

The delineation exercise provided us a resulted in few special cases where only one or only a few districts of a state were kept in a single zone. For agro-climatic zonal planning, these may be clubbed into the adjacent/ closely behaving zone for the sake of contiguity. However, we have retained those as special cases due to a significant variation in the livestock income (theme/classifying variable) and classified it as a

separate zone. This is important for formulation of district strategic plans for these differently performing districts.

Determinants of Livestock Income

The study attempted to identify the drivers of livestock income through multiple regression framework. A number of models were fitted to the district level data on selected dimensions. The impact of the income drivers on the livestock income was estimated by the model (2) :

$$\log(L_Income_i) = \beta_0 + \beta_1 \log(CB_IC_R_i) + \beta_2 \log(CB_MY_i) + \beta_3 \log(B_C_R_i) + \beta_4 \log(B_MY_i) + \beta_5 \log(IC_MY_i) + \beta_6 \log(Crop_Share_i) + \beta_7 \log(NonFarm_Share_i) + \beta_8 \log(S_M_N_i) + \epsilon \quad \dots(2)$$

where, L_Income indicates income from livestock sources, CB_IC_R implies crossbred adult female to indigenous adult female cattle ratio, CB_MY is crossbred milk yield, B_C_R is adult female buffalo to adult female cattle (crossbred plus indigenous) ratio, B_MY and IC_MY indicate daily milk productivity of buffaloes and indigenous cattle, respectively, $Crop_Share$ and $NonFarm_Share$ are the shares of income from crop and non-farm (including wages and salaries) sources in the total income of farmers from farm and non-farm activities, S_M_N describes the proportion of small and marginal land holders in total landholdings for i th district and $\beta_1, \beta_2, \dots, \beta_8$ are the output elasticities of the respective input variables. Due to paucity of district level milk yield information for few states, the analysis with respect to livestock income drivers was carried out for 335 districts of the country. For the ease of interpretation and policy prescription, the above regression model was estimated as double log function. The step-wise regression technique was followed to check the multi-collinearity problem and other diagnostics in the model.

Income from Livestock: Delineation of Zones

As detailed in section 2, districts were delineated into four different zones based on the livestock income. A wide variation was observed across the country in distribution of districts into different zones. A clear demarcation could be noticed in the distribution of districts in each state in terms of number and percentage

of geographical area in least performing, average performing, good/moderate performing and well-performing zones (Table 1). A large number of the districts (number) fell under least performing zone. Livestock farming appears to be a sound source of income in Haryana and Gujarat as more than 50 per cent of geographical area of these states was under good and well performing zones and area under LPZ was as low as 14 per cent in Haryana and 16 per cent in Gujarat.

The entire state of Chhattisgarh and the majority of the districts (more than 50 %) in almost all the eastern and southern states were least performing in terms of livestock income. Thus, a special package of practices is required for Chhattisgarh. On an average, an agricultural household in Chhattisgarh, earned only ₹ 426 per month, out of which 41 per cent was received from live animals and only 22 per cent was received from the sale of milk (NSSO, 2014). Similarly, in the case of West Bengal, Telangana, Jharkhand, Bihar and Maharashtra; more than 60 per cent districts are covered in the domain of LPZ. These states derive a sizeable amount of receipts from live animals other than selling of milk. Such states need special considerations and policy focus to boost livestock incomes. The twin states of Bihar and Jharkhand exhibited a contrasting behaviour in terms of livestock receipts; milk provided only 5 per cent receipts to an agricultural household in Jharkhand while it generated 76 per cent receipts for an agricultural household in Bihar (NSSO, 2014).

Dependence on other Sectors for Income

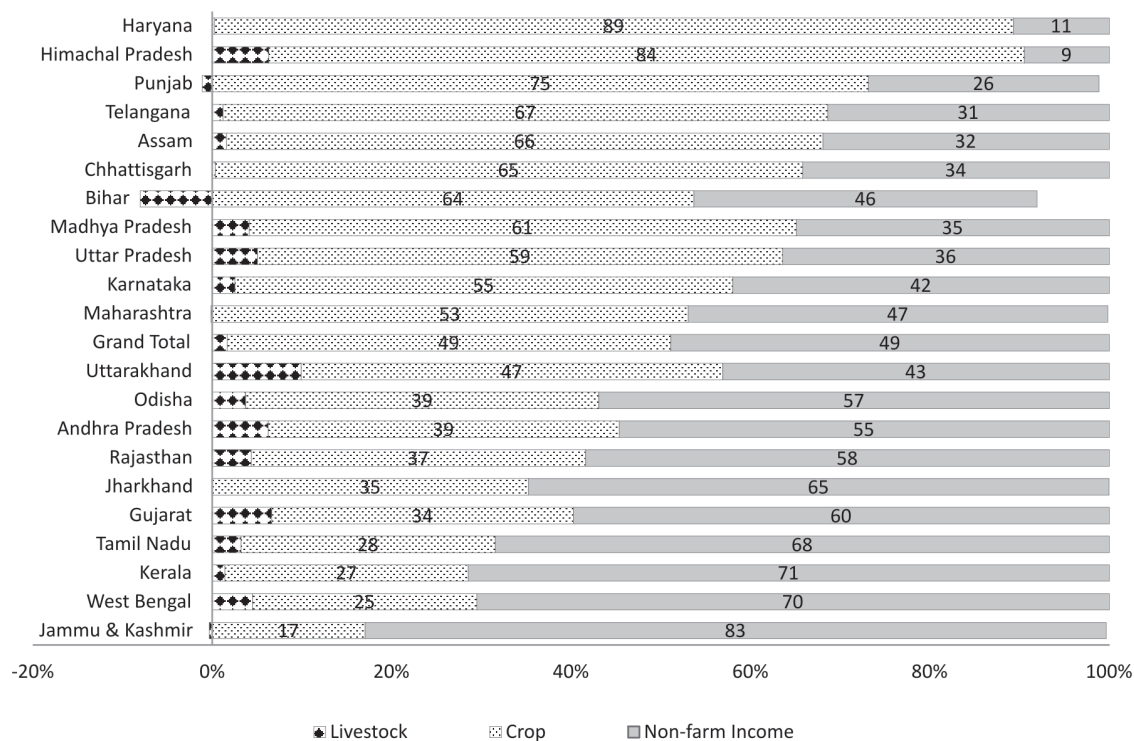
Depending upon the extent of livestock income, the agricultural households rely on alternate sources of income from either crop cultivation or non-farm sources. Even, in some cases, complementarity has been noticed in crop and livestock as the major sources of household income.

Least Performing Zone

The inter-zonal analysis clearly brought out that crop cultivation was the major source of income in the districts of northern states like Punjab, Haryana and Himachal Pradesh falling under this zone, whereas income from non-farm business contributed more (e'' 70 %) in total farm income in Kerala and Jammu & Kashmir (Figure 1). The state of Jharkhand had the least share in farmers' income. Sirohi and Chauhan

Table 1. Proportion of states across the zones delineated on livestock performance basis

States	Least Performing Zone		Average Performing Zone		Good Performing Zone		Well Performing Zone		State Total	
	Districts (No.)	Area share (%)	Districts (No.)	Area share (%)	Districts (No.)	Area share (%)	Districts (No.)	Area share (%)	Total districts	Geographical area (sq. km)
Andhra Pradesh	6	42	3	32	2	18	2	8	13	160205
Assam	13	44	8	24	4	25	2	7	27	78438
Bihar	24	64	13	35	1	1		0	38	94163
Chhattisgarh	18	100		0		0		0	18	135192
Gujarat	4	16	9	18	8	28	5	38	26	196244
Haryana	3	14	5	15	7	48	6	24	21	44212
Himachal Pradesh	1	12	9	53	2	35		0	12	55673
Jammu & Kashmir	11	86	6	6	4	8		0	21	101387
Jharkhand	18	79	2	5	2	6	2	11	24	79716
Karnataka	16	59	11	26	2	8	1	7	30	191791
Kerala	8	61	5	28	1	11		0	14	38852
Madhya Pradesh	19	38	24	49	7	13		0	50	308252
Maharashtra	20	58	7	20	6	22		0	33	307713
Odisha	16	50	3	13	6	20	5	17	30	155707
Punjab	6	27	7	35	4	23	3	16	20	50362
Rajasthan	9	27	17	42	7	31		0	33	342239
Tamil Nadu	16	51	10	33	4	10	1	3	31	130060
Telangana	7	75	2	25		0		0	9	114840
Uttar Pradesh	32	45	35	48	3	5	1	2	71	240928
Uttarakhand	5	46	6	30	2	23		0	13	53483
West Bengal	16	83	2	17		0		0	18	88752
All states (above)	268	49	184	29	72	16	28	6	552	2968209

**Figure 1. Different sources of income for Least Performing Zone in livestock sector**

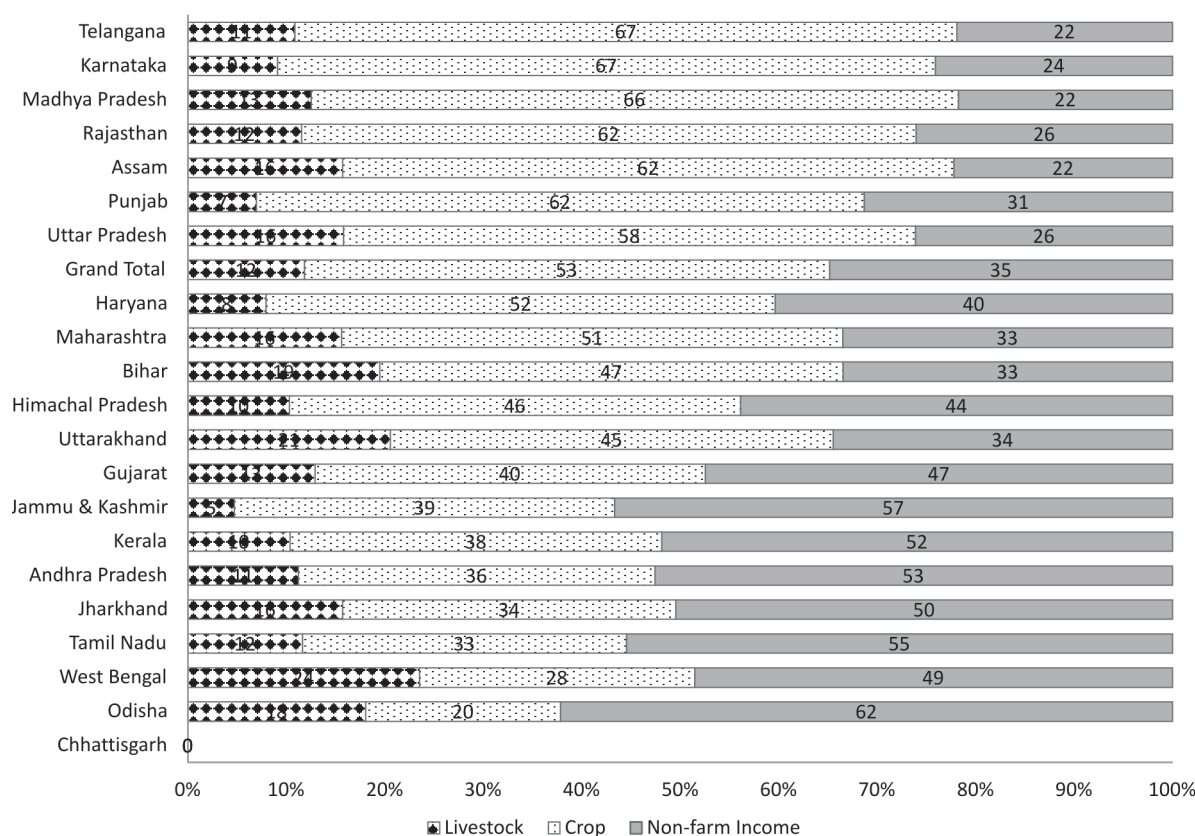


Figure 2. Different sources of income for Average Performing Zone in livestock sector

(2011) have reported that productivity of large and small ruminants is poor in the state due to lack of adoption of improved technology, feeding and management practises along with improper health care and poor infrastructural facilities.

Average Performing Zone

The share of income from livestock farming varied between 5 and 24 per cent in the APZ, while dependency on crop cultivation varied widely across the states and contributed as high of 67 per cent to total farm income in the states of Telangana and Karnataka. The non-farm sources contributed the highest in southern coastal states like Odisha, Andhra Pradesh, Tamil Nadu, Kerala and hilly state of Jammu & Kashmir.

Good Performing Zone

In this zone, the range of income share from livestock sources shifted upward and contributed a minimum of 13 per cent as in case of Punjab, Haryana

and Uttar Pradesh to the maximum of 44 per cent (Jammu & Kashmir) (Figure 3). Crop cultivation was the major source of income in the good performing zone of eastern state of Bihar to central Madhya Pradesh along with the northern states of Punjab, Haryana, Uttar Pradesh and Uttarakhand. The non-farm share had a major hold in the good performing zone of hilly territories of Jammu & Kashmir, Himachal Pradesh and southern states of Karnataka and Kerala.

Well Performing Zone

The well performing zone largely depends on the farm incomes from crop cultivation as well as animal husbandry. This zone comprises the well-endowed districts from ten states of the country (Figure 4). Within WPZ, the share of non-farm income was found ranging from 5 per cent in Karnataka to the highest of 32 per cent in Punjab, Assam and Gujarat. In WPZ, the income derived from livestock ranges from 17 per cent (Uttar Pradesh) to 74 per cent (Jharkhand). Only two districts of Jharkhand, viz. Garhwa and Palamu

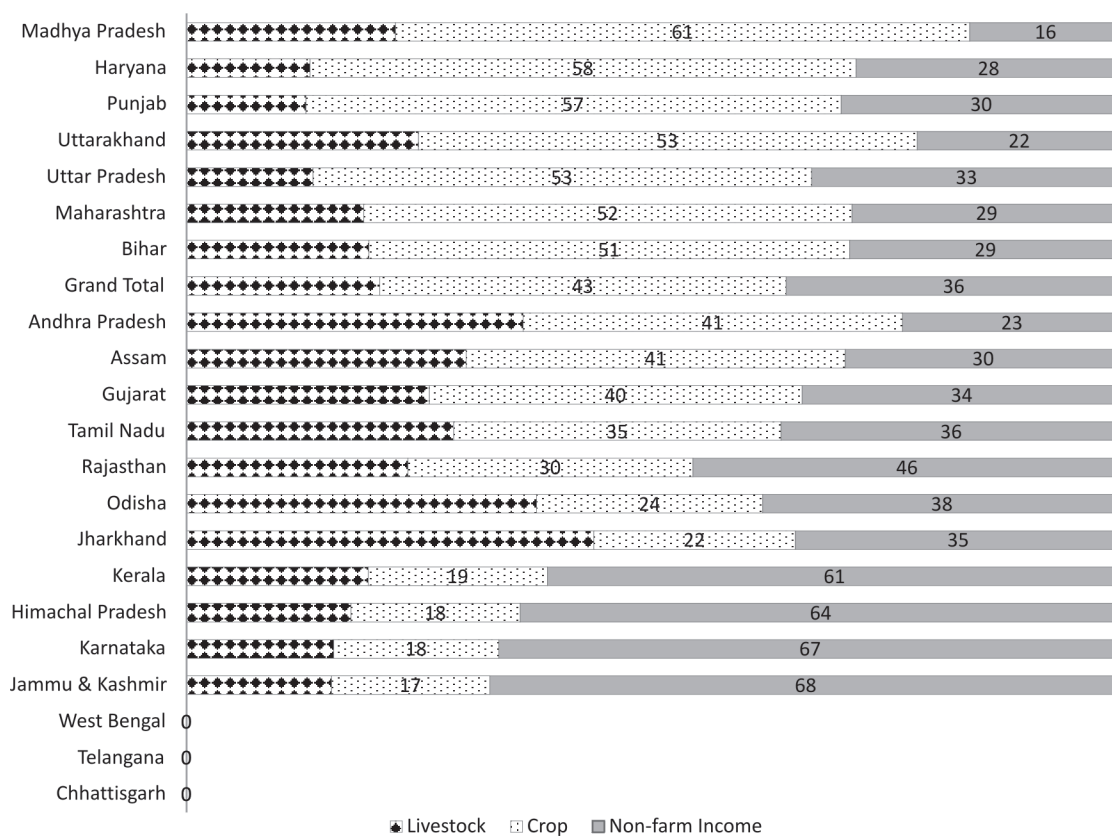


Figure 3. Different sources of income for Good Performing Zone in livestock farming

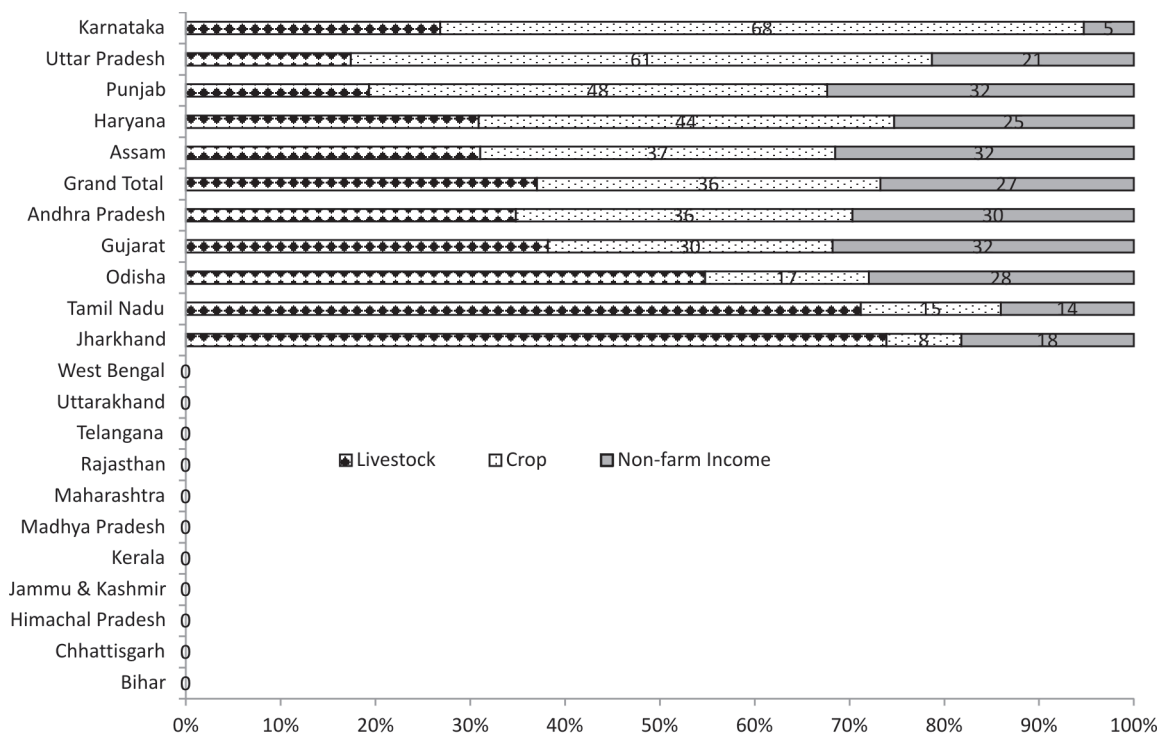


Figure 4. Different sources of income for Well Performing Zone in livestock farming

are parts of WPZ, these districts derive least income (8%) from crop cultivation. Thiruvallur in Tamil Nadu has performed outstandingly and earned around ₹ 11715 per month only from livestock. Saharanpur is the only district in Uttar Pradesh which comes under WPZ. The contribution of livestock income was less than 20 per cent in the well performing regions of Uttar Pradesh (17%) and Punjab (19%). These regions of WPZ were mainly dependent on crop farming. The crop cultivation with 68 per cent contribution was the major source of income in the well performing zone of Karnataka. Well performing regions of Odisha, Tamil Nadu and Jharkhand showed very high dependency, to the tune of 55 to 74 per cent, on livestock farming.

Drivers of Livestock Income

Buffalo to Cattle Ratio

The buffaloes account for about 36 per cent per cent of India's bovine animal population (male plus female) according to the Livestock Census 2012, showing a growth of 3.19 per cent over the previous Census. This designates the increasing importance and preference for buffalo rearing. Buffalo is preferred over cattle in many parts of the country due to its superior quality of milk, disease-resistance capacity, longer productive life and higher milk productivity; therefore, while cattle population is witnessing a downward trend, buffalo population has increased as per 19th Livestock Census (CIRB Vision 2050). Haryana, Punjab, Gujarat and Uttar Pradesh dominate in terms of buffalo population. The proportion of in-milk female adult buffalo population in these states ranges from 21 per cent in Haryana, 37 per cent in Gujarat, 40 per cent in Uttar Pradesh, and 42 per cent in Punjab to the total female population. Amongst top five milk-producing states of Uttar Pradesh, Rajasthan, Andhra Pradesh, Gujarat and Punjab, a predominant contribution to milk pool is from buffalo (CIRB Vision 2050). The buffalo milk realizes higher market price due to its superior quality in terms of high fat content (7.0-7.5 %), which is almost double than in cow milk.

Another output from buffalo rearing, viz. buffalo meat is gaining prominence in the international market. The dominance of buffalo meat in total export from livestock products and its increasing share in agricultural export, especially from the year 1993 owing to abolition of minimum export price condition,

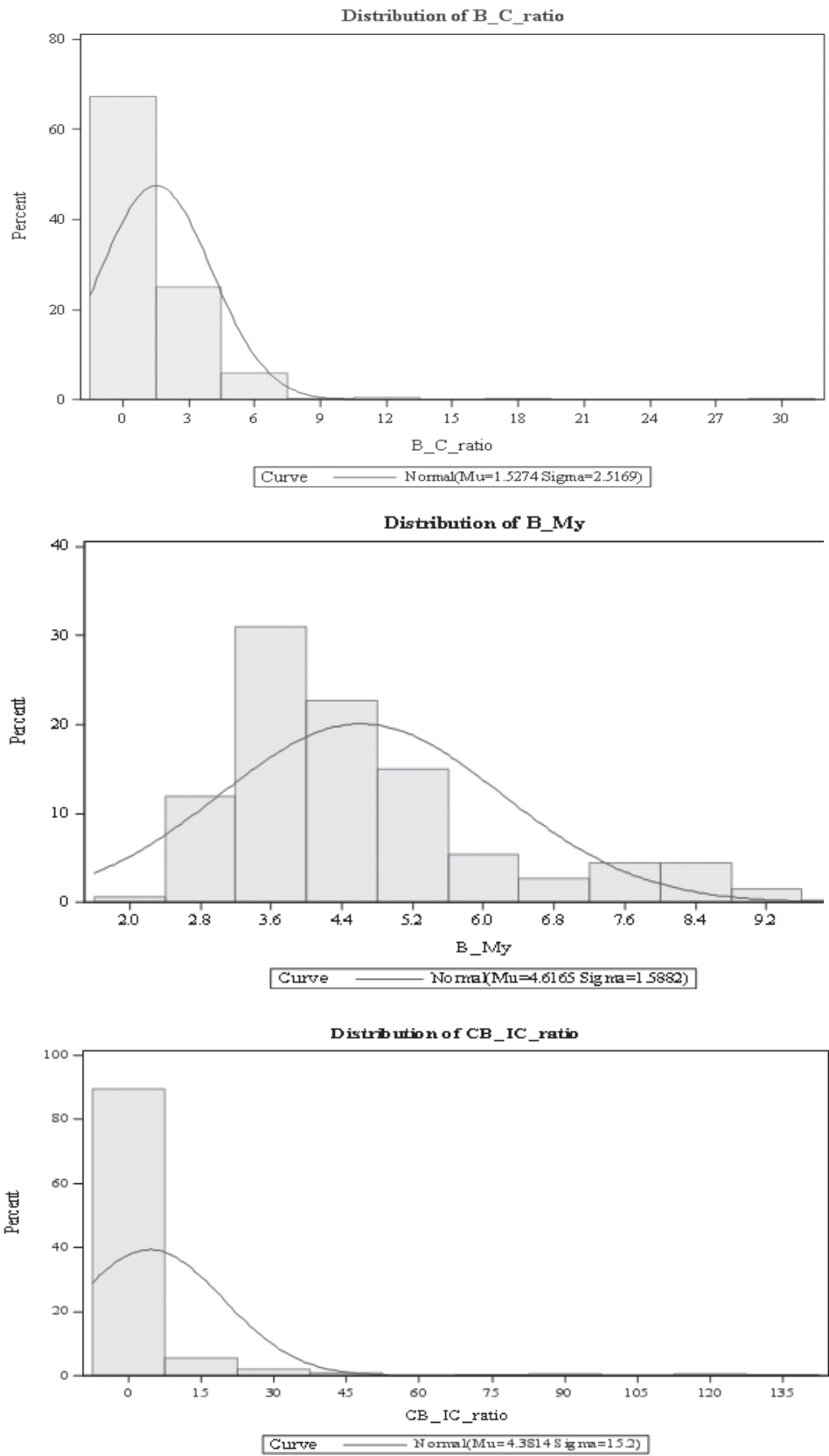
has been well acknowledged (Birthal, 2008; Kumar, 2010; Sirohi and Chauhan, 2011). It contributed around 98 per cent to the total meat exports and around 70 per cent to the total export of animal products from India in 2016-17 (<http://agriexchange.apeda.gov.in>, APEDA). Buffalo meat exports have grown by about 169 per cent during past ten years. Around 1.3 million tonnes of buffalo meat, worth ₹ 26307 crore, was exported from India in 2016-17. The buffalo cattle ratio (BCR) indicates the ratio of adult female buffalo to adult female total cattle (crossbred and indigenous). As we move from low performing zone to well performing zone, the mean value of buffalo to cattle ratio accentuates (Table 2) with maximum value reaching 30 indicating the dominance of buffalo in well performing zone in terms of livestock income. Less than unity mean value of the ratio in least performing zone (0.84) indicates the dominance of cattle in the region and cattle farming was found more prominent in the majority of the districts of least performing zone making the distribution positively skewed (Box 1). The emphasis on buffalo breeding and rearing in LPZ may boost the livestock income. The regression result also clearly indicated the positive significant impact of BCR on livestock income (Table 4). One per cent increase in BCR ratio will increase the livestock income on an average by 0.16 per cent.

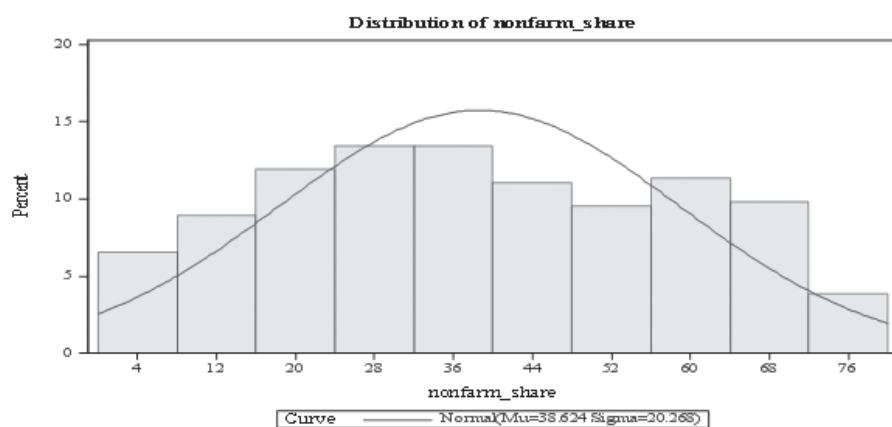
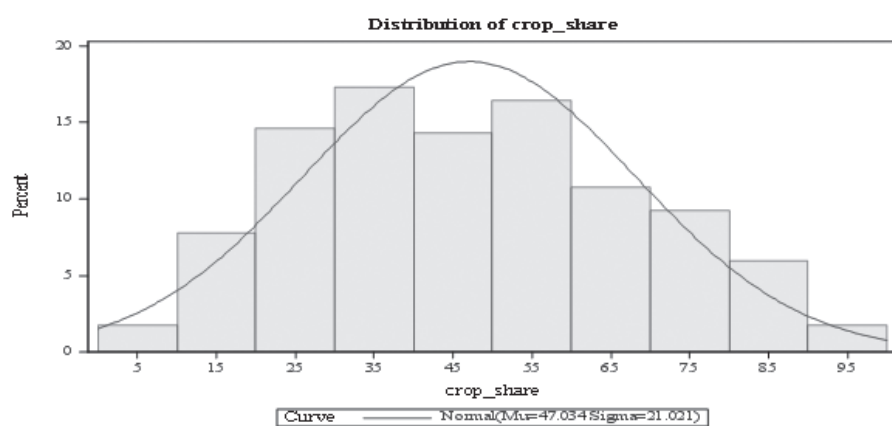
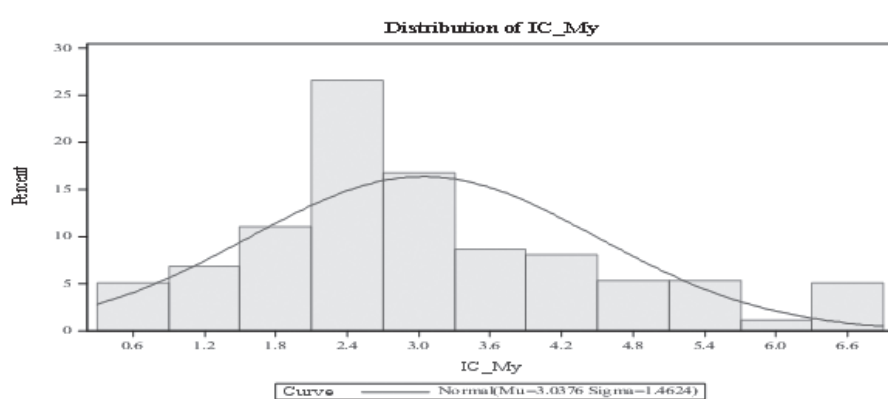
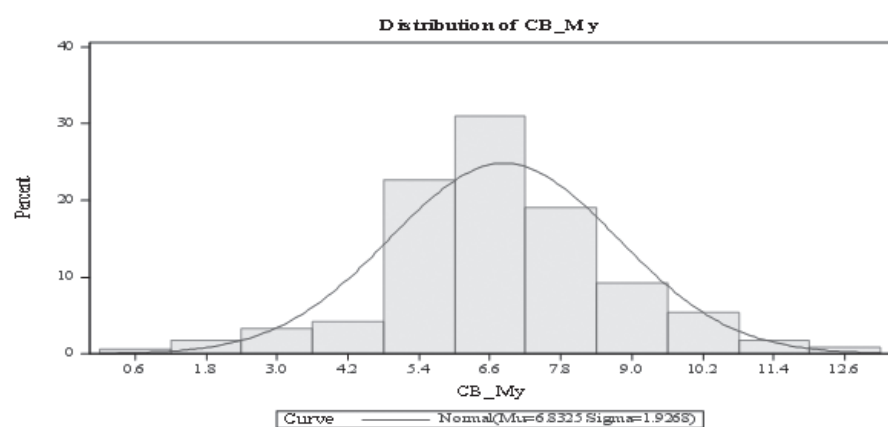
Buffalo Milk Yield

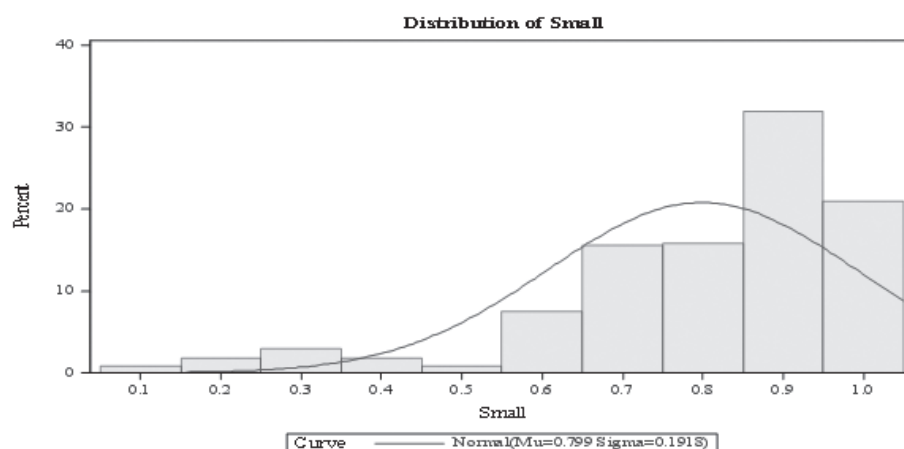
On an average, a female (in-milk) buffalo produced around 4.7 litres of milk per day. The productivity of buffalo is higher than indigenous cattle but lower than crossbred cattle in all the states. The buffalo productivity is highest in Punjab (8.67 litres per animal per day) followed by Haryana (7.33 litres/ animal/ day). However, the productivity is 15 per cent lower in Haryana than in Punjab. Uttar Pradesh, which inhabited around 26 per cent of total in-milk female buffalo population according to Livestock Census 2012, produced only 4.44 litres of milk per day; which is around 50 per cent of the best producing state in the country. There exist pronounced yield gaps across states in terms of buffalo milk productivity, which needs to be addressed through proper breeding strategies and facilitating operating environment.

In the present study, the buffalo milk yield indicates the daily milk productivity of in-milk buffalo during the year 2013-14. The average yield increased from

Box 1. Distribution Plot and descriptive statistics for buffalo milk yield







Note: B_C_ratio is buffalo to cattle ratio, B_My is buffalo milk yield, CB_IC_ratio is crossbred to indigenous cattle ratio, CB_My is crossbred milk yield, IC_My is indigenous cattle milk yield, crop_share and nonfarm_share represent the share of crop and non-farm activity in total household income and small indicates percentage of smallholders in total landholdings.

Table 2. Descriptive statistics for selected drivers of livestock income

Value	Least performing zone	Average performing zone	Good performing zone	Well performing zone	Overall
Buffalo cattle ratio					
Mean	0.84	1.44	2.28	4.01	1.52
S.D	1.19	1.61	4.13	4.81	2.51
Buffalo milk yield (litres/day/animal)					
Mean	4.27	4.54	5.31	5.61	4.61
S.D	1.24	1.59	1.76	2.14	1.58
Crossbred to Indigenous cattle ratio					
Mean	4.90	4.37	6.33	8.66	4.38
S.D	17.99	12.75	21.83	24.98	15.19
Crossbred Milk Yield (litres/day/animal)					
Mean	6.19	6.88	7.53	8.33	6.83
S.D	1.69	2.01	1.85	1.90	1.92
Indigenous cattle milk yield (litres/day/animal)					
Mean	2.57	3.15	3.55	3.77	3.03
Minimum	0.34	0.35	0.60	0.66	0.34
Maximum	6.61	6.71	6.66	6.77	6.77
S.D	1.23	1.44	1.55	2.05	3.02
Crop income (%)					
Mean	45.56	50.48	40.02	34.83	47.12
S.D	24.16	21.25	20.07	16.88	1.46
Non-farm business (%)					
Mean	51.14	34.63	3.55	25.82	38.62
S.D	23.68	19.70	1.55	13.54	20.26
Smallholder (ratio to total holdings)					
Mean	0.84	0.79	0.74	0.74	0.79
S.D	0.16	0.20	0.19	0.21	0.19

least performing zone to well performing zone, however, the difference was not significant. Also, the milk yield was not found to have any significant impact on livestock income (Table 4). The mean overall yield was 4.61 litres/day (Table 1). In most of the districts, the average daily productivity of buffalo was around 3.6 litres/day and the distribution of the yield was positively skewed in the overall region (Box 1).

Crossbred to Indigenous Cattle Ratio

The crossbreeding of indigenous cattle with exotic germplasm is an important programme for dairy development in India. The crossbred cows produce much higher yield over the indigenous cows. The empirical studies across the country have reported economic superiority of crossbred cows over indigenous cattle and increasing gains of crossbred adoption (Kumar, 1994; Dixit, 1999; Paul and Chandel, 2010; Bhowmik *et al.*, 2006). The gross returns from the crossbred animal were found about 2.8-times higher than the local cattle, due to productivity differences in Tripura (Bhowmik *et al.*, 2006) and, thus, presented a promising case for crossbreeding adoption.

The crossbred to indigenous cattle ratio indicates the adoption of crossbred over indigenous cattle and represents the ratio of adult female crossbred cattle to adult female indigenous cattle in a particular zone. The mean value of the ratio in the well performing zone was almost double to that of least performing zone, indicating a higher crossbred adoption in the WPZ (Table 2). The overall mean value of 4.38 signifies the dominance of crossbred over local cows owing to higher productivity of the previous breed to that of the later. The lowest value of crossbred to indigenous cattle ratio indicates that certain areas are intensely inhabited with local breeds with very low productivity levels. Such districts need special plans to boost livestock sector. The regression estimates clearly indicate that a unit percentage increase in the ratio significantly increases the income from livestock sources by 0.09 per cent (Table 4). Improvement in indigenous cattle breeding strategies along with improved adoption of crossbred will induce livestock income.

Crossbred Milk Yield

The crossbred cattle provide significantly higher yields as compared to the indigenous cattle and even buffaloes. Punjab is the most efficient state in the

country even in the crossbred milk productivity and yielded 11 litres of milk per animal per day in 2013-14, the other major states being Gujarat and Haryana. Many previous studies have reported that yields of crossbred are much higher than of indigenous cattle. For illustration, Geetha and Lavanya (2013) have reported that the per day per animal milk production was highest for cross-bred cows (10.24 - 19.63 litres/day in all farm groups) as compared to indigenous cows (4.54 - 6.83 litres / day) and buffaloes (2.78 - 4.15 litres / day) in the Coimbatore district of Tamil Nadu.

Here, the crossbred milk yield represents the average daily productivity of crossbred cattle in the year 2013-14. This had a significant impact on the livestock income (Table 4). The unit percentage increase in the average milk yield of crossbred cattle increased the overall livestock income by 0.42 per cent. The progressive increase in the mean value of the milk yield from LPZ to WPZ (Table 2) validated the positive and significant estimate of the regression coefficient.

In spite of the existing higher levels of crossbred cattle, there is still considerable scope to enhance the yield levels as there exists significant yield gaps in terms of (a) deviation from the highest producing states, and (b) experiment station yield. In North-East, the average milk yield realized on experimental stations was 8.39 litres per day, which was the highest yield level to be achieved by the farmers in the region; the potential farm yield was 7.65 litres per day and the actual milk yield realized by the average household was 4.62 litres per day (Paul and Chandel, 2010).

Indigenous Cattle Milk Yield

The productivity of indigenous cattle is the lowest among the three major categories of large ruminants in the country. Awfully, the low-income states like Chhattisgarh, Madhya Pradesh, Bihar, Jharkhand, Uttar Pradesh and most of the North-Eastern states are dominated by the existence of indigenous cattle. In North-Eastern states, indigenous cattle yield less than 2 litres/day. The crossbreds demonstrate the promising story, particularly for the North-Eastern states, where productivity of indigenous cattle is abysmally low. The average daily productivity of local cows did not bear any significant influence on livestock income, as indicated by the regression estimates (Table 4). The mean value increased marginally from LPZ to WPZ and the overall mean value was 3.03 litres/day.

Share of Crop Cultivation in Farmer's Income

As per the Situation Assessment Survey of Households, the agricultural households draw their income from crop cultivation, animal husbandry, wages & salaries and non-farm business. The share of income derived from crop cultivation is relatively higher in Punjab, Haryana, Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Uttarakhand; is noticed lowest in Jammu & Kashmir, Tamil Nadu and West Bengal. The areas with lowest livestock income find alternative avenues in either crop cultivation or non-farm avenues.

The crop share followed a slight different pattern in its mean from LPZ to WPZ. The average share from crop cultivation increased from least performing zone to average performing zone and subsequently declined, indicating that crop cultivation was the major source of income in APZ. A comparatively higher value of the parameter in least performing and average performing zones as compared to the other two zones is obvious and indicates higher dependency of the population in these zones on crop cultivation. However, the crop cultivation was the major source of income in the overall region contributing on an average 47 per cent to the total income from all farm sources. The inverse relation between income from livestock and crop sources was also established by the negative and significant value of the regression estimates. A unit percentage increase in the crop share decreased the overall share of livestock income by 1.58 per cent.

Share of Non-farm Business

Non-farm business remains a major source of income for the disadvantaged farming sections, viz. small and marginal farmers. Non-farm share indicates the percentage income share of wages & salaries along with non-farm business to the total income from farm. Table 2 clearly reveals that non-farm income was the main source of livelihood in the LPZ as indicated by the highest mean value (51.14). The mean value subsequently declined, as per expectation, as the income from livestock had a major hold in total farm income in GPZ and WPZ. The income from all non-farm sources, with average percentage share of around 38 per cent to the total farm income, was the second most important means of livelihood after crop cultivation in the overall region. A unit percentage increase in the non-farm share significantly declined the livestock income by 0.92 per cent (Table 4).

Dominance of Smallholders

The smallholders (marginal and small farmers) dominate the scene of Indian agriculture. The situation is found to be worst in states like Kerala, Bihar, West Bengal, Jammu & Kashmir, Uttar Pradesh, Odisha, Tamil Nadu, Uttarakhand along with few NE states and UTs, where the share of smallholders is found to be more than 90 per cent. Out of these, states like Bihar, West Bengal and Uttar Pradesh have higher shares of geographical pockets with lowest incomes in the country. The majority of the farmers (79 %) in the country were either small (1-2 ha) or marginal holders (< 1 ha). Among the four delineated zones, the population percentage was highest in LPZ (84 %). Kishore *et al.* (2016) have reported that smallholder farmers not only own a disproportionate share of milking bovines but also own 78 per cent of India's crossbred cows. However, the sign of regression coefficient, though not statistically significant, indicates that the larger existence of smallholders will derive less livestock income perhaps due to scale inefficiency. The small marketable surplus along with the inability to access distant urban markets owing to high transaction cost are the other limitations faced by smallholders to capitalize on the increasing livestock demand and emerging markets (Birthal *et al.*, 2005; Birthal, 2008; Pingali *et al.*, 2005).

The group of selected income drivers have a significant impact on the livestock income in the overall region as indicated by Table 3 (ANOVA table) and explain 35 variations of the dependent variable (Table 4).

Milk Marketing Pattern

The Choice of agency and milk selling pattern exert influence on the receipts from milk selling. In order to capture the milk marketing scenario, the milk marketing pattern was examined for the identified zones in the country, based on Situation Assessment Survey of NSSO (2014). Table 5 shows that unlike crops, most of the produced is disposed of in the first disposal; however, a sizeable quantity is also kept for other purposes that mainly include self-consumption. As far as marketing channels are concerned, milk is directly sold to other households, local traders, and commission agents, along with cooperative and government agencies. The cooperatives procure a large

Table 3. ANOVA results for the regression analysis

Source	Analysis of variance				
	Degree of freedom	Sum of squares	Mean square	F value	Pr > F
Model	8	222.02	27.75	22.76	<0.0001
Error	326	397.52	1.21		
Corrected total	334	619.54			

Table 4. Determinants of livestock income: Regression results from double log function

Dependent variable: Livestock Income

Estimation method: Least Square model

Variables	Parameter estimates	Standard error	t-value
Intercept	14.88	0.92	16.17
Buffalo to cattle ratio	0.16*	0.03	5.33
Buffalo milk yield	-0.39	0.26	-1.50
Crossbred to indigenous cattle ratio	0.09*	0.02	4.50
Crossbred milk yield	0.42**	0.18	2.33
Indigenous cattle milk yield	0.25	0.15	1.66
Crop share	-1.58*	0.15	-10.53
Nonfarm share	-0.92*	0.10	-9.20
Smallholder percentage	-0.28	0.17	-1.64
R ²	0.35*		
Total observations (No.)	335		

Note: *significant @ 1 per cent level, **significant @ 5 per cent level

quantity of milk in better performing zones. A little quantity of milk is also sold to the processors and other agencies.

A significant variation in the choice of agency is observed across zones. More than 80 per cent producers in the least performing zone sell milk to the local traders. However, as we move from low income to high income zones, the share of cooperatives and government agencies increases, which is a more reliable source of procurement along with assured price. In general, lower prices are offered to livestock households in low income zone as compared to other zones. Even cooperative and government agencies are paying lesser price in low income or least performing zone. The marketing system in least performing zone needs to be strengthened to support the livestock households with assured procurement and prices as prevail in other zones.

As far as the satisfaction level of livestock milk producer-sellers is concerned, more than three-fourth

households were found satisfied with the existing status of the agencies in the milk disposal pattern. The level of dissatisfaction varied across zones for different agencies and was high for commission agents, that is why the produce sold through commission agents was small (only 3.7%) in all the zones. The main reason for dissatisfaction in all the zones revolved around the price factor. It was perceived that the procurement agencies provide a lower price to the farmer-sellers as compared to the prevailing market price. This provides a clear base that milk marketing needs to be strengthened across zones. Providing further opportunities for value addition and processing at the producer level will create a win-win situation and further augment the incomes. There is a need to increase milk procurement by cooperative and government agencies in the least performing zones and provide the milk farmers remunerative prices so that not only their cost get covered but they should realize a sizable profit also. Apart from this, price disparity among agencies

Table 5. Zone-wise livestock marketing pattern across sample households

Parameter	Least Performing Zone	Average Performing Zone	Good Performing Zone	Well Performing Zone	Overall
1. Milk sold at each disposal (% share)					
First stage	54.0	50.2	51.8	57.0	52.8
Second stage	0.6	0.1	0.7	0.9	0.5
Other stages	45.3	49.7	47.6	42.1	46.6
2. Milk sold through first major disposal (% of farmers selling milk)					
Directly to other households	34.5 (22.9)	27.8 (21.6)	30.4 (16.8)	19.0(11.8)	31.4(20.4)
Local traders	46.9 (48.7)	36.6(31.2)	28.7 (27.9)	15.2(13.4)	38.1(38.2)
Commission agent	4.5(14.8)	2.6(5.6)	3.3(5.1)	1.2(0.9)	3.7(9.9)
Cooperative & government agencies	11.6 (12.2)	32.3(40.8)	34.6(44.7)	61.1(72.7)	24.4(29.2)
Processors	0.6(0.8)	0.6 (0.8)	1.4(5.0)	1.5(0.6)	0.9(1.9)
Others	1.8(0.5)	0.1(0.1)	1.6(0.4)	2.0(0.6)	1.5(0.4)
3. Price offered (₹/litre)					
Direct milk buying households	27.3	30.6	33.1	26.6	29.3
Local traders	24.1	33.9	25.6	25.8	25.9
Commission agent	21.3	25.4	21.0	23.4	21.8
Cooperative & government agencies	23.8	28.3	24.6	31.2	26.3
Processors	36.0	24.3	23.9	24.8	27.8
Others	35.9	26.9	27.6	25.4	32.3
4. Level of Dissatisfaction (% of farmers dissatisfied w.r.t. respective agency)					
Overall	24	26	25	24	25
Direct milk buying households	16	10	15	18	15
Local trader	28	29	34	28	29
Commission agent	34	33	31	73	34
Cooperative & government agencies	29	37	27	25	29
Processors	14	41	26	00	21
Others	10	00	02	04	07
5. Reasons for dissatisfaction (% of farmers dissatisfied)					
Lower than market price	96.5	87.5	95.0	96.1	94.7
Delayed payments	2.1	2.8	1.9	0.0	2.0
Deduction for loans borrowed	0.5	0.7	0.3	0.7	0.5
Faulty weighing and grading	0.1	2.4	0.0	0.0	0.4
Other cause of dissatisfaction	0.8	6.5	2.8	3.2	2.4

Note: Figures within the parentheses indicate the percentage of volume of milk sold to respective agency.

Source: Computed by authors based on Situation Assessment Survey (2014)

should be minimized to provide handfull gains to the producers.

Conclusions and Implications

Livestock development represents a promising opportunity to enhance farmers' income, especially in

the less- developed regions. The district level livestock income varies significantly across regions and states and therefore clustering approach was followed in this study for proper policy formulation and implication. The study has identified the livestock performance zones based on livestock incomes which can be used

by the policy makers and stakeholders for furtherance of disaggregate strategic plans.

A significant buffalo to cattle ratio with non-significant estimate of buffalo milk yield has clearly signified the importance of animals in generating income through meat production. A niche export-oriented product 'buffalo meat' contributes significantly to the total livestock exports.

Crossbred adoption and crossbred milk yield contribute significantly in enhancing livestock income, particularly income from dairying. Crossbreeding strategy should be geared up, especially in the least performing zone (LPZ) to boost income from livestock sources. Although indigenous cattle does not have any significant influence on livestock income, due attention on the productivity enhancement of the local cows will be a win-win strategy owing to their good adaptation potential to climate stress compared to buffaloes and crossbreds.

In LPZs of many states the agricultural households rely on non-farm sources of income. Therefore, efforts need to be made to link value addition and processing activities in LPZs to create synergies between the producing zone and non-farm business opportunities in terms of small scale milk processing. Enhancing of livestock incomes, particularly from dairying requires that the milk producer-sellers are backed by an assured marketing system. The choice of agency exerts strong influence on the receipts from milk sales. The least performing zone needs special attention for strengthening marketing network. The co-operatives, which provide an assured procurement and price in better performing zone, do not hold much importance in LPZ as only 12 per cent of milk quantity is sold through cooperatives. The cooperative network in LPZ needs to be strengthened and revamped to provide assured marketing arrangements.

The state governments in conjunction with research institutions have to play a major role in ensuring that livestock development programmes and services enable the poor livestock keepers to take full advantage of this opportunity. Specific priorities to foster investment on sustainable livestock development need to be listed for promoting livestock intensification amongst smallholders after addressing their concerns appropriately. The state governments need to play a

catalytic role in mainstreaming livestock development as an entry point for poverty reduction, especially in the disadvantaged regions. The symbiotic roles of the public and private sectors in livestock extension service delivery and management systems by blending improved technologies with indigenous knowledge and practices for the poor along with development of public-private partnerships, need to be accelerated. This need to be coupled with enhanced access to rural financial and marketing systems. Thus, increased efforts and investments are necessary for enhancing agricultural and livestock sectors with specific interventions to ensure that the small producers are not excluded from the economic growth and social progress in India.

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Annexure I

Box 1. Identified zones and districts based on livestock income

State	Least performing zone	Average performing zone	Good performing zone	Well performing zone
Andhra Pradesh	East Godavari, Guntur, Krishna, Prakasam, Visakhapatnam, West Godavari	Anantapur, Chittoor, Kurnool	Cuddapah, Nellore	Srikakulam, Vizianagaram
Assam	Barpeta, Bongaigaon, Darrang, Dhemaji, Dibrugarh, Goalpara, Kamrup, Lakhimpur, Marigaon, Nagaon, Nalbari, Sonitpur, Tinsukia	Baksa, Cachar, Chirag, Guwahati, Hailakandi, Karimganj, North Cachar Hills, Udalguri	Golaghat, Jorhat, Karbi Anglong, Sibsagar	Dhubri, Kokrajhar
Bihar	Araria, Banka, Begusarai, Bhagalpur, Darbhanga, Vaishali, Gopalganj, Katihar, Khagaria, Kishanganj, Madhepura, Madhubani, Munger, Supaul, Muzaffarpur, Purnia, Purba Champaran, Saharsa, Samastipur, Saran, Sheohar, Sitamarhi, Siwan,	Arwal, Aurangabad, Bhojpur, Buxar, Gaya, Jamui, Jehanabad, Kaimur (Bhabua), Nalanda, Nawada, Patna, Rohtas, Sheikhpura	Lakhisarai	
Chhattisgarh	Bastar, Bijapur, Bilaspur, Dantewada, Dhamtari, Durg, Janjgir - Champa, Jashpur, Kanker, Kawardha, Korba, Koriya, Mahasamund, Narayanpur, Raigarh, Raipur, Rajnandgaon, Surguja			
Gujarat	Ahmadabad, Gandhinagar, Rajkot, Surendranagar	Bharuch, Dohad, Narmada, Navsari, Surat, Tapi, The Dangs, Vadodara, Valsad	Amreli, Anand, Bhavnagar, Jamnagar, Junagadh, Kheda, PanchMahals, Patan, Porbandar	BanasKantha, Kachchh, Mahesana, SabarKantha
Haryana	Jind, Panipat, Sonipat	Faridabad, Gurgaon, Mewat, Palwal, Rewari	Bhiwani, Fatehabad, Hisar, Jhajjar, Mahendragarh, Rohtak, Sirsa	Ambala, Kaithal, Karnal, Kurukshetra, Panchkula, Yamunanagar
Himachal Pradesh	Chamba	Bilaspur, Hamirpur, Kinnaur, Kullu, Mandi, Shimla, Sirmour, Solan, Una	Lahul & Spiti Kangra	
Jammu & Kashmir	Anantnag, Badgam, Baramula, Doda, Kargil, Kupwara, Leh (Ladakh), Pulwama, Punch, Srinagar	Ganderbal, Kishtwar, Kulgam, Ramban, Reasi, Shopian	Jammu, Kathua, Rajauri, Samba	
Jharkhand	Bokaro, Chatra, Deoghar, Dhanbad, Dumka, Giridih, Godda, Gumla, Hazaribagh, Kodarma, Latehar, Lohardaga, Pakaur, Simdega Pashchimi Singhbhum, Sahibganj, Purbi Singhbhum, Ranchi	Khunti, Ramgarh	Jamtara, Seraikela-kharsawan	Garhwa, Palamu
Karnataka	Bagalkot, Bellary, Bidar, Bijapur, Chikmagalur, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Haveri, Koppal, Raichur, Shimoga, Udupi, Uttara Kannada	Bangalore, Bangalore Rural, Chamarajanagar, Chikkaballapura, Dakshina Kannada, Hassan, Kodagu, Mandya, Mysore, Ramanagar, Yadgir	Kolar, Tumkur	Belgaum
Kerala	Ernakulam, Kannur, Kasaragod, Kozhikode, Malappuram, Palakkad, Thrissur, Wayanad	Alappuzha, Kollam, Kottayam, Pathanamthitta, Thiruvananthapuram	Idukki	
Madhya Pradesh	Bhind, Chhatarpur, Damoh, Datia, Guna, Gwalior, Mandsaur, Morena, Neemuch, Panna, Rewa, Sagar, Satna, Shahdol,	Alirajpur, Anuppur, Ashoknagar, Sehore, Seoni, Balaghat, Barwani, Betul, Bhopal,	Dewas, Dhar, Indore, Jhabua, Ratlam, Shajapur, Ujjain	

Contd...

Annexure I — Contd.

State	Least performing zone	Average performing zone	Good performing zone	Well performing zone
Maharashtra	Sheopur, Shivpuri, Sidhi, Tikamgarh, Umari	Burhanpur, Chhindwara, Dindori, East Nimar, Katni, Vidisha, Mandla, Harda, Hoshangabad, Jabalpur, Narsimhapur, Raisen, Rajgarh, Singrauli, West Nimar	Ahmadnagar, Bid, Latur, Pune, Raigarh, Thane	
Odisha	Akola, Amravati, Aurangabad, Bhandara, Buldana, Chandrapur, Dhule, Gadchiroli, Gondiya, Hingoli, Jalgaon, Jalna, Nagpur, Nanded, Nandurbar, Nashik, Parbhani, Wardha, Washim, Yavatmal	Koraput, Malkangiri, Nabarangapur	Balangir, Baudh, Kalahandi, Nuapada, Rayagada, Sonapur	Bargarh, Debagarh, Jharsuguda, Sambalpur, Sundargarh
Punjab	Fatehgarh Sahib, Hoshiarpur, Jalandhar, Ludhiana, Nawanshahr, Rupnagar	Barnala, Bathinda, Mansa, Patiala, S J A S Nagar (Mohali), Sangrur, Tarn Taran	Faridkot, Firozpur, Moga, Muktsar	Amritsar, Gurdaspur, Kapurthala
Rajasthan	Alwar, Bharatpur, Bikaner, Churu, Dhaulpur, Ganganagar, Hanumangarh, Jhunjhun, Karauli	Ajmer, Banswara, Baran, Barmer, Bhilwara, Bundi, Chittaurgarh, Dungarpur, Jalor, Jhalawar, Kota, Pali, Pratapgarh, Rajsamand, Sirohi, Tonk, Udaipur	Dausa, Jaipur, Jaisalmer, Jodhpur, Nagaur, Sawai Madhopur, Sikar	
Tamil Nadu	Ariyalur, Coimbatore, Cuddalore, Dharmapuri, Dindigul, Erode, Kancheepuram, Karur, Namakkal, Perambalur, Salem, The Nilgiris, Tiruchirappalli, Tiruvannamalai, Vellore, Viluppuram	Kanniyakumari, Krishnagiri, Madurai, Ramanathapuram, Sivaganga, Theni, Thoothukkudi, Tirunelveli, Tiruppur, Virudhunagar	Nagapattinam, Pudukkottai, Thanjavur, Thiruvallur	
Telangana	Adilabad, Karimnagar, Mahbubnagar, Medak, Nalgonda, Nizamabad, Rangareddi	Khammam, Warangal		
Uttar Pradesh	Agra, Aligarh, Auraiya, Baghpat, Bareilly, Bijpur, Budaun, Bulandshahr, Etah, Etawah, Farrukhabad, Firozabad, Gautam Buddha Nagar, Ghaziabad, Hardoi, Hathras, Jyotiba Phule Nagar, Kannauj, Kanpur Dehat, Kheri, Lucknow, Mainpuri, Mathura, Meerut, Moradabad, Muzaffarnagar, Pilibhit, Rae Bareilly, Rampur, Shahjahanpur, Sitapur, Unnao	Allahabad, Ambedkar Nagar, Azamgarh, Bahraich, Ballia, Balrampur, Banda, Varanasi, Barabanki, Basti, Chandauli, Chitrakoot, Deoria, Faizabad, Fatehpur, Ghazipur, Gonda, Gorakhpur, Hamirpur, Jaunpur, Kashiramnagar, Kaushambi, Kushinagar, Lalitpur, Mahoba, Mahrajganj, Mau, Mirzapur, Pratapgarh, Sant Kabir Nagar, Sant Ravidas Nagar, Bhadohi, Shrawasti, Siddharthnagar, Sonbhadra, Sultanpur,	Jalaun, Jhansi, Kanpur Nagar	Saharanpur
Uttarakhand	Chamoli, Dehradun, Rudrapur, Tehri Garhwal, Uttarkashi	Almora, Bageshwar, Champawat, Hardwar, Nainital, Udham Singh Nagar	Garhwal, Pithoragarh	
West Bengal	Bankura, Bardhaman, Birbhum, Dakshin Dinajpur, Darjiling, Haora, Hugli, Jalpaiguri, Koch Bihar, Maldah, Murshidabad, Nadia, North Twenty Four Parganas, Pashim Midnapur, Puruliya, Uttar Dinajpur	Purba Midnapur, South Twenty Four Parganas		