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Evaluation of the livestock sector contribution to small holders in eastern India

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ABSTRACT

The eastern region of India occupies about 21.85% of the total geographical area of the country and sustains 1/3rd of the total human and bovine population. Though livestock husbandry support to livelihood security of resource poor farmers' of the region, however, its synergy in cropping/farming systems has not been defined. Present study was designed to understand the contribution of livestock towards food and nutritional security besides sustaining the crop production system in seven eastern states. The data indicated that livestock and poultry is, by and large, reared in low input system and thereby the productivity of milk, meat and egg is low. Per capita availability of animal products was much lower than the national average. Growth and production efficiency of livestock/birds was influenced significantly by agro-climatic variations. Livestock productivity was comparatively better in Eastern Indo Gangetic Plains (EIGP). EIGP had highest egg and milk production. More than 80% of the total duck egg production is contributed by eastern India alone. Annual supplement of protein and energy was 3–4 fold lower in indigenous livestock/bird population than improved ones. Of the 106 million tonnes of manure, about 90 million is recycled into cropping/farming systems and rest is used as a source of biomass to meet out the domestic energy requirements. The data indicated that animal husbandry is an important food production system in eastern India besides crop production system and both the systems have been found complimentary to one another through emphasis on resource recycling.

Key words: Feeding practices, Fodder, Livestock, Manure, Per capita availability, Production

The eastern states of India comprise of Asom, Bihar, Chhattisgarh, Eastern Uttar Pradesh (UP), Jharkhand, Odisha and West Bengal and situated between 17º–29ºN latitude and 80º–97ºE longitude. The climate of the region is tropical, hot and humid except in hilly areas with high rainfall. The region is characterized into agro-climatic zones, like Eastern Himalaya, Lower Gangetic Plains (LGP), Middle Gangetic Plains (MGP), Eastern Hills and Plateau (EHP), and East Coast Plain and Hills (ECPH). Though the region occupies 21.85% of the total geographical area of the country, it sustains 1/3rd of the total human and bovine population. The population density is very high in the region, i.e., 619 nos. as against 325 nos./km^2 at the National level (Bhatt *et al.* 2011). Likewise, the livestock density is estimated to be 230 nos. as against 155 nos./km^2 at the national level.

The region has more than 90% of indigenous livestock population and the productivity is low (Dey *et al.* 2012). The Eastern Indo Gangetic Plains (EIGP), which includes LGP and MGP, is considered the food bowl of the country keeping in view the soil fertility, access to water and favourable climatic conditions. Agriculture in EIGP is strongly supported by animal husbandry practices, which is evidenced from the fact that more than 60% of the livestock and bird population is found in this zone only. Keeping in view the importance of livestock in livelihood improvement of marginal, sub-marginal and landless farmers on the one hand and to sustain the agricultural production system on the other, the present study was conducted to quantify the role of livestock in agriculture, livestock productivity in terms of milk and meat, egg production, per capita availability of various animal products and organic manure production. The synergy of crop-livestock production system has also been discussed.

MATERIALS AND METHODS

The present study was conducted for 4 years (2011–12 to 2014–15). Studies on milk, egg and dung production were conducted by selecting 2 districts in each eastern state (Asom: Barpeta, Hailakandi; Bihar: Buxar, Patna; Chhattisgarh: Durg, Rajnandgaon; Eastern UP: Azamgarh, Ballia; Jharkhand: Dumka, Ranchi; Odisha: Keonjhar, Sambalpur; West Bengal: Burdwan, Hooghly). Further, from each district, 5 villages were selected involving 5 randomly selected livestock farmers. Hence, a total of 70 villages, involving 350 farmers, were surveyed in LGP, MGP and Eastern Hill and Plateau including the coastal area to complete the study (Gupta *et al.* 2014).

To estimate the fodder production, an experiment was

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conducted at research farm of the institute (Located between 25°11'N latitude and 85°32'E longitude, and an altitude of 53 masl). During the study period, mean annual rainfall was recorded 895.82±86.5 mm with highest precipitation in August-September during the period of experimentation. Mean monthly minimum temperature ranged from 6.5ºC (January) to 29.6ºC (August) whereas, maximum temperature varied from 18.7ºC (January) to 38.14ºC (May). Perennial forage (Napier, Setaria, Congo and Guniea), summer/rain season forage (sorghum, maize, bajra, jowar, cowpea and rice bean) and winter forage (maize, oat, berseem and annual rye) were cultivated in four replications in complete Randomized Block Design. The plot size for each replication was 25 × 25 m.

To assess the data on faecal material, 35 animals of different age group in each category were selected randomly in diverse agro-climatic zones. Dung production was calculated for 24 h in summer, rainy and winter. The sample of fresh dung was brought to the laboratory and oven dried at 100±5°C till constant weight to compute the dry matter content. Time spent in grazing was also calculated in the village ecosystems and the actual quantity of manure was corrected deducting the amount of manure excreted during grazing/browsing. A representative sample of faecal material was subjected to chemical analysis following the standard procedures (Anderson and Ingram 1989).

Feed and fodder offered to different categories of livestock and birds and residue left were measured actually at farmers' households for consecutive four days in sample households in summer, rainy and winter season. Feed and fodder were also subjected to chemical analysis (AOAC 1995). Energy and protein values of feed stuff were calculated based on the values reported by Animal Nutrition Group, NDDB (2012).

Periodic growth of livestock/birds was measured and compared with improved breed/strain in order to find out the differences in growth and body weight gain. The body weight of improved cattle, goat, poultry and pig was measured using digital balance, however, the body weight of indigenous cattle at field was calculated following modified Shaffer's formula.

$$w = \frac{G2 \times L}{300}$$

where, W, live body weight of animal in pounds; G, heart girth (inches); L, length from the point of shoulder to the point of pin bone (inches). Finally the body weight was converted from pound to kg (Khan *et al.* 2003). Likewise, the body weight of buffalo was calculated following Mullick's formula (1950).

$$X = 25.156\ (Y) - 360.232$$

where, X, estimate of body weight (pounds); Y, heart girth (inches).

The housing patterns in traditional animal husbandry practices across the states were also documented. However, secondary source of information was also used to calculate total population, meat, egg and milk production (Anonymous 2014).

Data collected were recorded in master table sheets from the questionnaire. Data were analyzed using SPSS (SPSS, version 16) to calculate descriptive such as mean, range, frequency and percentage. A number of tables were prepared on the basis of objectives of the study.

RESULTS AND DISCUSSION

Livestock population: The total livestock population in the region accounted for 165.31 million as against 512.06 million at the national level, thereby contributing 32.28% of the total livestock population. Likewise the rural poultry accounts for 21.82% of the total poultry population of India. Among various categories of livestock, cattle population was the highest (77.58 million), followed by goat (52.07 million). Buffalo rearing was confined mainly to Eastern UP and Bihar. Pig population was the highest in Asom (1.64 million), followed by Jharkhand (0.96 million). Poultry population was highest in West Bengal (52.84 million) and lowest (9.78 million) in Eastern UP.

Indigenous vs improved population of livestock/poultry: Eastern states have a large population of indigenous livestock. Similar was the case with poultry. Irrespective of states, the region had more than 80% indigenous cattle and pig population. India has more than 95% indigenous population of ducks and similar was the case in Eastern India.

Different category of livestock exhibited distinct population trend and it was governed by agro-climatic conditions, viz. EHP including coastal parts had highest livestock population (39.0%), followed by LGP (35.0%). On the other hand, more than 70% of total buffalo population was confined in MGP. Goat population was, however, more or less uniformly distributed in all the agro-climatic conditions. Pig and poultry population was, respectively, 45.0 and 50.0% in LGP. So far in total livestock was concerned, MGP was comparatively thickly populated (representing 38.0% of the total population), followed by EHP and coastal region (32.0%). Moreover, small land holding in the region compels smallholders to depend on livestock farming as it contributes 15–40% of total household income (Dey *et al.* 2012). The growth of crossbred cattle population has been observed in MGP because of implementation of Artificial Insemination Programme by State Milk Federation (Anonymous 2014). Buffalo population was confined, mainly, to MGP along the river Ganges as buffalo is most preferred dairy animal in the area due to its higher fat content in milk and ability to adopt in harsh climatic conditions. On other hand, in LGP and EHP, buffalo was only used as working animal. Pig, generally, is reared by Scheduled Caste and Scheduled Tribes households. Poultry population had also been observed high in LGP as poultry production had been spread as business model among rural youths in the form of contract farming. The impressive growth in the poultry sector in general and broiler industry in particular is the result of

technological breakthrough in breeding, feeding and health, and sizeable investments from the private sector (Sashidhar and Suvedi 2015).

Growth performance of different categories of livestock/ birds: The average body weight in different categories of indigenous and improved strains of animals and rural poultry was measured for 24 months. The average birth weight of indigenous and improved cattle was 18.60±3.58 and 28.70±0.25 kg, respectively. After 24 months of age, body weight was recorded 118.60±9.11 and 312.60±8.60 kg in indigenous and improved cattle, accordingly. The data indicated daily gain of 138.9±35.20 g in indigenous cattle as against 394.3±32.20 g in improved breed. The mean body weight of indigenous buffalo at birth was 28.80±1.22 kg and attained 230.60±11.19 kg after 24 months of rearing with daily weight gain of 280.28±22.20 g/day. The mean body weight of indigenous goat at birth was 1.06±0.23 kg and after 24 months of age it was 24.15±1.10 kg with a daily weight gain of 32.07±3.20 g. Average birth weight was recorded to be 0.84±0.21 and 1.16±0.15 kg, respectively, in indigenous and improved pig. After 24 months of age, indigenous pig attained the body weight of 56.20±5.13 kg, whereas the improved breed 196.52±24.20 kg; indicating average weight gain of 76.9±17.31 g/day in indigenous and 271.3±21.70 g/day in improved breed, respectively. The average birth weight was recorded as 23.40±3.51 and 31.13±1.13 g in indigenous and improved fowl, respectively. After 24 months of age, the body weight of indigenous fowl was 1471.0±88.12 g as against 2609.25±76.32 g in improved fowl, indicating daily body weight gain of 3.6±0.18 g in improved and 2.01±0.22 g in indigenous fowl; accordingly. Similarly, the average birth weight was recorded to be 32.80±2.12 and 38.0±1.81 g, respectively in indigenous and improved duck, respectively. After 24 months of age, indigenous and improved ducks were able to attain the body weight of 1610.0±110.10 and 1375.0±99.12 g, respectively, indicating daily weight gain of 2.2±0.14 g in indigenous and 1.8±0.24 g/day in improved strains.

The growth performance of cattle, buffalo, goat, pig, duck and poultry recorded in the present investigation was well within the range as reported by Kaushik *et al.* (2013) for pig, Deka *et al.* (2014) for poultry and Kumar and Prasad (2013); Islam *et al.* (2014) for poultry of the study area. In the present investigation, daily weight gain in cattle was 0.139 kg. Earlier Sreedhar (2015) reported the daily weight gain in cattle from 0.166 to 0.36 kg/day from Eastern India and coastal region of Southern India. These variations might be due to difference in feeding system, climatic factors and periodical use of anti-parasitic drugs. Further, the decrease in body weight during the middle of the laying cycle in improved duck may be due to higher egg production during that period. The present findings were in agreement with Padhi and Sahoo (2011) who reported body weight of 1.32 to 1.53 kg during the laying phase of ducks in Odisha.

Milk production: Large population of indigenous cattle had a very low milk yield (range 0.95±0.30 to 2.87±0.39 kg/day) with a mean value of 1.79 kg/day in the study area as against 2.36 kg/day at the national level (Fig. 1). The data indicated 25% low milk yield in indigenous cattle of Eastern India compared to the national average. Compared to indigenous breeds, crossbred population showed average milk yield of 5.48±0.82 kg/day in Eastern region as against 6.78 kg/day at the national level. Milk yield of crossbred cattle was 20.0% lower in Eastern India than the national average. Milk yield of indigenous buffalo ranged from 2.85±0.26 to 5.69±0.40 kg/day with average milk yield of 4.40±0.60 kg/day in Eastern India as compared to 4.80 kg/ day at the national level. Milk production was accounted for 16.24 million tonnes from 16.04 million nos. of indigenous and crossbred cattle population. On average, indigenous and improved cattle population could contribute 34.8 and 18.9%, respectively, of the total milk production at the national level. The study area has 5.61 million nos. of indigenous milch buffalo, which could produce 10.22 million tonnes of milk as against 70.44 million tonnes at national level and thereby contribute 14.51% of the total milk production.

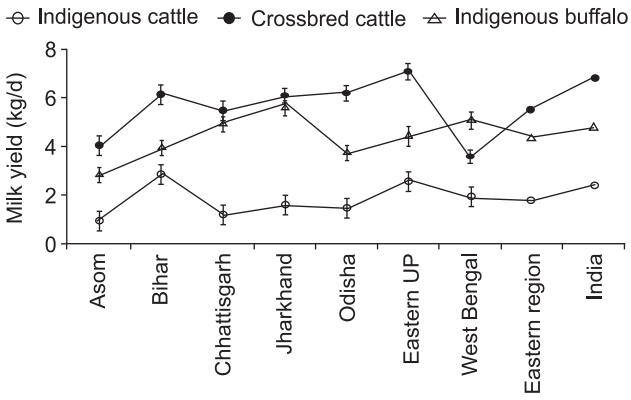

Fig. 1. Average milk yield of non-descript and improved livestock in Eastern India.

Average milk yield in cattle was comparatively higher in MGP (2.72 kg/day), followed by LGP (1.43 kg/day) and EHP and coastal region (1.40 kg/day). Buffalo milk yield was recorded to be 4.4 kg/day in the study area. Similar values of milk production of indigenous and crossbred cattle, and buffalo were reported by Singh *et al.* (2005) in different eastern states. However, Dhara *et al.* (2006) reported slightly higher milk yield (6.0–7.0 kg/day) in crossbred cattle than the present findings in LGP, which might be due to genetic potential of crossbred cattle, stage of lactation, parity and variations in feeding practices. Of the total buffalo milk production of 10.22 million tonnes recorded in the study area, 87% is contributed only by MGP as this area is dominated by buffalo population with medium milk production potential (Chandran *et al.* 2015). Total milk production in Eastern India has been accounted for 26.46 million tonnes. MGP, LGP, and EHP and coastal region, respectively, contribute 61.5, 21.0 and 17.5% of the total milk production.

Meat production: Based on the data available from

organized sector of meat production, it has been observed that Eastern region has a total meat production of 1.63 million tonnes as against 6.24 million tonnes at the national level. The data indicated 26% share of Eastern region in meat production at the national level. Among various sources of animal protein, highest production has been recorded through chicken and duck meat, and mutton and chevon (0.55 million tonne in each case). At the national level, the region contributes about 40.82% of the total pork production, followed by mutton and chevon (39.08%) and poultry and duck meat (28.80%).

Eastern states share 26% of the total animal protein at the national level from organized sector of meat production. However, the region also has the unorganized sector of meat production for which data is not available. Inter comparing meat production in different agro-climatic zones, it was observed that MGP and LGP, respectively contribute 43.0 and 42.0% of the total meat production of the region. Of the total chicken & duck meat, 61% alone was contributed by LGP. This zone also contributed 52.1% of the total mutton and chevon production. Contribution in pork was highest in MGP, where it contributed 66% of the total pork production. EHP and coastal area contributed lowest either in total meat production or through different sources of animal proteins. Since the people of the region are primarily non-vegetarian, their affinity towards rearing of meat animal (goat, chicken, duck, and pig) is well recognized (Feroze *et al.* 2010).

Egg production: Egg laying efficiency of indigenous fowl was comparatively higher (108.6±10.12 nos./yr) as against the national average of 105.71 nos./yr. However, egg laying efficiency of improved breeds of fowl was significantly low (210.45±12.12 nos./yr) in the region compared to national average of 276.61 nos./yr. Egg laying efficiency of improved fowl breeds was lower by 24% in eastern India compared to national level. In indigenous ducks, average egg laying efficiency was accounted for 108.5±11.12 nos./yr compared to national average of 121.79 nos./yr. Egg laying efficiency of improved breeds of duck was slightly better than the national figure.

Average egg production was higher in MGP either in indigenous or improved strains of fowl and duck. Egg production ranged from 131.0–147.3 and 216.5–253.01 nos./yr, respectively, in indigenous and improved fowl strains in MGP. Total egg production, however, showed the different trend. Of the total fowl egg production of 8011.70 million nos., LGP shared about 47.0% of the total production, followed by EHP and coastal region (35.0%). Moreover, more than 90% of the total duck egg production was confined in LGP, since the region comes under high rainfall area and presence of abundant water in the area. In a large number of low-income households, backyard/household production, particularly poultry, is the critical source of income and nutrition. In this low input system, the productivity is low, however, nutritional security is ensured. Starvation associated with dwindling biomass availability in villages is an important factor contributing to poor growth and survival in village poultry. These observations were in agreement with the earlier report of Kamal *et al.* (2016) in case of fowl and Gaur *et al.* (2010); Padhi *et al.* (2009) in case of duck.

Table 1. Per capita availability of milk, meat and egg

State	Per capita availability of milk (g/day)	Per capita availability of meat (kg/year)	Per capita availability of egg (nos./year)
Asom	71.98	1.28	15.11
Bihar	189.49	2.79	8.94
Chhattisgarh	129.75	1.17	56.09
Jharkhand	141.18	1.52	13.47
Odisha	121.42	3.57	56.25
Eastern UP	290.47	5.38	7.94
West Bengal	147.37	7.12	51.99
Eastern region	176.11	4.01	27.08
India	311.62	5.15	60.66
% share	56.51	77.86	44.64

Per capita availability: Per capita availability of milk, meat and egg is depicted in Table 1. Compared to national average of 311.62 g/day availability of the milk, Eastern states have the availability of 176.11 g/day. Per capita meat availability was 4.01 kg/yr in the region compared to 5.15 kg/yr at the national level. Similar was the case for egg availability. The region has the availability of 27.08 eggs/yr compared to national average of 60.66 eggs/yr.

Per capita availability of milk was almost 2-fold higher in MGP (240 g/day) compared to other agro-climatic zones. Meat availability in EIGP ranged from 4.08–4.20 kg/capita/year, as against 2.09 kg/yr in Eastern Hill and Plateau and coastal region. On the other hand, per capita availability of egg was highest (41.94 nos./yr) in Eastern Hill and Plateau and coastal area, followed by LGP (33.55 nos./yr). MGP, however, had the lowest per capita egg availability (8.44 nos./yr). The per capita availability of animal products was observed low than the national average of per capita availability of milk, meat and egg (Anonymous 2014). Per capita availability is continuously increasing since the implementation of operation flood on account of improved technological changes on breeding, feeding, health care and management and obviously creation of market linkages. During the study, it was observed that slaughtering of tender kids of goats (< 6 months of age) is quite common in the region and, therefore, meat production is very low. We recommend to enhance the slaughtering age at least 6 months to one year, for 2-fold higher mutton production. To improve the production in indigenous pigs, cultivation of tuber crops as alternative source of feed shall be employed. Many research findings are available which have proved significant gain in pig growth though use of non-conventional feed resources (Gupta *et al.* 2012).

Feeding practices in livestock/birds: The livestock including small ruminants are, by and large, reared on low input feeding practices in the study area. Grazing is practiced on an average 4–5 h daily (1300±11.2 to

1575.0±14.1 h/yr) in cattle and buffaloes, and 8 h (2560±22.1 h/yr) in goats besides stall feeding. Pigs and poultry are reared on scavenging system. Wheat and rice straw and green fodder constitute large part of diet of cattle and buffaloes in traditional animal husbandry practices. Irrespective of states, average fodder consumption in cattle was estimated to be 1460.0±67.50 and 1280.0±56.01 kg/yr of dry and green fodder, respectively. The corresponding values were 2190.0±81.54 and 1825.0±73.01 kg/yr in buffaloes. The data clearly indicated that dry fodder consumption is 13–17% higher than green fodder in cattle and buffaloes. Annual consumption of concentrate feed in improved cattle was accounted for 1175.0±4.62 kg/yr besides dry fodder consumption of 2172.76±52.12 kg and green fodder of 5596.0±57.08 kg, respectively. The concentrate feed ingredients include crushed maize (30%), rice bran (30%), mustard cake (19%) and pulse by-product (18%).

Stall feeding of goats revealed average green fodder consumption of 1272.50±35.01 kg/yr. Rice and wheat bran, mustard cake and broken rice are fed as concentrate to cattle, buffaloes and goats besides small amount of pulse by-product. Concentrate is fed only 10–13% of total green and dry roughage to cattle and buffaloes whereas, in goats, concentrate is used only 2.3–3.3% of the total green fodder consumption. Under low input production system, pig is fed only with rice bran and broken grain with average consumption of 203.6±7.15 kg/yr. The data revealed that daily feeding to pigs is hardly 0.56 kg. Improved pig was, however, fed with 580.0±8.22 kg/yr of concentrate with a feed ratio of crushed maize (40%), soybean cake (30%) and rice bran (27%). The feed consumption was estimated to be 18.50±3.20 and 27.3±1.70 kg/yr, respectively, to indigenous fowl and duck. Average consumption of feed for improved duck was 26.02±2.48 kg/yr with feed ingredients of broken rice (50%), soybean cake (20%), rice bran (17%) and maize (10%) whereas, improved poultry consume on an average 31.01±2.67 kg concentrate with feed composition of maize (57%), soybean oilcake (30%), rice bran (10%). The quantum, the type and quality of feed resources also vary across the states in the region. Improved livestock and poultry are reared in intensive system for commercial purpose and fed balanced feed to exploit the full production potential. However, in traditional system of animal rearing, crop residues and by-products are used as animal feed in the region. The feed resources used by the farmers of the region are not balanced in terms of protein and energy to meet the nutrient requirement of the animal leading to poor performance. The gap between demand and availability is major challenge to the animal owners especially during summer season (Feroze *et al.* 2010). The area under fodder is very minimal in the region. Farmers' mainly depend on common property resources, viz. permanent pastures and grazing lands, wastelands, fallows etc. for grazing of animals. Similar type of feeding practices of cattle, buffaloes, and small ruminants have been reported by Gupta *et al.* (2014). The animals were underfed in terms of quality nutrient. Energy requirement is deficit by 49% in cattle, 74% in buffalo, 38% in pig and 34% in goat. Food energy requirement for Indian cattle, buffalo, pig and goat has been worked to be 62.50, 54.43, 12.08, 4.43 MJ/individual, respectively. Earlier, Singh *et al.* (2005) quantified the nutritional requirement of dairy cattle in LGP, MGP, EHP which indicated the deficiency of protein and energy intake to the extent of 18 and 42%, respectively, compared to requirement. Similarly, traditional feeding system of backyard poultry has been reported by Johri *et al.* (2002) which is in agreement with the present findings.

Fodder productivity: Eastern region does not have organized fodder production in practice except in some parts of eastern UP. Compared to 7.77 million ha area under fodder production in India, the region possess only 0.32 million ha. Napier, Setaria, Congo signal and Guinea are cultivated as perennials with highest fodder productivity in Napier (250–280 t/ha) and lowest (115–120 t/ha) in Setaria. Sorghum, maize, bajara, jowar, cow pea and rice bean are cultivated as annual crop during summer/rainy season. Multi-cut sorghum showed highest productivity (65–90 t/ha), followed by maize (45–55 t/ha). Lowest yield was, however, recorded in rice bean. During winters, berseem, oat, rye, and maize are the important fodder crops with highest fodder productivity (60–65 t/ha) in rye and lowest (30–35 t/ha) in oat.

Annual supplement of nutrients: Annual supplement of protein to improved cattle was accounted for 548.81±39.80 kg/yr as against 114.93±56.50 kg/yr in indigenous cattle indicating 4.77-fold higher protein supplement to improved cattle than indigenous cattle. Concentrate feed, dry and green fodder, respectively, contributed 52.0, 14.5 and 33.5% of the total protein supplement to improved cattle. In indigenous cattle, dry fodder alone contributed more than 43% of the total protein, followed by green fodder (27%) and concentrate feed (20%). Similar was the case to indigenous buffaloes. In goats, more than 82% of annual protein supplement was contributed through green fodder. Annual protein supplement of pig was estimated to be 67.92% by rice bran alone and the rest was shared by broken rice/wheat/maize. Protein supplement was 3.0-fold high in improved fowl compared to indigenous strains. Improved duck revealed 2.0-fold higher protein supplement than indigenous population. Similarly, balanced feed in improved strains of fowl could supplement 6.57±0.80 kg of protein compared to 2.22±0.10 kg of protein/yr/bird in indigenous fowl population. Supplement of protein was similar to improved strains of ducks. However, indigenous ducks could gain only 2.91±0.31 kg of protein/bird/year, out of which 43.6% is contributed through broken rice and rest through whole paddy grain. On average, annual energy supplement was 3.5 fold higher in improved cattle compared to indigenous ones. In improved cattle, balance feed alone contributed more than 37% of the total energy. On the other hand, dry fodder shared more than 60% of annual energy supplement to indigenous cattle and buffalo. Goat rearing exhibited more than 85% of annual energy supplement from

green fodders. Energy gain in improved pig was found to be 2744.64±18.90 MJ/yr as against 765.98±16.64 MJ/yr in indigenous population. Rice bran contributed about 70% of the total energy gain in indigenous pigs.

The metabolisable energy was estimated to be 106.40±0.60 MJ/bird/yr in improved fowl as against 51.80±0.32 MJ in indigenous strains. In case of improved ducks, the energy supplement was estimated to be 98.0±0.56 MJ compared to 78.26±0.32 MJ in indigenous strains. Paddy grain as a whole contributed 65.1% of the total energy to indigenous ducks and rest was contributed by broken grains. Energy supplement was, respectively, 2.5 and 1.6 fold higher in improved fowl and duck than the indigenous populations.

Manure production: Total dung production in Eastern states was recorded 106.0 million tonnes as against 353.84 million tonnes at the National level and, therefore, share of the region in total manure production was estimated to be 30%. Of the total dung production, 20.0–25.0% is lost during grazing in buffalo and cattle, and up to 40% in goat and pig. Similarly, 60% of the total manure is lost during scavenging in poultry. However, of the total manure production, cattle contributed maximum (70%), followed by Buffalo (27.4%) in Eastern India (Table 2). Total manure production was highest (23.40 million tonnes) in Bihar, followed by Eastern UP (19.54 million tonnes) and West Bengal (17.31 million tonnes). Except Eastern UP, cattle contributed highest dung production whereas, in Eastern UP, buffalo alone contributed 57.7% of the total manure.

Manure is an important organic source of nutrients. Of the total manure production of 106 million tonnes, 40.5% was contributed by MGP, followed by EHP and coastal area (32.8%). Eastern states have the total production of 106 million tonnes of manure, out of which approximately 15 million tonnes is used as a source of biomass to meet out the domestic energy requirements. States like Bihar and Eastern UP use more than 20% of the cattle dung as a source of energy (Fig. 2). The region has, therefore, availability of approximate 90 million tonnes of manure to sustain rice-wheat food production system in more than 29.0 million ha net sown area besides inorganic sources of nutrients (Timsina and Connor 2001).

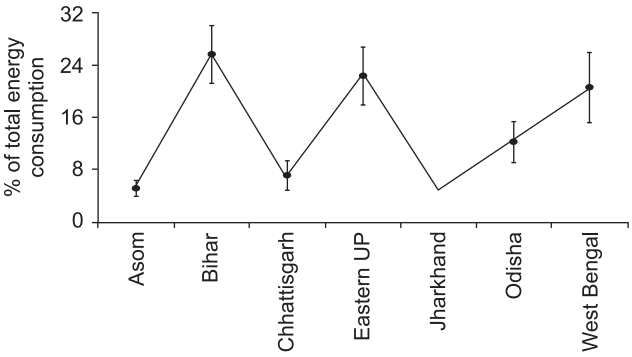

Fig. 2. Use of cattle dung as fuel in sample households.

The region has about 2.73 million ha area under ponds, tanks, reservoirs and beels, wherein recycling of manure can help in increasing the fish production through adoption of the integrated fish farming models (Bhatt *et al.* 2011a, Sarma *et al.* 2015).

Primary and secondary nutrients: Status of primary and secondary nutrients has also been estimated in various sources of manures. Nitrogen content was found to be

Table 2. Dung/droppings production in Eastern India (million tonnes- dry wet basis)

Eastern state	Cattle	Buffalo	Small ruminants	Pig	Poultry & duck
Asom	9.87 (13.16)	0.65 (0.81)	0.14 (0.24)	0.23 (0.35)	0.12 (0.30)
Bihar	11.72 (15.63)	11.26 (14.08)	0.27 (0.45)	0.09 (0.14)	0.06 (0.14)
Chhattisgarh	9.40 (12.54)	2.07 (2.59)	0.07 (0.12)	0.07 (0.10)	0.10 (0.25)
Jharkhand	8.36 (11.15)	1.77 (2.21)	0.16 (0.26)	0.14 (0.21)	0.06 (0.15)
Odisha	11.14 (14.85)	1.08 (1.35)	0.18 (0.30)	0.04 (0.06)	0.09 (0.22)
Eastern U.P.	8.01 (10.67)	11.27 (14.09)	0.15 (0.24)	0.06 (0.09)	0.05 (0.11)
West Bengal	15.82 (21.09)	0.89 (1.11)	0.28 (0.46)	0.09 (0.14)	0.23 (0.58)
Eastern region	74.32 (99.10)	29.00 (36.25)	1.25 (2.08)	0.72 (1.10)	0.70 (1.74)
India	182.91 (243.88)	161.88 (202.35)	4.39 (7.31)	1.46 (2.25)	3.20 (7.99)

Values in the parenthesis indicate the dung excreted during grazing or scavenging.

Table 3. Primary and secondary nutrients in different manures (in × 10^3 mg/kg)

Source	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sodium
Cattle	14.12±0.12	3.51±0.03	3.01±0.02	5.01±0.04	5.03±0.03	3.05±0.03
Buffalo	15.15±0.16	4.04±0.06	4.03±0.05	6.02±0.06	5.50±0.04	3.51±0.04
Goat	19.21±0.21	5.06±0.08	7.06±0.09	8.04±0.08	6.01±0.04	3.02±0.03
Poultry	22.03±0.19	14.02±0.10	8.02±0.10	17.03±0.13	3.02±0.03	4.06±0.05
Pig	31.04±0.24	14.01±0.11	11.01±0.11	3.01±0.04	2.01±0.01	3.05±0.04

highest in pig manure (31.04×10^3 mg/kg), followed by poultry manure (22.03×10^3 mg/kg). Similar was the case with phosphorus and potassium. Calcium was found highest in poultry manure (17.03×10^3 mg/kg), followed by goat dung (8.04×10^3 mg/kg). So far in secondary nutrients was concerned, goat manure exhibited highest magnesium content (6.01×10^3 mg/kg) whereas, poultry manure showed highest amount of sulphur, i.e. 4.06×10^3 mg/kg (Table 3).

Traditional animal husbandry practices: Traditional animal husbandry practices are, by and large, practiced in Eastern India with low input and output production system. Almost all the category of livestock/birds are housed in low cost houses, made up of locally available material and roofed with thatched grass/paddy straw or corrugated galvanized iron sheets across the region. Low cost housing could reduce average day temperature inside the house by 2–3°C, particularly during hot summer season, which is uniqueness of traditional housing patterns (Kamal *et al.* 2014). Fattening pig rearing is very common in scavenging system. Low cost small houses are prepared in the backyard for housing pigs. Similar practice was followed for goat rearing, however, majority of the farmers provide elevated platform in goat shed so as to protect them from cold (Otherwise goats are affected due to pneumonia and other respiratory diseases- personal observations of authors). Fowl and duck are housed in small low cost sheds in backyard. Use of bamboo baskets is also common in housing fowl and duck. These observations were in agreement with the earlier reports of Chandran *et al.* (2014); Rath *et al.* (2015) and Padhi (2014).

From the aforementioned discussion, it is well evident that Eastern region needs a focused attention on livestock production so as to exploit its synergistic role in farming system. Animal husbandry is an important food production system in EIGP which could be adversely affected because of reduced resource availability and lack of private support. Keeping in view the substantial area in the region under rainfed agro-ecosystem with occurrence of frequent natural disasters, the focus and direction of agricultural development programmes must be oriented towards multidisciplinary approach in improving the farm productivity in general and livelihood improvement in particular.

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