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Impact of rural infrastructure on performance of livestock sector in Uttar Pradesh

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ABSTRACT

This paper examines the emerging trends and growth of livestock sector at disaggregate level in Uttar Pradesh (UP) from 2004–05 to 2015–16. The share of crop sector in GSDP had declined sharply while livestock sector gained a significant share due to consistent higher growth in agricultural sector of the state. The regional level result indicated that Western UP outperformed Eastern, Central and Bundelkhand regions in that order with high disparities across the regions in case of livestock sector as well as rural infrastructure. Moreover, Fixed Effects model attested a positive and significant relationship between value of output by livestock and rural infrastructure index. It suggested that adequate development avenues via rural infrastructure, extension services, value chain development and research investments can boost the growth of livestock sector and mainstreaming the livestock development. Also, the state can utilize the opportunities by promoting livestock as a dominant approach towards livelihood diversification as adopted by other states as well. This will not only take care of the already overstressed agriculture sector but will also be instrumental in attaining the objective of doubling farmers' income.

Keywords: Disparities, Infrastructure, Livestock, Rural, Regional

Livelihood diversification is a viable strategy for livelihood security (Ellis 2000). One such sector that favours livelihood diversification and thereby can ensure livelihood security is the Livestock sector. Currently, livestock sector contributes around 25% in agricultural income of Uttar Pradesh. Moreover, at the national level, this sector contributes 16% to the income of small farm households as against an average of 14% for all rural households. Research studies argue that the incidence of rural poverty has declined considerably in states, viz. Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh, Kerala, Gujarat and Rajasthan where livestock accounted for an adequate share of agricultural income as well as employment. This sector also acts as a cushion against uncertainties of income during the lean seasons of agriculture and is also considered as an inclusive and pro-poor sector. Moreover, it plays a role in promoting food and nutritional security by way of provision of animal products like milk, meat and eggs. These benefits have favoured UP also quite well as it is the largest contributor (18%) to the national milk production and owes second highest cattle population and highest buffalo population in the country.

However, the synergies between livestock and crops sector have weakened considerably due to advancement in biochemical and mechanical technologies. In recent years, the growth of livestock sector has stagnated or remained constant. Achieving a growth rate of 5 to 6% in this sector has become a daunting task due to shortage of feed, fodder, frequent occurrence of some deadly diseases, unavailability of quality veterinary products and services, neglect of the financial and extension institutions etc. Also, rapid globalization of agri-food markets puts significant pressure and is a significant barrier to the commercialization of livestock production. Moreover, underinvestment in infrastructure creation plagues livestock sector immensely.

Given that public and private investment in infrastructure is a precondition for livestock development, hence, a needed thrust to infrastructure *per se* can help reap the benefits of the livestock sector commendably. On the demand side, investment needs to be made in ensuring availability of a number of necessary inputs and services, increasing competition and opening up the size of the market. This would increase the supply elasticity and efficiency of factors of production. On the supply side, development of livestock can initiate infrastructure facilitates in mobilizing potential savings and channelising them into productive investments. Infrastructure being a function of adequate quantity, quality and reliability can thus help in releasing latent productivity in the factors of production singly and in coordination. This will bring about an increase in the output of not only individual factors and units of production but also increase mutually additive effects through coordination in inputs, output, space and time. In this backdrop, it becomes essential to study emerging trends and prospects of livestock sector. The specific objectives are to study the emerging trends of livestock sector and rural infrastructure in state at disaggregate level; and to examine the association between performance of livestock sector and rural infrastructure.

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MATERIALS AND METHODS

The study is based on national and state level analysis of secondary data from 2004–05 to 2015–16. The data on Gross Domestic Product (GDP), GDP by agriculture sector (AgGDP) and value of output by agriculture sub sectors was collected from various issues of National Accounts Statistics (NAS), Government of India. The data on livestock population were compiled from the 19th Livestock Census. Data on various other aspects was retrieved from Uttar Pradesh Directorate of Economics and Statistics (UPDES) and Department of Animal Husbandry, Uttar Pradesh. The Compound Annual Growth Rates (CAGR) was computed using exponential function to examine the trends in different variables of agriculture and its sub-sectors.

Construction of Rural Infrastructure Index (RII): Rural Infrastructure Index (RII) includes three broad parameters, i.e. economic, institutional and social infrastructure. For the purposes of this study, these broad parameters of infrastructure were divided into eight indicators of infrastructure, viz. electricity, road transport, irrigation (water facility), telecommunication, literacy rate, primary agricultural co-operative societies, agricultural markets and heath facilities. These indicators were selected through the Principal Component Analysis (PCA) on the basis of Eigen value criterion. The method of normalization was used to standardize values of indicators of rural infrastructure at district level in Uttar Pradesh. The mini-max method of each indicator was transformed as follows:

$$I^t_{qd} = \frac{X^t_{qd} - \text{Min}_d(X^t_d)}{\text{Max}_d(X^t_d) - \text{Min}_d(X^t_d)}$$

where, $\text{Max}_d\ X^t_q$ and $\text{Min}_d\ X^t_q$ are the maximum and the minimum values of X^t_{qd} across all the districts d of Uttar Pradesh at time t. In this way the normalized indicators I^t_{qd} have values lying between 0 and 1. Thus, the higher the values of I^t_{qd}; the higher the district achievement in indicator q.

PCA and Factor Analysis were used in order to generate the weights of rural infrastructure. This facilitated to construct weights representing the information content of individual indicators without reducing the number of indicators (OECD 2008). Finally, Rural Infrastructure Index was given by the following equation for the all 70 districts and 4 administrative regions of Uttar Pradesh

$$\text{RII} = \sum_{q=1}^{Q} W_q I_{qd}$$

$$\text{with } \sum_{q=1}^{Q} W_q = 1 \text{ and } 0 \le w_q \le 1, \text{ for all } q = 1, 2, \ldots Q \text{ and } d = 1, 2, \ldots 70$$

Panel Data Regression Model: Apart from measuring the performance of livestock sector, the relationship between value of output by livestock sector and rural infrastructure was examined at district level in UP. Pooled Ordinary Least Square (OLS) regression model, Fixed Effect Model (FEM) and Random Effect Model (REM) were used. It was assumed that coefficients across time and cross-section remained the same in Pooled Ordinary Least Square method. The major problem with this model is that it does not distinguish between the various entities or panels (districts) that were present in our model. It means that it denied the heterogeneity and individuality condition. Therefore, fixed effect model (FEM) and random effect model (REM) were used with a balanced panel data. For finest model selection between fixed effect model (FEM) and random effect model (REM), Hausman specification test was applied to check which model was suitable. To find out relationship between values of output by livestock sector (VOLS) and rural infrastructure index (RII) was ascertained by applying the FEM and REM.

Fixed Effect Model (*FEM*): To take into account the individuality of each state (cross-sectional unit), intercept was varied by using dummy variable for fixed effects. Fixed effect model (FEM) at district level was:

$$\text{VOLS}_{it} = \beta_{1i} + \beta_2\, \text{RII}_{it} + u_{it}$$

Here, i = 1, 2, 3, ... 70 [cross section (districts)] and t = 1, 2, 3, ... 12 [time period]. Both variables were taken in logarithmic form.

Random Effect Model (*REM*): In the REM, it was assumed that the individual specific coefficient β_{1i} is fixed for each time-invariant. It was assumed herein that β_{1i} is a random variable with a mean value of β_1 and the intercept of any cross-section unit was expressed as:

$$\beta_{1i} = \beta_1 + \varepsilon_i$$

where ε_i is a random error term with mean '0' and variance σ^2_ε.

Therefore, random effect model for panel data was written as:

$$\text{VOLS}_{it} = \beta_1 + \beta_2\, \text{RII}_{it} + w_{it}$$

where,

$$w_{it} = \varepsilon_i + u_{it}$$

'w_{it}' has two components; representing the cross-section or individual-specific error component and representing the combined time series and cross-section error component.

Hausman specification test (1978) was used to select suitable model between FEM and REM.

The estimates of 'β' in the FEM ($\hat{\beta}_{FE}$) should be similar to the estimates of 'β' in the REM ($\hat{\beta}_{RE}$). The Hausman test statistic 'H' was expressed as:

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE})' \left[\text{Var}(\hat{\beta}_{FE}) - \text{Var}(\hat{\beta}_{RE})\right]^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE})$$

If Hausman test statistic value 'H' was statistically significant then the two models were different enough to reject the null hypothesis. Therefore, fixed effects model (FEM) was appropriate. Otherwise, in case of insignificant 'H' value, the random effects model may be appropriate for usage.

RESULTS AND DISCUSSION

Role of livestock sector in agricultural economy: India's livestock sector is one of the largest in the world. It has 56.7% of world's buffaloes, 12.5% cattle, 20.4% small ruminants, 2.4% camel, 1.4% equines, 1.5% pigs and 3.1% poultry (19th Livestock Census). The contribution and the growth performance of livestock sector at national level in terms of Gross Value Added (GVA) in agriculture at constant prices during 2004–05 to 2015–16 are given in Table 1. In 2004–05, livestock generated outputs worth ₹ 234,959 crore, which comprised 22.43% of the Agricultural GDP. GVA share of livestock sector in total agriculture sector had increased from 22.43% in 2004–05 to 30.36% in 2015–16 at constant prices (Table 1). On the other side, the contribution of agriculture sector in GVA had decreased from 23.25% in 2004–05 to 13.23% in 2015–16. Moreover, the compound annual growth rate of livestock sector was found higher than the compound annual growth rate of agriculture sector during the study period as well as its sub periods. It shows that the livestock sector has better prospects to achieve higher growth rate in agricultural economy at national level.

Table 1. Contribution of livestock sector in agriculture in India during 2004–05 to 2015–16

Year	GVA-Agriculture		GVA-Livestock	
	(₹ in crore)	Contribution towards GVA	(₹ in crore)	Contribution towards Agriculture
2004–05	1,047,581	23.25	234,959	22.43
2009–10	1,197,517	17.07	295,831	24.70
2015–16	1,387,714	13.23	421,369	30.36
Compound annual growth rate (CAGR)				
2004–05 to 2009–10		2.81		4.57
2010–11 to 2015–16		1.86		6.47
2004–05 to 2015–16		2.57		5.47

Note: Agriculture includes crops and livestock.
Source: Based on CSO, MoSPI.

Table 2 shows the commodity-wise CAGR of value of output by livestock sector in Uttar Pradesh and India in two sub-phases, i.e. 2004–05 to 2009–10 and 2010–11 to 2015–16 as well as whole period of the study. The value of output of five animal products like milk, eggs, meat, dung and wool were computed. Overall comparison of milk, eggs and meat from 2004–05 to 2015–16 shows that the CAGR values of UP were more than the national average while in case of dung and wool, the CAGR values were below the national average. For instance, in case of milk, the CAGR stood at 16.29% in case of UP while it was 15.76% in case of India. Similarly, for eggs, it was 21.89% in case of UP and 15.88% in case of India. In case of meat, the CAGR was 18.88 for UP and 18.11 in case of India while in case of dung, the CAGR value was only 8.18% in case of UP and 11.67% in case of India. Also, for wool the CAGR was 3.41% in case of UP and 5.98% in case of India.

Table 2. Commodity-wise growth rate of value of output by livestock sector in Uttar Pradesh and India

Region	Compound annual growth rate growth rate (CAGR)			Average share of UP towards India
	2004–05 to 2009–10	2010–11 to 2015–16	2004–05 to 2015–16	
Milk				
UP	12.48	17.06	16.29	17.04
India	12.75	15.82	15.76	
Eggs				
UP	14.09	21.86	21.89	2.31
India	18.05	11.97	15.88	
Meat				
UP	15.44	18.60	18.88	9.34
India	16.32	17.32	18.11	
Dung				
UP	6.36	6.87	8.18	12.48
India	8.96	11.85	11.67	
Wool				
UP	9.15	–7.20	3.41	8.70
India	5.94	4.46	5.98	

Source: Based on CSO, MoSPI.

This trend was also followed from 2010–11 to 2015–16 wherein the CAGR values for UP were higher than that of national level. The CAGR values of milk, eggs and meat were at 17.06%, 21.86% and 18.60% respectively which were higher from national average, i.e. 15.82% for milk, 11.97% for eggs and 17.32% for meat respectively. However, during the phase from 2004–05 to 2009–10, the figures revealed a different pattern. The CAGR values of almost all the animal products except wool were lower for the state of UP than that of the national average. For instance, in case of milk, eggs, meat and dung the CAGR values were 12.48%, 14.09%, 15.44% and 6.36% respectively which were lower than that of national average of 12.75% for milk, 18.05% for eggs, 16.32% for meat and 8.96% for dung respectively from 2004–05 to 2009–10. However, the CAGR values for wool were at 9.15% for UP which was higher than that of national average of 5.94% during 2004–05 to 2009–10.

Regional trends of livestock sectors in Uttar Pradesh: Share of agriculture sub-sectors in Net State Domestic Product (NSDP) in Uttar Pradesh (Fig. 1) revealed that crops sector constituted the maximum percentage in the NSDP over the years, followed by livestock sector. It further discerned a continuous decline with respect to agriculture, forestry and fishing coupled with the crops sub sector. For instance, the share of agriculture, forestry and fishing sector in NSDP declined from 35.21% in 2004–05 to 23.56% respectively in 2015–16. Similarly, in case of crops sector, it decelerated from 24.55% in 2004–05 to 15.29% in 2015–16. However, there was a positive trend in livestock sector NSDP during the study period at the rate 0.15% per annum. In livestock sector, the share in NSDP increased from five

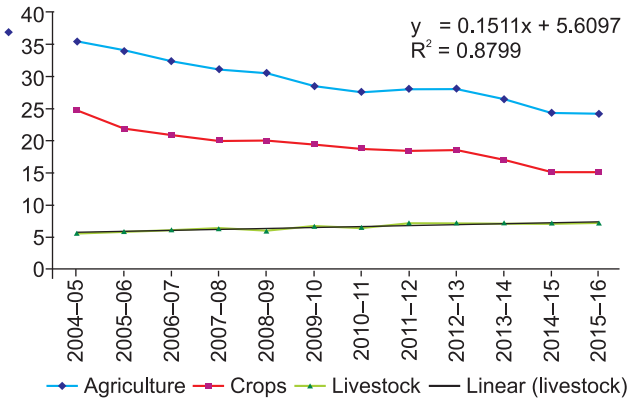

Fig. 1. Share of agriculture and its sub-sectors in NSDP of Uttar Pradesh at constant (2011–12) prices.

percent in 2004–05 to around 7% in 2015–16. Whereas, the share of agriculture as well as crop sector in NSDP declined continuously over the years during the study period.

Fig. 2 reveals the region-wise share of value of output by agricultural sub-sectors from 2004–05 to 2015–16 in Uttar Pradesh. Share of crop sector plummeted from 69.72% in 2004–05 to 64.90% in 2015–16. The same trend was observed across all regions of UP as well. The share declined from 67.02% in 2004–05 to 63.27% in 2015–16 in WUP. In EUP, the share decreased from 65.45% in 2004–05 to 61.75% in 2015–16. Similarly, in case of CUP and BDKL, the shares reduced from 78.90% and 80.05% in 2004–05 to 72.64% and 72.27% in 2015–16 respectively. On the contrary, share of value of output by livestock showed an increasing trend over the years. The share of value of output of UP state rose from 22% in 2004–05 to 27.06% in 2015–16. Similarly, the share increased across all the regions as well. For WUP, the share of livestock sector grew from 26.98% in 2004–05 to 31.24% in 2015–16 while in EUP, livestock sector increased from 21.56% in 2004–05 to 26.35% in 2015–16. In case of CUP and BDLK, the share accelerated from 12.96% and 13.73% in 2004–05 to 17.92% and 16.76% in 2015–16 respectively.

In case of forestry and fishing, share in the value of output by agricultural sub-sector was a mixed bag. At the UP level, a modest decline was witnessed in the share, i.e. from 8.28% in 2004–05 to 8.03% in 2015–16. Similarly in case of WUP and EUP, the share declined from 5.99% and

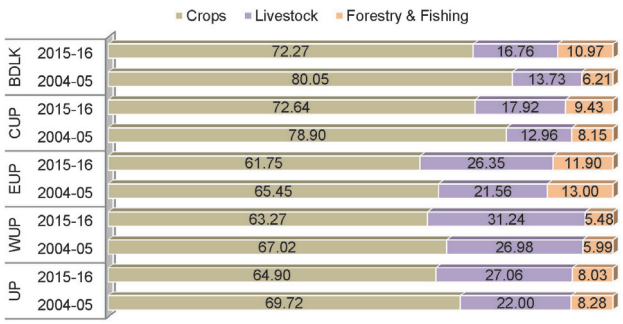

Fig. 2. Regional share of value of output by agriculture sub-sectors in UP from 2004–05 to 2015–16.

13% in 2004–05 to 5.48% and 11.90% in 2015–16 respectively. But in CUP and BDLK regions, the share rose from 8.15% and 6.21% in 2004–05 to 9.43% and 10.97% in 2015–16 respectively.

The regional growth of agriculture and livestock sector in Uttar Pradesh is presented in Fig. 3. In case of agriculture, the growth rate was highest for WUP at 3.63% per annum followed by 2.34% per annum in EUP, 2.13% per annum of BDLK and 0.29% per annum of CUP. The growth of agriculture for WUP was better than that of state average 2.66% per annum during the study period. Whereas, the growth rate of livestock was the highest for WUP at 3.66% per annum followed by 3.29% per annum in EUP, 2.68% per annum of CUP and became negative, i.e. –0.57% per annum for BDLK. The growth of livestock sector in WUP was also higher than that of state growth rate at 3.30% per annum. It could be inferred from the analysis that growth of livestock sector was more as compared to the agriculture sector in Uttar Pradesh. This points out to a rising trend of growth in the livestock sector.

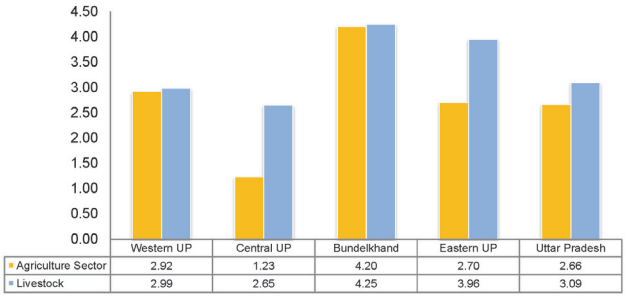

Fig. 3. Regional growth rate of agriculture and livestock sector in UP from 2004–05 to 2015–16.

Trends of livestock sector in Uttar Pradesh at district level: The trends of growth in value of output by livestock at districts level in Uttar Pradesh during 2004–05 to 2015–16 are presented in Table 3. The growth of values of output by animal husbandry had been categorized into three groups like Low (less than 2.09), Moderate (From 2.09 to 5.10) and High (more than 5.10). Districts like Gautam Budh Nagar, Saharanpur, Mainpuri, Bijnor, Bagpat, Haathras, Mathura, Pilibhit and Farrukhabad had low growth rate while Meerut, Aligarh, Rampur, Firozabad, Bulandshahar, Auraiyya, Kannauj, Shahjahanpur and Agra districts had moderate growth rate. Similarly, Moradabad, Etawah, J.B. Nagar, Badaun, Bareilly, Etah, Muzaffar Nagar and Ghaziabad districts had high growth rate among the total districts of western region during the study period.

On the contrary, the districts such as Barabanki, Kanpur Nagar and Lucknow had low whereas Unnao, Sitapur, Hardoi and Kheri districts had moderate growth rate in Central region. The districts like Kanpur Dehat, Fatehpur and Rae Bareli had high growth rate in Central region during the same period. In case of Eastern region, Sultanpur, Mau and Jaunpur districts had low but Maharajganj, Chandauli, Gorakhpur, Kushi Nagar, Ghazipur, Ambedkar Nagar,

Table 3. Growth levels of value of output by livestock at district level in Uttar Pradesh (region-wise)

Region	Low [Less than Q1 value: 2.09]	Moderate [From 2.09 to 5.10]	High [More than Q3 value: 5.10]
Western UP	Gautambudh Nagar, Saharanpur, Mainpuri, Bijnor, Bagpat, Haathras, Mathura, Pilibhit and Farrukhabad No of districts: 9	Meerut, Aligarh, Rampur, Firozabad, Bulandshahar, Auraiyya, Kannauj, Shahjahanpur and Agra No of districts: 9	Moradabad, Etawah, J.B. Nagar, Badaun, Bareilly, Etah, Muzaffar Nagar and Ghaziabad No of districts: 8
Central UP	Barabanki, Kanpur Nagar and Lucknow No of districts: 3	Unnao, Sitapur, Hardoi and Kheri No of districts: 4	Kanpur Dehat, Fatehpur and Rae Bareli No of districts: 3
Eastern UP	Sultanpur, Mau and Jaunpur No of districts: 3	Maharajganj, Chandauli, Gorakhpur, Kushi Nagar, Ghazipur, Ambedkar Nagar, Azamgarh, Allahabad, Siddharth Nagar, S.K. Nagar, Mirzapur, Ballia, Pratapgarh, Bahraich, Varanasi, Shravasti, Sonbhadra and Basti No of districts: 18	Deoria, Faizabad, Sant Ravi Das Nagar, Kaushambi, Balrampur and Gonda No of districts: 6
Bundelkhand	Chitrakoot, Jalaun and Banda No of districts: 3	Jhansi, Mahoba and Hamirpur No of districts: 3	Lalitpur No of districts: 1

Source: Based on UPDES, GoUP.

Azamgarh, Allahabad, Siddharth Nagar, S.K. Nagar, Mirzapur, Ballia, Pratapgarh, Bahraich, Varanasi, Shravasti, Sonbhadra and Basti had moderate growth rate in value of output by animal husbandry. The districts like Deoria, Faizabad, Sant Ravi Das Nagar, Kaushambi, Balrampur and Gonda had high growth rate in the Eastern region. In case of Bundelkhand region, Chitrakoot, Jalaun and Banda districts had low growth rate whereas Jhansi, Mahoba and Hamirpur districts had moderate growth rate but Lalitpur is the only district which had high growth rate during the study period.

Trends of rural infrastructure index in Uttar Pradesh at disaggregate level: Table 4 highlights the districts level rural infrastructure index (RII) of Uttar Pradesh during 2004–05 to 2015–16. Districts, viz. Balrampur, Chitrakoot, Gonda, Sonbhadra, Basti, Siddhratha Nagar, Mahoba, Bahraich, Hamirpur and Sant Ravidas Nagar were bottom 10 districts in case rural infrastructure index during 2004–05 while Mathura, Aligarh, GB Nagar, Kanpur Nagar, Saharanpur, Baghpat, Muzzaffarnagar, Hathras, Meerut, Lucknow and Ghaziabad were top 10 districts. In 2015–16, Balrampur, Sonbhadra, Sant Ravidas Nagar, Chitrakoot, Sant Kabeer Nagar, Mahoba, Shravasti, Banda, Bahraich and Basti were found in category of bottom 10 districts in rural infrastructure. Whereas, JP Nagar, Etah, Lalitpur, Kannauj, Faizabad, Jhansi, Mainpuri, Lucknow, Ghaziabad, Meerut and GB Nagar held the position of top 10 districts in rural infrastructure. This indicates that in terms of rural infrastructure, there are wide disparities between districts in Western region and districts in other regions. A perusal of temporal variation in value of rural infrastructure index revealed that 22 districts had shown less than 25% change in rural infrastructure index whereas 29 districts witnessed a change between 25% to 50% change in the RII during the study period. Similarly, 19 districts of Uttar Pradesh showed a change of greater than 50% in rural infrastructure from 2004–05 to 2015–16.

The values of RII were divided into three groups, i.e. low, moderate and igh. Values less than the quartile (Q1) average of the districts were taken low groups, from Q1 to Q3 were taken moderate and values more than the Quartile (Q3) were taken high. It was found that 17 districts like Balrampur, Sonbhadra, Sant Ravidas Nagar, Chitrakoot, Sant Kabeernagar, Mahoba, Shravasti, Banda, Bahraich, Basti, Kheri, Hamirpur, Pilibhit, Siddharthnagar, Ambedkarnagar, Jaunpur, and Ghazipur had low RII. Contrary to it, 29 districts like Aligarh, Bareilly, Haathras, Baghpat, Saharanpur, Firozabad, Mau, Mathura, Sultanpur, Agra, Rampur, Kanpur Nagar, Moradabad, Bulandshahr, Farrukhabad, Raebarelli, Hardoi, Muzzafarnagar, JP Nagar, Etah, Lalitpur, Kannauj, Faizabad, Jhansi, Mainpuri, Lucknow, Ghaziabad, Meerut, and GB Nagar had high rural infrastructure during the study period. Moreover, there were wide disparities across the administrative regions of Uttar Pradesh. The value of rural infrastructure index was highest in Western UP followed by Central UP, Eastern UP and Bundelkhand in that order. However in terms of per cent change, the highest was witness in Bundelkhand followed by EUP, CUP and WUP respectively. It can be inferred that there are wide fluctuations across all districts in rural infrastructure development in Uttar Pradesh. This gives a clarion call for states to focus on rural infrastructure at districts level in term of its roads, electricity, telecom, irrigation systems, water supply and sanitation, market, schools and health.

Relationship between livestock and rural infrastructure: Infrastructure enhances not only livestock production and productivity but also increases the 'comparative advantage'

of that region in which infrastructural investment is made. Adequate infrastructure facilities are an absolute necessity for rapid achievement of sustainable livestock growth (Palei 2014). This has positive implications on the price factor depending on the nature of the elasticity of demand for the livestock commodity (Odongo and Ojah 2016).

The average value of output by livestock sector (VOLS) and rural infrastructure index (RII) at regional level in state during 2004–05 to 2015–16 is presented in Table 5. Average value of livestock sector was ₹ 233.46 crores in Bundelkhand, followed by ₹ 451.25 crores in Central, ₹ 421.28 crores in Eastern and became highest ₹ 992.50 crores in Western region. Whereas, the value of Rural Infrastructure Index (RII) was lowest 0.2978 in Bundelkhand, followed by Central UP (0.3555), Eastern (0.3112) and reached highest (0.3873) in Western region. Data indicated a direct association between rural infrastructure and value of output by livestock sector at state and regional level. Moreover, the coefficient of correlation between them was positive and significant at aggregate as well as disaggregate level.

Infrastructure is a physical framework of facilities through which goods and services are provided to the public. The livestock growth has evidently happened hand in hand with the development of its infrastructure. To quote famous economist Dr VKRV Rao: "The link between rural infrastructure and livestock development is a continuous process". For the identification of relationship between VOLS was and RII, the perusal of matrix correlation revealed Value of Output by Livestock Sector (VOLS) was

Table 4. Rural infrastructure index (RII) at district level in Uttar Pradesh

District	RII (2004–05)	RII (2015–16)	Per cent change	District	RII (2004–05)	RII (2015–16)	Per cent change
Agra	0.3271	0.3972	21.43	Jalaun	0.2913	0.3589	23.23
Aligarh	0.3687	0.3940	6.86	Jaunpur	0.2507	0.3388	35.15
Allahabad	0.2533	0.3869	52.75	Jhansi	0.2832	0.4472	57.91
Ambedkar Nagar	0.3587	0.3357	-6.41	Kannauj	0.2997	0.4333	44.58
Auraiya	0.2540	0.3884	52.93	Kanpur Dehat	0.2448	0.3450	40.90
Azamgarh	0.2306	0.3789	64.27	Kanpur Nagar	0.3802	0.4001	5.23
Baghpat	0.3926	0.3929	0.09	Kaushambi	0.2839	0.3442	21.22
Bahraich	0.1789	0.3073	71.75	Kheri	0.2287	0.3215	40.60
Balia	0.3432	0.3595	4.75	Kushinagar	0.2325	0.3487	50.00
Balrampur	0.1324	0.2122	60.28	Lalitpur	0.2604	0.4315	65.74
Banda	0.2262	0.3055	35.05	Lucknow	0.4489	0.5098	13.56
Barabanki	0.2649	0.3822	44.31	Maharajganj	0.2543	0.3472	36.56
Bareilly	0.3082	0.3924	27.31	Mahoba	0.1714	0.2946	71.86
Basti	0.1680	0.3135	86.66	Mainpuri	0.3405	0.4648	36.48
Bijnor	0.2800	0.3827	36.67	Mathura	0.3638	0.3961	8.88
Budaun	0.3503	0.3730	6.48	Mau	0.2603	0.3953	51.88
Bulandshahr	0.3201	0.4036	26.07	Meerut	0.4281	0.5165	20.65
Chandauli	0.2945	0.3608	22.52	Mirzapur	0.2150	0.3427	59.39
Chitrakoot	0.1328	0.2810	111.53	Moradabad	0.2935	0.4001	36.32
Deoria	0.3028	0.3652	20.62	Muzzafarnagar	0.3948	0.4241	7.43
Etah	0.2684	0.4277	59.39	Pilibhit	0.2360	0.3259	38.06
Etawah	0.3074	0.4115	33.87	Pratapgarh	0.2859	0.3867	35.27
Faizabad	0.2631	0.4405	67.45	Raebarelli	0.3373	0.4094	21.39
Farrukhabad	0.2783	0.4082	46.68	Rampur	0.3030	0.3975	31.17
Fatehpur	0.2379	0.3449	44.95	Saharanpur	0.3905	0.3930	0.66
Firozabad	0.2686	0.3934	46.43	S.K. Nagar	0.2316	0.2942	27.05
Ghazipur	0.2521	0.3391	34.49	SR Nagar	0.2078	0.2772	33.39
GB Nagar	0.3704	0.5271	42.29	Shahjahanpur	0.3067	0.3525	14.91
Ghaziabad	0.4677	0.5146	10.03	Shravasti	0.2751	0.2956	7.46
Gonda	0.1558	0.3509	125.27	Siddharth Nagar	0.1699	0.3325	95.65
Gorakhpur	0.2808	0.3630	29.25	Sitapur	0.2366	0.3529	49.16
Haathras	0.4093	0.3924	-4.13	Sonbhadra	0.1612	0.2624	62.80
Hamirpur	0.1982	0.3239	63.42	Sultanpur	0.2918	0.3961	35.78
Hardoi	0.2402	0.4103	70.80	Unnao	0.2696	0.3778	40.11
JP Nagar	0.2833	0.4247	49.93	Varansi	0.3261	0.3448	5.75
Region-Wise Rural Infrastructure Index (*RII*)							
Western UP	0.33	0.41	24.24	Central UP	0.29	0.39	34.48
Bundelkhand	0.22	0.35	59.09	Eastern UP	0.25	0.34	36.00
Uttar Pradesh	28.11	37.53	33.50				

Source: Based on UPDES data.

Table 5. Relationship between gross value of livestock sector and rural infrastructure at regional level

Region	Variable	Average value	Correlation coefficient	t-statistic
Bundelkhand	VO by Livestock	233.462	0.201[a]	16.88
	Rural Infrastructure Index	0.298		
Central UP	VO by Livestock	451.247	0.488[a]	34.93
	Rural Infrastructure Index	0.356		
Eastern UP	VO by Livestock	421.279	0.469[a]	31.01
	Rural Infrastructure Index	0.311		
Western UP	VO by Livestock	992.498	0.429[a]	29.09
	Rural Infrastructure Index	0.387		
Uttar Pradesh	VO by Livestock	618.940	0.478[a]	33.07
	Rural Infrastructure Index	0.344		

Note: [a]Indicate significant at 1% and [b]significant at 5%. *Source:* Author's calculation.

positively correlated (r=0.4781) with Rural Infrastructure Index (RII) which was positive and significant at 1% level of significance. It infers that there is extensive variation in the value of output by livestock sector and rural infrastructure index at regional level. This reveals a broad pattern that a good rural infrastructure yields higher value of output by livestock.

However, amongst all regions, the Western region showed a much better performance in terms of livestock sector and rural infrastructure in the state. To achieve objectives of a self-accelerating process of livestock sector development, progress in development has to be preceded, accompanied and followed by progress in rural infrastructure. Therefore, infrastructure may be considered as the wheels of the livestock sector.

Regression: The Chi-square value of Hausman test confirms preference of fixed effect model (FEM) to evaluate the drivers of value of output by livestock sector (VOLS) at the districts level for the period of 2004–05 to 2015–16 (Table 6). The result of FEM shows that rural infrastructure index (RII) had positive and significant impact on value of output by livestock sector (VOLS) throughout the study period. The computed value of elasticity of rural infrastructure with respect to value of output by livestock sector was 0.77 confirming that 10% change in the RII leads to 7.70% change in the value of output by livestock sector. The results confirm that available rural infrastructure facilities have substantial impact for increasing livestock growth (value of output) in Uttar Pradesh. This finding is corroborated by various researchers who argued that rural infrastructure development provides an indispensable support to induce growth and promotes sustainable development in agriculture and livestock sector (Chen and Lin 2002, Fan Hazell and Thorat 2000, Gulati 2005). Thus, a major thrust in the domain of rural infrastructure development can benefit the livestock sector in a big way.

The livestock sector contributes nearly one-fourth towards value of output by agriculture and about 5% in total state domestic product in Uttar Pradesh. At regional level, the growth of livestock sector is more than that of crop sector in the state. The highest growth in the livestock sector is recorded in the Western region followed by Eastern, Central and Bundelkhand region respectively. The phase at which the livestock development takes place depends mainly on the level of rural infrastructure. The strong positive correlation between the level of infrastructure and the economic development has been a well established fact in the development economics literature. Also, correlation and regression results reveal a positively significant relationship between livestock sector and rural infrastructure. Moreover, rural infrastructure has positive and significant impact on livestock value of output. A 10% change in rural infrastructure leads to 7.70% change in the value of output by livestock sector. This empirical evidence establishes the fact that investment in rural infrastructure fostered livestock growth in Uttar Pradesh. Currently, rural infrastructure stocks of UP are way below the capacity required to support its required levels of livestock production. Livestock economists and policy-makers are concerned that continued underinvestment in rural infrastructure might restraint livestock development efforts in various districts and adversely impact regional livestock growth. Broadly, districts and region with higher levels of rural infrastructure index also have higher income levels; similarly, districts and regions with low infrastructure levels

Table 6. Fixed effect regression model result

Dependent variable: value of output by livestock sector (VOLS)

R-squared
Within = 0.1663 Number of observations = 840
Between = 0.3642 F (1,769) = 153.34
Overall = 0.3035 Prob. > F = 0.0000

Independent Variable	Coefficient (β)	Standard error (SE)	Test statistics (t-value)	Significance level P>|t|
RII	0.7701289	0.062192	12.38	0.0000
Constant	6.954772	0.0679258	102.39	0.0000

Hausman test statistics
(Ho: difference in coefficients not systematic)
Chi-square (10) = 230.52 Prob. > chi^2 = 0.0000

Source: Author's calculation.

also have low value of livestock output. There is urgent need to bring more and balanced investment in rural infrastructure to induce equitable livestock growth. This would be possible when rural infrastructure complements other factors of livestock production, viz. improvement of total factor productivity by lowering input costs or by expanding the production frontier (Barro 1990). Thus adequate development of rural infrastructure facilities holds the key to translate the release of latent economic potential of factors of livestock production to enhance the rural household income. Therefore, infrastructure may be considered as the wheels of the livestock sector.

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