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Spatio-temporal distribution of subsidy on major livestock inputs and services in India

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Abstract We estimate the subsidies on the major inputs and services to the livestock sector in India. The livestock subsidy increased at 7% per annum from 2006 to 2017. Of the total livestock subsidy, veterinary and health services accounted for 75%, and livestock insurance the least, although it grew at a high rate. We also construct an agricultural development index. The rank correlation between the livestock subsidy and the index shows that the allocation of subsidy is higher to states that rank low on the index, as it should be, because less developed regions need more support for growth and development.

Keywords Livestock, subsidy, spatio-temporal analysis, agricultural development index, development

JEL codes Q12, C22, C23, C82, O11

Livestock is one of the fastest-growing sub-sectors of agriculture in developing countries (Thornton 2010). The world's production of milk grew by 13% per annum from 2002 to 2007, predominantly through smallholder dairy production in China, India, and Pakistan (FAO 2010).

The livestock sector in India provides a livelihood to 20.5 million people and employment to about 8.8% of the population. The sector contributes around 4% of the gross domestic product (GDP) and 25.6% of the agricultural GDP (GoI 2019). The income elasticities of demand for livestock products are higher; every 1% increase in income raises expenditure by 1% (Ghandi and Zhou 2010). Therefore, the demand for livestock products is increasing; and the sector is evolving rapidly in response (Steinfeld and Mäki-Hokkonen 1995).

Livestock is the mainstay of small and marginal farmers, who make up almost 85% of agricultural households. Individually, most farmers are resource-poor; subsidies on livestock inputs and services make smallholder production systems sustainable, and the government has instituted many schemes to help farmers make livestock farming a primary occupation rather than a secondary one. The marketable surplus of livestock farmers is small, but they produce about 73% of the milk in the country. Collectively, therefore, they represent an opportunity for aggregation.

The livestock sector's share in agricultural GDP has been growing at 4% per annum, and the growth in yield is often linked to poverty reduction (Bathla, Joshi, and Kumar 2019). And structural changes in livestock production are supported by institutional reforms (Chandel, Lal, and Kumari 2019). But the livestock sector receives fewer resources and less institutional support than commensurate with its contribution to the economy (Qureshi et al. 2015).

Yet, few researchers have studied the livestock sector, and livestock subsidies have not been quantified because these were implicit or disbursed through development programmes and agricultural subsidies were estimated under subsidies on irrigation, fertilizer, power, and credit. The literature on livestock subsidies is sparse, therefore, and this study attempts to fill the gap by determining whether the subsidy to the livestock sector is commensurate with its contribution to the economy.

Forms of subsidy to the livestock sector

Subsidies are disbursed in many ways, and a wide range of methodologies is used to estimate subsidies. The methodologies are described in the Global Subsidies Initiative manual (Jones and Steenblik 2010). We use the FAO (2003) guide for identifying, assessing, and reporting on subsidies in the fishery sector.

Subsidies to the livestock sector may be direct, or these may take the form of subsidies on veterinary and health services, credit or interest, or livestock insurance.

Direct subsidy

The financial accounts of the centre and the states have a head called "subsidy". The direct subsidy is the expenditure mentioned directly under the subsidy head; it is the financial allocation made for subsidies under the schemes and components and routed mainly through the state departments of agriculture and allied sectors. But subsidies are not presented in the same pattern in the finance account documents of all the states.

From the state financial accounts, we collected the data on livestock subsidies on cattle and buffalo development, feed and fodder development, dairy development projects and milk federations, veterinary services and institutions, livestock insurance, and other livestock development schemes.

Subsidy on veterinary and health services

Artificial insemination centres and veterinary hospitals provide veterinary and health services (such as vaccination). The expenditure accounts for 25% of the total public expenditure (Birthal and Taneja 2012) but the services are provided free or at a nominal fee. The difference between the expenditure and receipts, or the unrecovered cost, is a form of subsidy to the livestock sector.

We follow the unrecovered cost approach (Mundle and Rao 1991; Srivastava et al. 2003) to estimate the subsidy on veterinary and health services. We collected the data on public expenditure and receipts from the state finance accounts and aggregate it to generate country-level estimates.

Credit/interest subsidy

We cannot calculate the credit/interest subsidy directly, because the central and state financial documents club the agriculture and livestock sectors' loans outstanding into the "agriculture and allied sectors" head. Therefore, we followed a multi-step procedure to estimate the credit/interest subsidy to the livestock sector.

First, we selected a few states and banks, and their major loan-disbursing branches, and determined the amount of loans disbursed to the livestock sector. Drucker et al. (2006) used this so-called survey method to determine the main subsidy types to the piggery sector.

Then, we calculated the state-level loans outstanding to the livestock sector by segregating its average share in the loans outstanding at these branches to the agriculture and allied sector.

We collected our primary data from commercial nationalized banks. We found that they disbursed credit at a concessional rate to animal husbandry for the purchase of animals; setting up mini dairies, milking parlours, and cold chain facilities; and the purchase of bulk milk cooling units and dairy processing infrastructure.

We obtained the outstanding credit in agriculture and allied sector from secondary sources: cooperatives, regional rural banks, and commercial banks.

To segregate the outstanding country- and state-level credit to the livestock sector from that to the agriculture and allied sector, we used the percentage share of the outstanding livestock credit in the total agricultural credit.

Banks charge the agricultural and livestock sectors a lower credit/interest rate than the other sectors of the economy. To estimate the credit subsidy to the livestock sector, we multiplied the outstanding credit with the difference between the interest rate to agriculture and to the other sectors of the economy.

Livestock insurance subsidies

The difference between the premium paid by farmers and the premium fixed by insurance companies is the livestock insurance subsidy. The subsidy data was directly available for most states. In the cases where data was not available, we estimated the livestock insurance subsidy on the basis of the number of animals insured and the subsidy sharing pattern between the state and central governments (50:50).

We quantified the livestock subsidy for the period from 2006 to 2017. Then, to remove the impact of inflation, we deflated the values using a GDP deflator with 2011–12 as the base year.

We computed the compound annual growth rate (CAGR) and conducted a tabular analysis to estimate the real growth in subsidies, and we compared the real growth in the zones. We conducted a spatio-temporal analysis and estimated the subsidy allocated per unit to remove the effect of the size.

Agriculture development and the state agriculture development index

How are subsidies related to a state's agricultural development? We conducted correlation analysis and rank correlation analysis to answer this question.

We constructed an agricultural development index using 10 indicators—irrigation percentage, cropping intensity, share of area under cereals to total area, share of small and marginal holdings to total holdings, animal density, number of animals served per cooperative society, milk production, per capita milk availability, percentage of crossbred animals, and farmer's income—and scored the major states on the index.

We collected the data on the indicators for the triennium ending (TE) 2016–17 from a variety of secondary sources. We collected the data on irrigation percentage, cropping intensity, area under cereals, and small and marginal holdings were collected from the Handbook of Statistics on Indian States, the Economic Survey reports of states, and the websites.

We collected the data on livestock data related to animal density, number of animals served per cooperative societies, milk production, per capita milk availability, and the number of crossbred animals from reports of Basic Animal Husbandry and Fishery Statistics and the 19th Livestock Census.

We collected the data on farmers' income from the National Sample Survey (NSS) 70th round report on Income, Expenditure, Productive Assets and Indebtedness of Agricultural Households in India.

We normalized the data to make it unit-free, or bring them into a comparable range, by subtracting the minimum value from the observed value and dividing the range of the corresponding indicator (Mahida et al. 2018; Feroze and Chauhan 2010; Ayyoob, Krishnadas, and Kaeel 2013; Ponnusamy, Sendhil, and Krishnan 2016). Then, using E-views to conduct principal component analysis, we assigned weights to each indicator:

$$W_i = \Sigma |L_{ij}| E_j \quad \ldots(1)$$

where,

W_i is the weight of the i^{th} indicator

E_j is the eigenvalue of the j^{th} factor

L_{ij} is the loading value of the i^{th} state on j^{th} factor.

We summed the product of weights and value of indicator and divided the sum by the aggregate value of weights to calculate the index:

$$I_{State} = \frac{\Sigma_{i=1} X_i W_i}{\Sigma_i W_i} \quad \ldots(2)$$

Where,

$$W_i = \Sigma |L_{ij}| E_j \quad \ldots(3)$$

I_{state} is the index value of each state

X_i is the normalized value of i^{th} indicator.

We calculate each state's score on the index, rank them by score, and categorize the states by type of development into low, medium, and high. We also rank the states by total subsidies allocated per unit and determine if the allocation of subsidy was disproportionate. We estimated a rank correlation coefficient (ρ) to determine whether a state's rank on the agricultural development index was the same as the total subsidy per unit.

$$\rho = 1 - \frac{6\Sigma d_i^2}{n\,(n^2-1)} \quad \ldots(4)$$

where

ρ is a rank correlation coefficient, and

D is the rank difference between two variates of the ith state, and 'i' varies from 1 to n.

Results and discussion

Researchers have estimated the subsidy to the livestock sector by component and state in aggregate and per unit. We calculate the rank correlation between the

livestock subsidy per unit and a state's agricultural development index to determine whether and how much the allocation of livestock subsidy to a state depends on its development status.

Subsidy by component

We computed the proportion and quantum of subsidy allocated to the livestock sector by component (direct subsidy, veterinary and health services, credit, and insurance) from 2006 to 2017 (Table 1). We also calculated the CAGR.

Around 80% of the subsidy to the livestock sector takes the form of veterinary and health services; the allocation, INR 1,791.47 crore (USD 223.93 million) in TE 2008–09, grew at 5.97% per annum to INR 2,870.39 crore (USD 358.75 million) in TE 2016–17. But the percentage share decreased during the study period, implying that the subsidy to other components increased faster.

The rest of the subsidy to the livestock sector, around 20%, takes the form of direct subsidies and subsidies on credit and insurance (1–3%). The subsidy on livestock credit, INR 174.62 crore (USD 21.83 million) in TE 2008–09, increased at 6.62% per annum to INR 283.57 crore (USD 35.45 million) in TE 2016–17.

The third highest allocation was to direct subsidy, the subsidy provided to purchase animals and small equipment for dairying. The subsidy to livestock insurance was the least.

The subsidy on insurance and the direct subsidy are increasing at a higher rate, indicating the success of several schemes implemented to uplift the sector.

The intensity of allocation as depicted by subsidy per milch animal reveals that the allocation to veterinary and health services was the highest, and it increased from INR 162 (USD 2.03) to INR 235 (USD 2.94) over the period, at a CAGR of 4.64%.

The veterinary and health services subsidy per animal grew at a lower rate than the total subsidy, implying that the subsidy on veterinary and health services has not risen commensurate with the increase in the population of milch animals.

The Government of India initiated a subsidized livestock insurance scheme in 2006. But the scheme could cover only 900,000 dairy animals by 2010–11 and only 300 districts and 6% of the animal heads

Table 1 Livestock subsidy by component (constant prices, base year 2011–12)

Components	Triennium average						CAGR (%)	
	TE 2008–09		TE 2012–13		TE 2016–17		Total	Per milch animal
	Total (INR crore/ USD million)	Per milch animal (INR / USD)	Total (INR crore/ USD million)	Per milch animal (INR / USD)	Total (INR crore/ USD million)	Per milch animal (INR / USD)		
Direct subsidy	78.53 / 9.82 (3.79%)	7.00 / 0.09	245.11 / 30.64 (8.16%)	21.00 / 0.26	33.13 / 265.04 (7.51%)	22.00 / 0.23	24.32%	22.76%
Veterinary and health services	1791.47 / 223.93 (86.44%)	162.00 / 2.03	2440.39 / 305.05 (81.23%)	206.00 / 2.60	2870.02 / 358.75 (81.33%)	235.00 / 2.94	5.97%	4.64%
Livestock insurance subsidy	27.83 / 3.50 (1.34%)	3.00 / 0.04	59.23 / 7.40 (1.97%)	5.00 / 0.06	110.38 / 13.80 (3.13%)	9.00 / 0.11	19.57%	15.68%
Livestock credit subsidy	174.62 / 21.83 (8.43%)	16.00 / 0.20	259.55 / 32.44 (8.64%)	22.00 / 0.28	283.57 / 35.45 (8.04%)	23.00 / 0.29	6.62%	5.28%
Total	2072.45 / 259.06 (100.00%)	187.16 / 2.34	3004.28 / 375.54 (100.00%)	253.85 / 3.17	3529.01 / 441.126 (100.00%)	288.56 / 3.61	7.00%	6.65%

Source Estimation based on data from secondary sources
Note Figures in parentheses are percentages of column total

excluding poultry by 2013 (Birthal and Taneja 2012). Farmers do not subscribe to livestock insurance schemes despite the subsidy mainly because of technical or implementation reasons. Therefore, the government needs to raise awareness, increase the number of delivery channels to doorstep, and devise a mechanism for settling claims immediately. That will encourage farmers to subscribe to insurance schemes and also increase the livestock insurance subsidy.

Subsidy by state

We analysed the allocation of subsidy by state and milch animal (Figure 1). The allocation was the highest in Maharashtra, Rajasthan, Haryana, and Tamil Nadu in all the triennium averages.

We plotted the subsidy per animal against the total allocation in each state. We found that higher the allocation, less the subsidy per animal—or the allocation intensity was disproportionate to the animal population—and exceptionally so in Kerala and Himachal Pradesh (for the subsidy by components, see Tables 1 to 4 in the Appendix).

The subsidy allocated per animal improved in TE 2016–17 in Haryana and Tamil Nadu. The subsidy per animal on veterinary and health services was higher in these states, and its effect is evident in the higher milk productivity and share of crossbred animals.

The livestock subsidy is allocated disproportionately among the states, overall; the total allocation to the topmost states is high but the allocation per animal is low. The variation in the subsidy allocated per animal between the states has increased.

There were improvements in some states; for instance, the livestock subsidy per animal almost doubled in Haryana because veterinary and animal health services improved. Dairy farming is advanced in Gujarat and Punjab. Their marketing networks are strong, and they provide many services to dairy farmers without needing recourse to subsidy. That is why the allocation of livestock subsidy (total and per animal) was lower in both states. Punjab spent more than Gujarat on livestock credit and insurance but less on veterinary and health services.

Growth rate by state

The livestock subsidy grew at 5.65% CAGR and the subsidy per animal grew at 7.00% CAGR (Table 2). Kerala received the highest subsidy per milch animal.

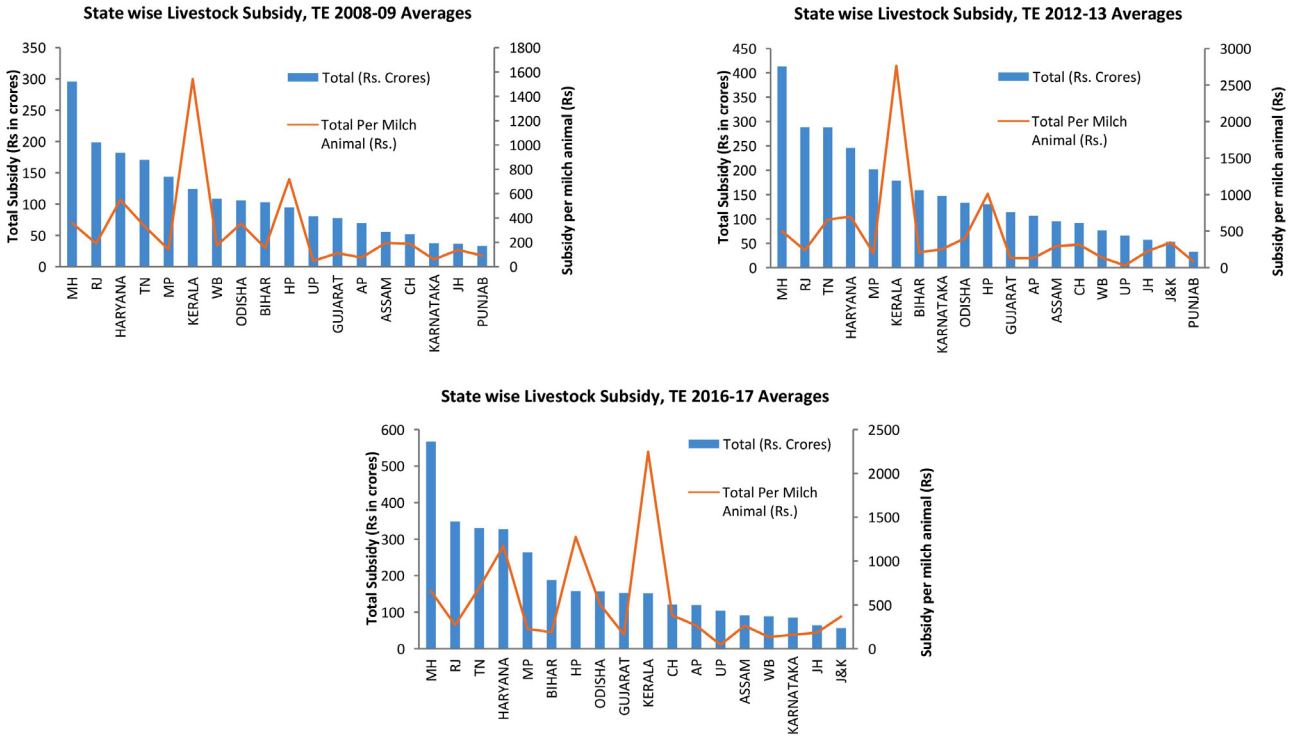

Figure 1 State-wise total livestock subsidy and per milch animal subsidy for three time intervals

Table 2 Distribution of states by growth rate in livestock subsidy and in subsidy per animal (2006–07 to 2016–17)

CAGR (%)	Total subsidy (overall growth rate 7.00%)	Per milch animal (overall growth rate 5.65%)
Lower decrease (–5–0%)	Kerala, Punjab, West Bengal	Kerala, Punjab, Sikkim, West Bengal
Lower increase (0–5%)	Manipur, Sikkim, Tripura, Uttarakhand	Assam, Bihar, Gujarat, Jharkhand, Odisha, Tripura, Uttar Pradesh
Moderate increase (5–10%)	Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Meghalaya, Odisha, Tamil Nadu, Uttar Pradesh	Arunachal Pradesh, Chhattisgarh, Haryana, Himachal Pradesh, Madhya Pradesh, Tamil Nadu, Uttarakhand
Higher increase (>10%)	Chhattisgarh, Jammu and Kashmir, Karnataka, Mizoram, Nagaland	Andhra Pradesh, Jammu and Kashmir, Karnataka, Manipur, Meghalaya, Mizoram, Nagaland

Source Estimation based on data from secondary sources

Kerala, Punjab, West Bengal, and Sikkim had a negative growth rate.

The subsidy per animal increased at 5–10% in most states and at more than 10% in Andhra Pradesh, Chhattisgarh, Jammu and Kashmir, and some north-eastern states.

The total subsidy grew at a lower rate in Andhra Pradesh and Uttarakhand but the subsidy per animal grew at a higher rate because the number of milch animals decreased. In Gujarat and Chhattisgarh, however, the total subsidy grew at a higher rate but the subsidy per animal grew at a lower rate because the number of milch animals increased.

States that had a larger share of the subsidy grew at a higher rate (Figure 2). The subsidy to Kerala and West Bengal increased marginally. The subsidy per animal was highest in Kerala. The share of subsidy was lower in Andhra Pradesh, Uttar Pradesh, Assam, Karnataka, and Jharkhand, but it had grown at a high rate in the past.

States that had a high subsidy per animal grew at a lower rate than did states that had a lower subsidy per animal (Figure 4). The subsidy per animal grew at more than 15% in Jammu and Kashmir, Andhra Pradesh, and Karnataka.

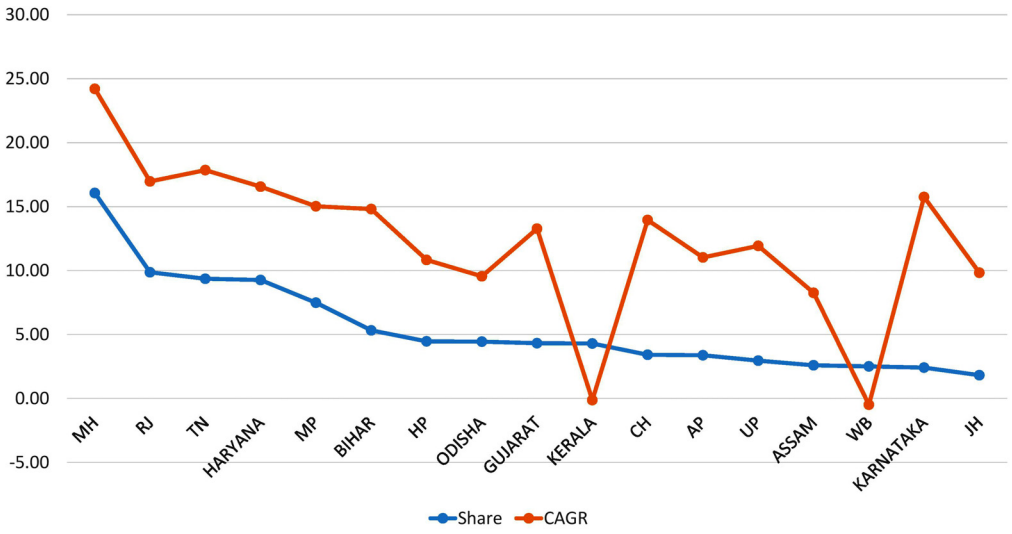

Figure 2 Trend in CAGR and share of total livestock subsidy in major states

Source Estimation based on data from secondary sources

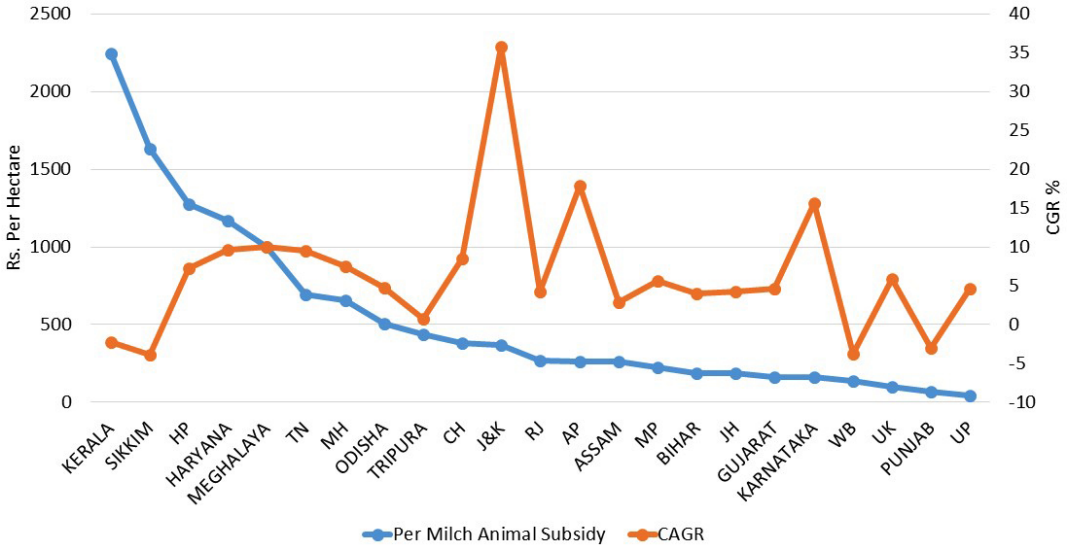

Figure 3 Trends in CAGR and subsidy per animal
Source Estimation based on data from secondary sources

The subsidy per animal on veterinary and health services increased substantially in Jammu and Kashmir, and livestock insurance improved in Andhra Pradesh and Karnataka (for the livestock subsidy by state and animal, see Table 2 in the Appendix).

Relationship of subsidy with agricultural development

To calculate the rank correlation, we correlated the states' rank on the index with their rank in the total subsidy. The rank correlation coefficient between the livestock subsidy and the agricultural development index was –0.3725, and it was –0.3376 between the livestock subsidy and the value of output from the livestock sector. The coefficient is negative, implying that the livestock subsidy was higher to the states where the value of output from the livestock sector was low or the states that ranked low on the index.

The subsidy per animal was low in the states that ranked high on the index (like Punjab, Uttar Pradesh, and Rajasthan) and high in the states that ranked low on the index (Figure 4). That is needed, as the less

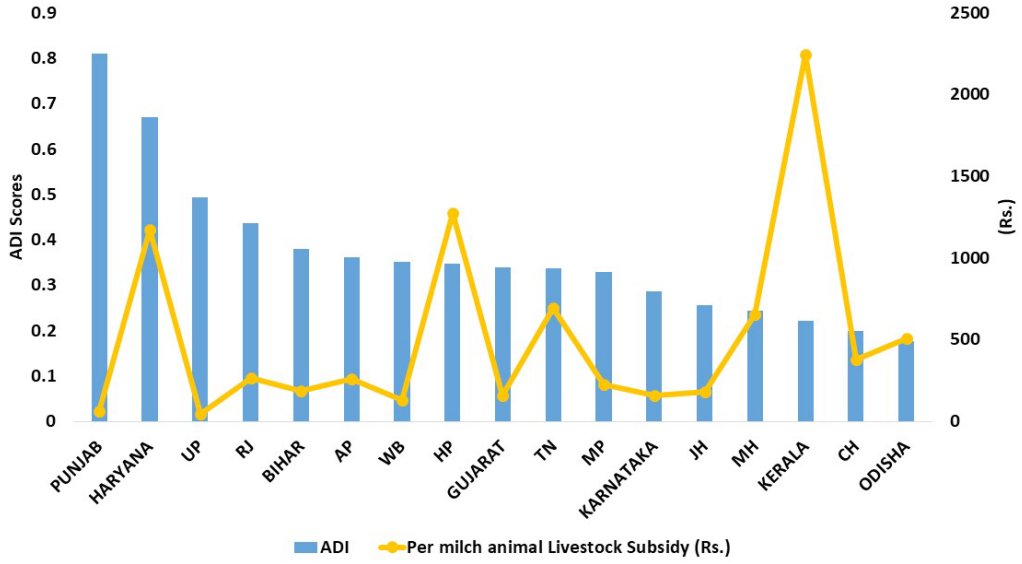

Figure 4 Agricultural development index and livestock subsidy per milch animal
Source Estimation based on data from secondary sources

developed regions require more support in the form of subsidies than the less developed regions.

Conclusions

The green revolution subsidies increased input use and, in turn, productivity (Buringh and Dudal 1987; Gordon 2000; Hazell et al. 2007; Ajah and Nmadu 2012). Agricultural development is the combination of the primary outcomes of subsidies (production and income) and the secondary outcomes (welfare effects, level of input use, farm labour employment); and it is positively correlated with subsidies (Deshpande and Reddy 1992).

Government documents cite some budgetary subsidies; for example, a report (GoI 2006) indicates that in the 11th Five Year Plan, the interest subsidy on the purchase of milk processing equipment was INR 550 crore (USD 8.75 million) and the capital subsidy in the 12th Five Year Plan was INR 4,000 crore (USD 500 million). The total subsidy in the central budget on crop husbandry was INR 4,672 crore (USD 584 million) in 1998–99; the subsidy in terms of unrecovered costs on the economic services of animal husbandry and dairy development was INR 138 crore (USD 17.25 million), or 2.95% of the total central budget subsidy on crop husbandry (Srivastava et al. 2003).

Both subsidies and investment increase the use of fixed inputs and improve agricultural income, and the government must keep subsidies and investment at equilibrium. But subsidies, now constituting about 2.5% of India's GDP, also impose negative externalities on both the exchequer and the environment. As agricultural growth stagnates, and because the resources for expenditure are limited, policymakers must shift the expenditure from subsidies to investment to boost growth (Jha 2011; Qureshi et al. 2015). The government is planning to support farmers by direct benefit transfer, phase out the subsidies, and replace these with additional production and sales subsidies; these measures would raise real farm income by about 4% and improve welfare overall (Dixon et al. 2020).

We attempt to quantify the subsidy to the livestock sector and analyse whether it is commensurate with the sector's contribution to the economy. To do so, we consider the range of indicators of agricultural development and construct a comprehensive agricultural development index that includes the components of the livestock subsidy.

The livestock subsidy, INR 2,072.45 crore (USD 259.06 million) in TE 2008–09, grew at 7% per annum to INR 3,529.01 crore (USD 441.13 million) in TE 2016–17. In comparison to the livestock sector's share in the economy (4.9% of gross value added in 2017–18), the subsidy was disproportionately low; and the subsidy per milch animal, which grew at a low 5.65% CAGR, was still not commensurate with the animal population. About 75% of the subsidy was allocated to veterinary and health services. The insurance subsidy had the least of the allocation, but it grew at a high rate.

The livestock subsidy allocated to poorly developed regions was greater than to well-developed regions. That indicates that the allocation of the subsidy was rational. The subsidy per animal was high in states where the allocation was high, in all the three TE averages, with a few exceptions.

There were improvements in some states; for instance, the livestock subsidy per animal almost doubled in Haryana because veterinary and animal health services improved. Dairy farming is advanced in Gujarat and Punjab. Their marketing networks are strong, and they provide many services to dairy farmers without needing recourse to subsidy. That is why the allocation of livestock subsidy (total and per animal) was lower in both states.

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