SOCIO-ECONOMIC STATUS AND SYSTEM OF FARMING PRACTICES WITH DIARA BUFFALOES IN THE MIDDLE GANGETIC PLAINS OF BIHAR, INDIA

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ABSTRACT

Farming systems and socio-economic status of farmers rearing Diara buffaloes were studied by visiting 183 farmers' herds belonging to Diara breeding tract in Patna district of Bihar, India. Results indicated that the estimated population of Diara buffaloes in the breeding tract was 0.60 million out of 3.91 million in Bihar state. Reduction in forest area, cultivable waste land, permanent pastures and grazing land, and fallow land to the tune of 36.0%, 60.6%, 55.1% and 44.4% poses a major challenge to the simple existence of Diara population. A total of 63.4% of the farmers in the breeding tract provided their buffaloes housing in terms of temporary sheds. The estimated age at first calving of Diara buffaloes was found to be 46.4±2.56 months whereas the mean service period and dry period of these buffaloes in the breeding tract were observed to be 88.1±5.25 and 127.18±4.56 days, respectively. The inter-calving period in the habitat was found to range from 15 to 21 months. Interaction studies between different components of farming systems with Diara farmers showed that the distance between agriculture and buffalo rearing was the shortest with 15 units in the study area. Percentage contribution of Diara buffaloes to the overall income was highest with landless farmers (41.3%), followed by marginal (38.5%) and small farmers (33.8%). Regression analysis of different independent variables disclosed that investment on bullocks had highly significant (P<0.01) effect on the income of Diara farmers. Improving the role of Diara buffaloes from sustaining the farmers to prospering the farmers has been discussed.

Keywords: buffaloes, *Bubalus bubalis*, Diara buffaloes, farming system, reproduction, socio-economics, regression coefficient

INTRODUCTION

Economy of many countries in Indian subcontinent is riding on the back of agriculture in which contribution from the sector of animal husbandry is increasing day by day. Most of the households in these countries possess cattle and buffaloes and these species act as a financial reservoir for the farmers who are rearing them. Generally, these animals are maintained in a small holder animal rearing system in which the farmers rear one or two, if not, more than ten animals, to suffice the domestic needs apart from generating

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substantial earning to the individual household. However, performance of different livestock species in Indian subcontinent does not match with the performance of animals in developed nations. Considering the nutrient availability to these animals and other harsh environmental factors prevailing in the region, performance of these animals cannot also be rated inferior, but one could certainly say that there is still large scope for improvement.

India is known for its livestock wealth by possessing 190.9 million cattle and 108.7 million buffaloes, and the country ranks 1st in the world in terms of bovine population (DAHDF, 2012). Further, the country also possesses 40 and 13 registered breeds of cattle and buffaloes respectively (NBAGR, 2017), which serve the farming communities in different ways. Diara buffaloes are one of the notable buffalo populations of India which inhabit in marshy land region on the shores of river Ganga and its tributaries in the Middle Gangetic Plains. These buffaloes survive in a low input system where they are mostly being managed by feeding farm outputs and by grazing farm wastes. Being roped in the central axis of economy in majority of the households, these buffaloes engulf maximum load in supporting the livelihood of Diara farmers.

Nature of different farming systems and farming operations adopted by various farming communities in Indian subcontinent in managing their natural resources vary widely and they are mostly dependent on microenvironment prevailing in the local conditions. Methods of management of different livestock breeds also differ in the vast expanded region in the same way, which need detailed analysis and documentation. This may help assess the efficiency of the system and enable anyone to further intervene in the system whenever necessary. On this backdrop, this paper gives an account of environmental factors prevailing in the breeding tract of Diara buffaloes, management strategies adopted by the farmers in the habitat, analysis of farming system in which Diara buffaloes play a major part and the role of these buffaloes on the socio-economic status of buffalo farmers in the Middle Gangetic Plains.

MATERIALS AND METHODS

The area of study comprises humid sub-tropical conditions in the Middle Gangetic Plains in India. A total of five blocks including Barh, Athmalgola, Belchhi, Pandarak and Mokama of Patna district of Bihar, India were selected for studying the socioeconomic status of Diara farmers (Figure 1). During the period from June 2016 to March 2017, a cross-sectional study was conducted in 43 villages and a total of 183 farmers, selected by simple random sampling, participated in the study for providing information pertaining to socioeconomic parameters. Landless livestock rearers and the farmers with varying land holding size in the breeding tract were included in the survey. Farmers possessing the land were classified into marginal (< 1 ha), small (1 to 2 ha), semi-medium (2 to 4 ha), medium (4 to 6 ha) and large (> 6 ha), according to the possession of farmland.

Detailed questionnaires encompassing all the parameters of farming practices, husbandry techniques adopted by the farmers and their socioeconomic status were prepared based on local needs and on the guidelines suggested in the breed descriptors of FAO (1986). The questionnaire was pretested with the local livestock farmers for any kind of duplicity and biasness, and the questionnaire was edited to the extent possible for

efficiency and convenience. By planned field visits at regular intervals, the primary data were collected from the farmers by personal interview and also by direct observation on the animal rearing practices.

Quantitative analyses on the interaction of various components of farming system adopted by Diara farmers were carried out based on the input and output data of different components. The distance between various components and the main component was estimated by keeping main component at the centre and other components at the periphery of circle having varying length of radii of the circle. Data pertaining to socioeconomic parameters and relationship between different variables on income from Diara buffaloes were then analysed using the formula suggested by Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Origin and population status

The study could not reveal any authentic origin of Diara buffaloes. However, it disclosed that these buffaloes were mostly concentrated in the marshy areas of Gangetic riverine basin. The distribution pattern of these buffaloes suggest that these population might be evolved due to continuous inter-se breeding within population over a long period of time. Alternatively, the established breed like Murrah might also have been used to breed local germplasm since long, and inter-breed mating followed by inter-se mating might have resulted in the new germplasm. This hypothesis is supported by the observation on milk yielding capability of Diara buffaloes, which is promising if not despairing. Earlier reports on habitat and the socio-economics of farmers rearing Diara buffaloes are scanty. However, Chandran *et*

al. (2015) gave an account on distribution of these buffaloes which are included in the regions adjacent to the banks of river Ganga and its tributaries from Buxar to Bhagalpur district of Bihar and to some extent in the territories outside Bihar in India.

The present study revealed that the estimated population of Diara buffaloes was 0.60 million (15.35%) out of 3.91 million buffalo population in Bihar state. Though this population appears to be 'normal' from conservation point of view, the artificial insemination campaigns in the breeding tract may pose a threat to the existence of Diara buffaloes in its true form.

Composition of livestock species

Apart from buffaloes, the breeding tract witnessed quite a good number of other species of livestock. Population of different species of livestock in Diara breeding tract as per 2007 livestock census (Directorate of Economics and Statistics, 2012) is given in Table 1. This indicated that the breeding tract possessed a large number of cattle and goats, apart from a sizeable number of sheep and pigs. However, there were no farmer, who possessed the Diara buffaloes along with sheep and pigs in the breeding tract. Contrary to this observation, Lambertz *et al.* (2012) reported rearing buffaloes along with cattle, pig and chicken by the buffalo farmers in Thailand. Local customs, religious and regional taboos might be behind this variation.

Land utilization pattern in Diara breeding tract

Land utilization data collected from Directorate of Economics and Statistics (2012) over 24 years from 1987 to 2010 were analysed and furnished in Table 2. The results indicated that there is a generalized reduction in the area of land used for different agriculture and grazing purposes.

In fact, there is a huge reduction in the area under cultivable waste land (60.63%), permanent pastures and grazing land (55.10%), and fallow land (44.42%) noticed over the years in the breeding tract of Diara buffaloes. These factors might have played decisively in reducing the number of cattle and dairy buffaloes under extensive small holder systems, the most prevalent system of dairying in South Asia. Continuous reduction of grazing area in the breeding tract may, in long run, alter the management practices adopted by the buffalo farmers or, sometimes it may even challenge the mere existence of the Diara buffaloes.

Housing management of Diara buffaloes

All the farmers in the breeding tract had either *pucca* (permanent houses) or *kachcha* (temporary houses) houses for keeping their buffaloes. The prevalence of *pucca* houses in the breeding tract was 36.6% whereas the rest were *kachcha* houses (63.4%). The *pucca* houses were generally made with bricks, cement and wood. The *kachcha* houses were made with mud walls which were, in most cases, ceiled by dried stems of local plants with plastic base. Invariably manual chaff cutter machines were fitted either inside or outside the cattle shed in the study area. Generally, the buffaloes were kept outside the shed in the tree shades throughout day and night in all the seasons except during winter. During nighttime in the winter season, the buffaloes and their calves were housed inside the sheds which were completely closed on all the sides. Considering the socioeconomic conditions of the farmers, the housing systems provided to Diara buffaloes could not be considered inferior. This might be due to the fact, that income from Diara buffaloes occupies a significant share in the Gross Household Product in most of the farmers' families. Chandran *et al.*

(2014) reported almost similar housing practices adopted by the farmers of Bachaur cattle, a registered breed distributed in adjacent districts in the Middle Gangetic Plains.

Breeding interventions and management

The study revealed that Diara buffaloes had sound reproduction potential. The estimated age at first calving of Diara buffaloes was found to be 46.4±2.56 months. The mean service period and the mean dry period of this buffalo in the breeding tract were observed to be 88.1±5.25 days and 127.18±4.56 days, respectively. Most of the buffaloes in the study area were found to be regular and cyclic, and produced calves once in 15 to 21 months. Das *et al.* (2005) reported the mean age at first calving, dry period, service period and intercalving period of swamp buffaloes of Assam to be 56.63±0.47 months, 193.41±4.68 days, 187.30±4.57 days and 510.68±4.53 days, respectively which were higher than the same observed in Diara buffaloes.

Among the surveyed animals, 75.4% of animals were bred with Diara buffalo bulls available in the breeding tract. In rest of the cases, the female Diara buffaloes in oestrum were artificially inseminated, with the frozen semen doses from Murrah breed. The Diara buffalo bulls were just roaming in the breeding tract without any ownership or they have been reared by unregistered local breeders. Heat detection in the breeding tract of Diara was not a problem as issues pertaining to silent heat were not reported by the farmers. Findings of the present study are more or less comparable with report of breeding practices of buffaloes reported in several districts of Rajasthan (Gupta *et al.*, 2008) and in Indore district of Madhya Pradesh (Ahirwar *et al.*, 2010). Plenty of water available throughout the year for

adequate wallowing of Diara buffaloes might be one of the reasons for good reproductive health of Diara buffaloes. Buffaloes are, in general, prone for heat stress condition due to minimal number of sweat glands and high heat absorption due to black coat colour. Wallowing in the water for a long duration might be the factor for minimizing heat stress condition in Diara buffaloes as wallowing increases both heat conductivity and evaporative heat loss as reported by Perera, 2000.

Though calving was reported throughout the year, most of the calving were observed during rainy season followed by autumn in the breeding tract. This clearly indicates that most of the Diara buffaloes might have been expressing estrum during autumn and winter season. Kushwaha *et al.* (2011) reported similar calving seasons for Murrah and Bhadawari breeds of buffaloes in Bundelkhand region of India.

Feeding practices in the breeding tract

There were abundant green fodders in Diara region almost from July to December every year. During this period, the major feed components were only green fodder and limited quantity of concentrates. Multi-cut fodder maize was the primary green fodder cultivated in the breeding tract. The quantity of concentrate feed was determined only by the quantity of milk Diara buffalo yielded. During the scarce period, the Diara buffaloes were primarily fed with wheat *bhusa* and little concentrate ration depending upon the milk yield. Apart from these, 17.8% of farmers sent their buffaloes for grazing during daytime. The grazing distance varied from 3 km to 6 km and the grazing duration averaged 4.6 h a day. Feeding practices observed in Diara breeding tract more or less corroborates with the feeding practices adopted by the buffalo farmers of Indore district of Madhya Pradesh (Ahirwar *et al.*, 2010), Khammam district of Andhra Pradesh (Kishore *et al.*, 2013) and Bihar and Eastern Uttar Pradesh (Gupta *et al.*, 2014).

Healthcare management in the Diara breeding tract

Deworming was not generally practiced in the breeding tract, though some of the Diara buffaloes were vaccinated against Foot and Mouth disease, Hemorrhagic Septicemia and Black Quarter. Enteritis and Ectoparasites were noticed in 17 and 46% of Diara calves, respectively. Findings on ectoparasites in Diara buffaloes were more or less similar to the report on the occurrence of ectoparasites in buffaloes reared in Sheikhpura district of Pakistan as reported by Mustafa *et al.* (2010).

Utility of Diara buffaloes

Diara buffaloes were reared only for milk in their breeding tract. Males and females were never used for agricultural operations. Male calves, after their use in letting the milk down, were sold to the local middlemen. Milk from Diara buffaloes were sold either to cooperatives or to the local milk vendors. Apart from these uses, 32% farmers in the study area used the dung from Diara buffaloes both for fertilizing the land and for *Goita* (Dried dung cakes) making for fuel purpose. Rest of the farmers used the entire dung exclusively for *Goita* making, as they managed their entire fuel need of family from this resource. Hence, apart from milk, dung from Diara buffaloes also played a vital role in the livelihood of Diara farmers (Figures 2, Figures 3 and Figures 4).

Buffalo as a species of livestock, is being utilized in different ways by humankind in different parts of the world. Lambertz *et al.* (2012) reported that dung from livestock species were given as

gifts in Thailand apart from their usage as fertilizer and materials for sale. Further, Riedel *et al.* (2012) found that buffaloes, in Yunnan province of China, were mainly used for the purpose of traction and power, apart from buffalo meat, where buffalo milk was generally not used for human consumption. Custom and priorities differ in different parts of the world and the goal of selection and breeding in animal production moves in the direction for producing the differentially abled populations suitable for different production system.

Farming practices in Diara breeding tract

Most of the farmers (56%) rearing Diara buffaloes were landless. A majority of them (76%) were tenant farmers, who took cultivable land on lease from the land owners on the basis of annual rentals, and engaged in cultivation of food crops, mainly wheat, and to the smaller extent, maize. The annual rentals for the land varied from ₹12,000/- to ₹16,000/- depending on the fertility and distance of the land from the villages. Remaining farmers, who are landless, permitted their family workforce to migrate from the state to work in other places to earn revenue to their family.

The study also revealed that 43.7% of farmers, who were rearing Diara buffaloes also reared milch cattle to boost their income. The number of cattle heads available with Diara farmers ranged from 1 to 4 with the average being 2.3. The cattle in the study area comprised of Holstein Friesian crossbreds and non-descript cattle in almost equal proportion. Increased number of private players operating in the breeding tract in providing artificial insemination in an uncontrolled way might be the reason for increasing frequency of crossbred population in Diara breeding tract. In addition, 9.2% of farmers, who had both buffaloes and cattle, also had goats, which were primarily

of Black Bengal type. Other than cattle and goats, the buffalo farmers did not have any other livestock species. Hence, the fundamental farming system followed by Diara farmers comprised of agriculture, cattle and buffaloes, and goats.

Interaction studies between different components in the farming system adopted by Diara farmers showed that the interacting distance between goat and the main component, agriculture, was the highest with 25 units (Figure 5). On the other hand, Diara buffaloes enjoyed a close association with the main component with the distance of just 15 units. Sustaining maximally with agricultural output from farmland to the tune of 78% is the major factor for the close proximity of Diara buffaloes and agricultural practices in Diara breeding tract. This study further clarifies that the existence of Diara buffaloes would be challenging if there is a drop in cultivation of crops.

Buffalo rearing system is quite different in Thailand where buffalo farmers were also rearing chicken and pigs with the levels of inclusion from 60.0 to 95.0, and 5.0 to 10.5% (Lambertz *et al.*, 2012). Generally, rearing of other livestock species including goats was considered inferior to the social status of the farmers in the Diara breeding tract.

Socio-economic status of Diara farmers

Socioeconomic status of farmers rearing Diara buffaloes are given in Table 3. Irrespective of land holding, most of the farmers were possessing cattle and buffaloes ranged from 1 to 8. However, medium and large farmers in the breeding tract did not possess any sheep and poultry. The levels of illiteracy were very high with landless, marginal and small farmers to the tune of 89.13%, 86.24% and 80.51% and the trend of literacy was increasing with the increased herd size of buffaloes. Literacy

levels of the farmers rearing buffaloes almost corroborates with the findings Mustafa *et al.* (2010) who reported 90% of illiteracy with the buffalo farmers owning small farms in Sheikhupura district of Pakistan.

Most of the medium and large farmers in the breeding tract involved in agriculture where the major crop was rice during monsoon and wheat during winter. Incorporation of different components of mixed farming could be seen with marginal and small farmers who seek income from different sources. Ahirwar *et al.* (2010) reported dairy as well as agriculture as the mainstay of 68.33% of farmers which is almost similar to the findings of the present study. Kishore *et al.* (2013) reported agriculture as the major occupation of buffalo farmers of Andhra Pradesh which more or less corroborates with the findings of the present study. Role of Diara buffaloes in determining the household economy was vital in landless, marginal and small farmers where more than 30% of household income dependent on Diara buffaloes.

Regression of independent variables

Regression coefficients of different independent variables showed that the investment on buffalo bullocks had significant (P<0.01) effect on income from Diara buffaloes followed by cost of feeding of buffaloes (Table 4). Cost on health care is very high with marginal farmers and to some extent with small farmers owing to poor maintenance of animals.

The result of the present study on regression analysis is more or less agreeable to similar studies with small ruminants by Chandran *et al.* (2013) which showed that improving flock size had highly significant (P<0.0l) effect on the income of the farmers. Improving the stocking density to the extent of highest management capability is likely

to yield better returns in most of cases pertaining to livestock rearing.

CONCLUSION

Diara buffaloes, an offshoot from crossing between Murrah and local buffaloes over the years, possess promising characteristics and production potential. The breed is maintained in a low input small scale farming system and provides vital livelihood support to the buffalo farmers. The study estimated Diara population 'normal' but envisages continuous threat in the breeding tract due to rampant artificial insemination with the semen of other breeds. Housing and feeding management of these buffaloes requires adoption of methodical principles and scientific interventions and these may reduce incidence of diseases and boost the productivity parameters. Distance between agriculture and buffalo components in the farming system could still be reduced by further resourcing concentrate feed from agriculture fields. Farming system with Diara buffaloes need to be graded up from small scale farming to medium to large scale farming systems. The authors foresee that the proposed system would not only support the input need of agriculture completely but also it would accelerate the financial condition of the farmers in positive direction.

Policies need to be framed exclusively for Diara buffalo development in the breeding tract. Establishing exclusive semen station or semen bank for storing and distributing semen of genetically superior Diara buffalo bulls is a primary need and this requires sourcing of male calves from superior dams from the habitat. Similarly, knowledge on round the year fodder production shall be imparted to the farmers and satellite fodder banks
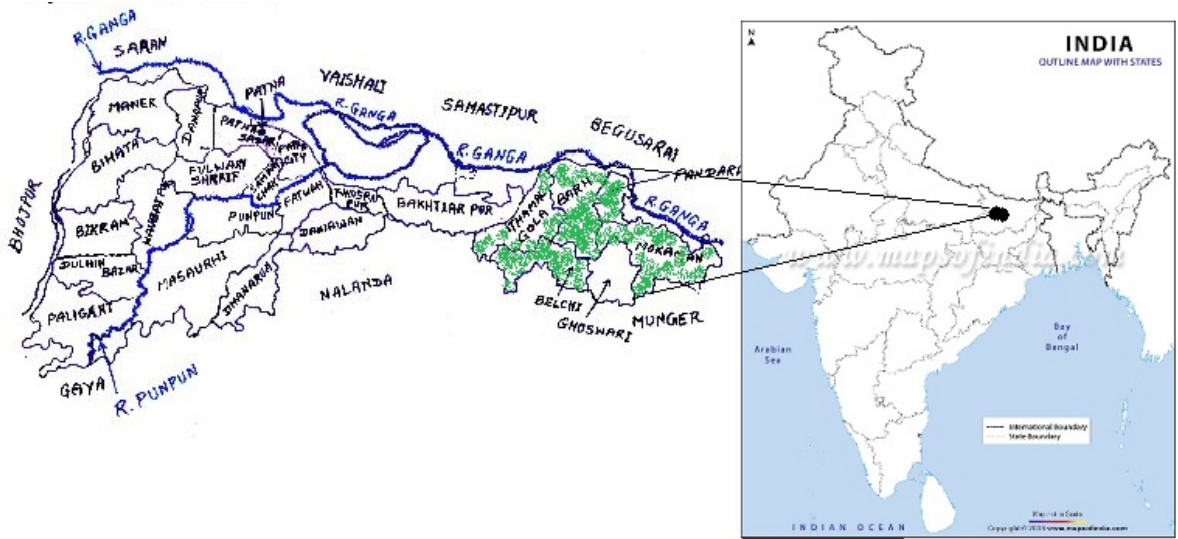
Figure 1. Area under study on Diara buffaloes. (Map sources: http://patna.bih.nic.in; www.mapsofindia.com)

Figure 2. Diara buffalo wallowing in a stream.

Figure 3. Diara herd grazing in the field.

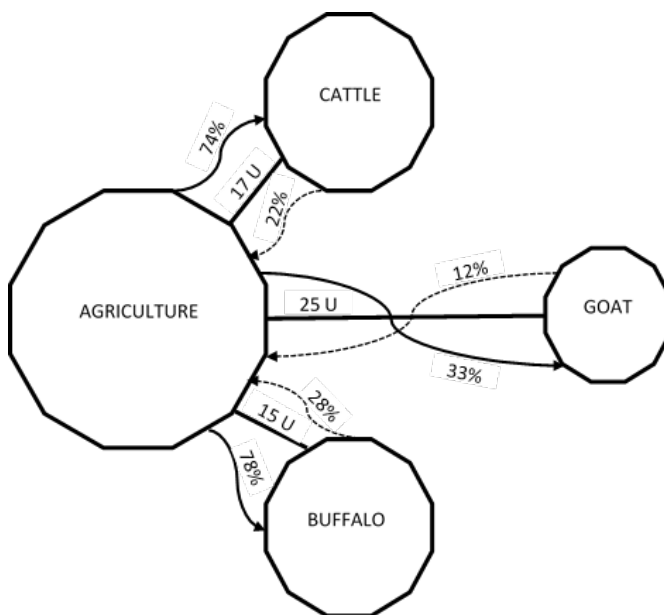Figure 4. 'Goita', an energy source from buffalo manure.

Figure 5. Quantitative interaction between various components of farming system adopted by Diara farmers.

Table 1. Population of different livestock species in Diara breeding tract.

Livestock species	Population
Bovines	10216357
Sheep	140195
Goat	5190222
Pigs	254076
Total livestock	15854092

Table 2. Land utilization pattern in the Diara breeding tract.

Year	1987-1992	1992-1997	1997-2002	2002-2007	2007-2010	Corrected value 1987-1992	Percentage change
Geographical area	5038099	4494751	4494257.4	4495625.8	4556160	4556160	0.00
Forest area	337727	190380	191417.4	211350.6	195569	305420	-35.97
Barren uncultivable area	252927.8	195787.6	194507.4	192712.2	194098.33	228733	-15.14
Land put to non-agriculturable use	797847	769497.4	815551	816661.4	850846.67	721526	17.92
Cultivable waste land	36659.6	24071.2	14218.8	15971.33	13050.67	33153	-60.63
Permanent pastures and grazing land	13360	8573.2	5718.6	6156.2	5424.67	12082	-55.10
Land under misc. tree crop and groves	96741.7	97798.6	94187	99915.73	98860.33	87487	13.00
Fallow land other than current fallow	89879.9	65434.8	50841	50065.6	45172.67	81282	-44.42
Current fallow	322192.6	304547.4	188876.4	196998.07	241992.33	291372	-16.95
Total uncultivable land	1947335.6	1656090.2	1555317.6	1589831.1	1645014.7	1761056	-6.59
Net sown area	3090763.4	2838660.8	2938939.8	2905794.7	2911145.3	2795104	4.15

Table 3. Socio-economic status of farmers rearing Diara buffaloes.

Factor	Landless livestock rearers	Marginal farmers	Small farmer	Semi-medium farmers	Medium farmers	Large farmers
Average land holding size (in ha)	0.01*	0.35	1.27	2.85	4.92	10.31
Livestock possession						
Cattle	2.18	1.12	1.88	1.51	1.07	0.96
Buffalo	3.45	2.36	2.76	1.29	1.04	0.85
Goat	5.89	1.26	0.31	Nil	Nil	Nil
Sheep	2.86	0.37	Nil	Nil	Nil	Nil
Poultry	10.11	5.77	0.81	Nil	Nil	Nil
Family size	7.83	8.21	6.58	5.56	4.81	4.16
Literacy level						
Illiterate	89.13	86.24	80.51	72.18	53.74	23.55
Semi-literate	9.21	12.82	15.16	20.28	30.45	37.62
Literate	1.66	0.94	4.33	7.54	15.81	38.83
Major occupation	Labour (71.20)	Mixed farming (61.48)	Mixed farming (74.56)	Agriculture (54.05)	Agriculture (70.34)	Agriculture (66.12)
Annual income (in Indian Rs.)	71,252	92,587	1,22,377	1,64,311	2,15,236	2,65,376
Percentage Share of Diara buffaloes in total income	41.28	38.45	33.79	27.18	22.37	18.89

Figures in the parentheses are percentages; *Leased in land.

Table 4. Regression coefficients of different independent variables on income from Diara buffaloes.

Independent variables	Marginal farmers	Small farmers	Semi-medium farmers	Medium farmers
Investment on bullocks	4687.10**	12162.61**	2831.49**	952.40**
Cost of feeding	1300.9**	1228.8**	1049.12**	1002.9**
Cost on health care	934.52**	497.03**	105.2**	94.05*

** P<0.01; * P<0.05

need to be established for continuous storage and utilization for Diara buffaloes.

To conclude, Diara buffaloes are raw, but noteworthy natural resource for the farmers of Middle Gangetic Plains, and it is in the hands of all the stakeholders to make them sparkling by infusing suitable scientific and policy interventions.

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