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RESEARCH ARTICLE

Economics of livestock-based farming systems in saline and normal areas of West Bengal: A comparative analysis

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Abstract: Salinity has deleterious effects on both crops and livestock. The present study evaluated the impact of salinity and estimated the cost and returns of different livestock-based farming systems in saline and normal areas of West Bengal. The study suggested the farmers the best farming systems to be adopted based on output-input ratio. Saline areas are dominated by the indigenous cow and normal areas by the crossbred jerseys. This may be due to shortage of green fodder in saline areas. Cattle-goat-crop (N2) had highest crop area (1.80 acres) while Cattle-goat-crop-fish (S3) had highest fishing area (0.70 acres). Due to low maintenance cost, Sheep-poultry (S1) and Goat-poultry (S2) farming systems had output-input ratios close to 2. Whereas other farming systems in saline areas, the output-input ratios were close to 1.5. In case of normal areas, Cattle-goat-crop-fish had the highest output-input ratio of 1.58. Goat-poultry (S2) farming system had the highest net return of ₹ 53,967.68 per annum among landless farmers and cattle-goat-crop-fish (S3) with a net return of ₹ 1,01,686.50 per annum among landholders in saline areas. The farming system, Cattle-goat-poultry-crop (N1) had highest net return of ₹ 1,15,578 per annum) in normal areas. Share of labour was highest (56% to 58%) in total cost in crop enterprises and feed and fodder cost had a major share (53% to 72%) in total cost for livestock enterprises. Share of cattle enterprise in total cost and net return was highest. However, its share in net return was lower than its share in total cost. In case of goat and fish enterprises, their share in net return was higher than their share in total cost.

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Introduction

Salinity condition of the soil is becoming more and more prominent each year, making it difficult for farmers to maintain their property (Wongsomsak, 1986). Due to salinity issues, agricultural potential is limited (Ladeiro, 2012). High salinity affects 20 per cent of total cultivated area and 33 per cent of irrigated agricultural land around the world (Shrivastava and Kumar, 2015). Degraded land covers around 147 million ha in India, with 23 million ha degraded due to salinity/alkalinity/acidification, the second most common source of soil degradation after water erosion (94 million ha) (Kumar and Sharma, 2020). Soil salinity, which is responsible for around 20 per cent yield reduction in these areas, puts a strain on rice yield, spikelet sterility, and thousand-grain weight in the coastal belt (Clermont et al. 2010). Due to salinity, there is a shortage of fodder crops in coastal saline areas, which affects cattle milk yield (Wistrand, 2003). Skin illnesses, liver fluke, diarrhoea, body weight loss, and immune system breakdown plague animals in salty locations due to ingestion of salinity-affected fodder crops (Alam et al. 2017). Due to the intake of salinity-affected agricultural goods, pregnant women in coastal areas experience greater gestational hypertension than pregnant women in non-coastal areas (Khan et al. 2008; WHO, 2003).

The Indo Gangetic Plains (IGP) are well recognised for providing approximately half of the country's total food consumption and feeding 40 per cent of the people (Pal et al. 2009). The plains are the agriculturally most fruitful region of the country, with almost 36 per cent of the country's bovine population. The bovine sector alone contributes 235 billion to the IGP GDP among the livestock sector (Singh et al. 2005). Every year, approximately 10 per cent of the extra land becomes salinized, and by 2050, nearly half of all arable land will be contaminated by salt (Kumar and Sharma, 2020). Salinity increases in the area beneath the Indo-Gangetic plains will jeopardise our country's food security. West Bengal controls 78.84 per cent (4,41,272 ha) of the total saline areas in the IGP region (5,59,719 ha) (Mandal et al. 2010). The coastal saline zone suffers from both soil and water salinity, as well as a

milk and livestock deficit (Wistrand, 2003). Hence, the West Bengal state was considered as an ideal location for a comparative study of livestock-based farming systems in saline and normal environments.

Methodology

Sampling plan

The major part of the coastal saline areas in West Bengal is in the Sundarban area of districts South 24 Parganas, parts of North 24 Parganas and Purba Midnapore (Bandyopadhyay *et al.* 2003). Sampling units were selected with the help of the multistage sampling technique. Within the selected districts where saline soil can be found, 17 blocks of South 24 Parganas, 6 blocks of North 24 Parganas and 10 blocks of Purba Midnapore is having saline areas. The rest of the blocks i.e., 12 blocks of South 24 Parganas, 16 blocks of North 24 Parganas and 15 blocks of Purba Midnapore are considered normal areas for the comparison of livestock-based farming systems in saline and normal areas (GoW, 2018). Finally, from the above-mentioned blocks in saline and normal areas, Basanti, Namkhana and Canning II from South 24 Parganas; Hingalganj from North 24 Parganas; Khejuri II and Nandigram I from Purba Midnapore were randomly selected for saline areas. For normal areas, Mograhat I and Mograhat II from South 24 Parganas; Barasat I and Bongaon from North 24 Parganas; Bhagwanpur I and Bhagwanpur II from Purba Midnapore blocks were selected randomly. Twenty households from each block were selected based on random sampling. A total of 120 households were selected from each of the saline and normal areas, thus total sample size constituting 240 households. Primary data were collected through the personal interview method on a structured interview schedule from the door-steps of the respondents on various aspects of livestock and crop enterprises from selected households for the year 2019-2020. Farmers who were having 50 per cent or more income from livestock were only considered as respondents for the present study.

Identification of different types of livestock-based farming systems was done based on the highest income contribution from livestock enterprises. For example; if the highest share of income earned by a household from livestock enterprises is through sheep rearing, then the system will be named sheep-based farming system and so on.

Cost categories of different enterprises

Table 1. Conversion factors of man equivalent days

Particulars	Man-equivalent days
Child workers (<14 years)	0.50
Male (15-39 years)	1
Female (15-39 years)	0.75

Fixed costs: Depreciation on farm machinery and farm building, land revenue cesses and other taxes and interest on working capital. Rent paid for leased in land, interest on the value of owned capital assets, the rental value of owned land and rent paid for leased in land were considered as fixed costs for the study.

Variable costs: Value of purchased material inputs such as seed, insecticide and pesticide, manure, fertilizer, etc., hired human labour, animal labour (hired or owned) hired farm machinery, irrigation charges, feed and fodder cost, veterinary and miscellaneous expenditure. In case of purchased feed and fodder, the cost was worked out as a product of the quantity fed to animals and the purchase price of respective feed. In case of home-grown feed and fodder, the relevant prices were the farm-harvest prices. When the concentrate feed was prepared at home, its cost was computed by taking the weighted prices of ingredients used in the concentrate, the weights being the share of each ingredient in the concentrate composition.

Labour cost: It included the cost of the family as well as paid labour (hired labour). The cost of hired labour was calculated considering the type of work allotted and wages paid whereas, family labour costs were determined based on the existing wage rate of permanent farm labour. Total time spent was converted to man-days by using conversion as presented in Table 1:

Veterinary and miscellaneous costs: The expenditure on breeding and health care of the animals was covered under the veterinary expenses. It included the cost of artificial insemination (AI), natural service, vaccination, medicines, the fee of veterinary doctors and other related expenses. The miscellaneous expenditure included expenses for repair of fixed assets, water and electricity charges, insurance premiums and any other incidental charges. These being joint costs, apportionment of the same was based on SAU.

Standard Animal Units (SAUs): Considering the differences in regional endowments of animal wealth and species, the livestock animals were converted into SAUs using factors suggested by Kumbhare *et al.* (1983) (Table .2);

Table 2. Standard animal units for different livestock animals

Type of Animals	SAU
Local cow	1.00
Crossbreed cow	1.40
Buffalo	1.30
Bullock/he-buffalo	1.00
Local cow/ Buffalo heifer >2 years	0.75
Crossbreed heifer >1 year	0.75
Calf of buffalo & local cow >1 year	0.50
All calves <1 year	0.33
Goat & Sheep	0.50
Other animals	1.00

Depreciation cost: Capital Recovery Cost (CRC) method was used to calculate depreciation cost which is defined as the annual payment that will repay the cost of fixed input over the useful life of input and provide an economic rate of return on investment. The interest on fixed capital does not need to be accounted for separately in the CRC approach. The formula for estimation of CRC is:

$$R = Z\left[\frac{(1+r)^n r}{(1+r)^n - 1}\right]$$

Where,

R = Capital recovery cost

Z = Initial value of the capital asset

r = Interest rate

n = Useful life of the assets

In case of practical difficulties in getting the information on initial outlay at the field level, the current value of the asset was considered. When the asset was purchased from borrowed capital the actual interest rate charged by the bank was taken as 'r', while useful life (n) of both fixed and livestock assets were considered as the value suggested by Rao, 1991 (Table 3). The total CRC was then apportioned to the individual animal by the Standard Animal Units (SAUs).

Cost concepts:

Total cost: It was obtained by adding all the cost components including fixed and variable costs.

Total cost = Total variable cost + Total fixed cost

Table 3: Useful life of farm assets

Fixed assets	In years
Own fund (Term deposits)	1-5
Pucca cattle shed	50
Katcha cattle shed	10
Manual chaff cutter	6
Power-operated cutter	10
Livestock	
Local cow (in years)	10
Crossbreed cow (in years)	8
Buffaloes (in years)	10
Sheep (in months)	6-8
Goat (in months)	3-5
Pig (in months)	5-6

Gross returns: Gross returns were obtained by multiplying the milk yield of an individual milch animal with respective prevailing prices in the study area

Gross returns = Quantity of milk × Market price of milk

Net returns: Net return was calculated by subtracting net cost from gross returns

Net returns = Gross returns -Total cost

Gross returns from farming systems: Gross returns were estimated by summing up the returns obtained from both main product and by-products of various farm enterprises undertaken on the farm, evaluated at their market prices.

Output-Input Ratio:

$$\text{Output} - \text{Input Ratio} = \frac{\text{Gross return of output}}{\text{Total cost of inputs}}$$

Results and Discussion

The farming systems identified in saline and normal areas of the study area in West Bengal are presented in Table 4.

Composition of livestock and poultry and average operational area under different farming systems

Due to increased salinity, there is a shortage of grazing land and fodder crop for livestock production. Saline areas were dominated by indigenous cows because these breeds can withstand low fodder availability. Cross breeding in cattle is a total failure due to the non-availability of feed, salinity, lack of availability of artificial insemination services coupled with the absence of a market for milk (Das, 2011). A study conducted in saline areas of Bangladesh by Sarker et al. (2018) also found that 17 per cent of the household kept crossbred cows and 62 per cent had indigenous cows. Although the performance of the indigenous or native stock is poor relative to highly selected commercial lines, they can survive in harsh and challenging environments (Crawford and Christman, 1992). The cattle-goat-crop-fish (S3)

Table 4: Identified farming systems in the study area

Code	Type of farming systems identified
	Farming systems in saline areas
S1	Sheep-Poultry
S2	Goat-Poultry
S3	Cattle-Goat-Crop-Fish
S4	Cattle-Poultry-Crop-Fish
	Farming systems in normal areas
N1	Cattle-Goat-Poultry-Crop
N2	Cattle-Goat-Crop
N3	Cattle-Poultry-Crop

had the highest average Standard Animal Unit (SAU) of cattle under this system (5.16) followed by cattle-poultry-crop-fish (3.08) under saline areas (Table 5).

In normal areas, crossbreed jersey is a popular dairy animal. Under cattle-goat-poultry-crop (N1) on an average 6.03 SAU of cattle were available followed by cattle-poultry-crop (N3) (5.71 SAU) and cattle-goat-crop (N2) (3.08 SAU).

In saline areas, two types of farming systems were popular among the landless farmers, i.e., sheep-poultry (S1) and goat-poultry (S2). Near the Matla River of the Sundarban area few landless farmers engaged in Garole sheep farming. Salinity in the Matla increased by around 32 per cent between 1984 and 2013 (Trivedi et al. 2016). Garole breed is known for its bi-annual lambing, high prolificacy rate, high mothering instincts, adaptability to marsh saline as well as hot and humid climatic condition, grazing on aquatic weeds and grass in knee-dip water and resistance to some common diseases (Banerjee, 2008: Sahana et al. 2001). Interestingly this breed has naturally developed resistance against foot rot, FMD and reproductive disorders, etc. and is considerably more resistant to the dreaded roundworm *Haemonchus contortus* as well as to the tropical liver fluke (Nimbkar, 2002). Households engaged in sheep-poultry farming system hold on an average 7.50 SAU of Garole sheep.

Black Bengal goat, which is famous for its high-quality meat and skin, was common in both saline and normal areas. Landless farmers under the goat-poultry farming system depend heavily on Black Bengal goats, on average, they had 7.50 SAU followed by cattle-goat-crop-fish (S3) (5.30 SAU). In normal areas, average SAU under cattle-goat-poultry-crop (N1) and cattle-goat-crop (N2) was 5.25 and 5.50, respectively.

Poultry birds are mainly reared for egg purposes. Chicken breeds like Vanaraja, Rhode Island Red along with domestic duck breed Khaki Campbell were reared in the back yard of the household. In saline areas, the highest number of birds were found in the goat-poultry (S2) farming system (15 nos.) followed by sheep-poultry (13 nos.) and cattle-poultry-crop fish (12.50 nos.).

In normal areas, two types of farming systems such as cattle-goat-poultry-crop (N1) and cattle-poultry-crop (N3) include poultry enterprises with an average number of birds of 12 and 11.50, respectively.

In West Bengal, 82 per cent of the farmers are marginal with landholding of less than one hectare (Mandal, 2016). The findings of the current study were also in the same line as the previous studies (quote some references). In saline areas, only two farming systems, i.e., cattle-goat-crop-fish (S3) and cattle-poultry-crop-fish (S4), have crop and fish components. Under S3 on an average 1.10 acres was under crop cultivation, and 0.70 acres are under fish cultivation and in case of S4, it was 0.75 acres and 0.55 acres, respectively (Table 5). Rice and fish constitute the principal diet in the Bengali community. Households in this area are engaged in mono-cropping of rice both in the *kharif* and *rabi* seasons. The land use map showed that 80 per cent of the total agricultural land is under rice cultivation (Ghosh and Mistri, 2020). Salinization of coastal lands threatens the livelihood security of thousands of small rice farmers. Sea-level rise, storm surge, and coastal

Table 5: Average composition of livestock and poultry under different farming systems

Animal Type	Farming systems						
	S1	S2	S3	S4	N1	N2	N3
				Cattle (in SAU)			
Milch	-	-	3.00	2.00	4.20	2.80	2.80
Heifer	-	-	1.50	0.75	1.50	0.75	2.25
Calf	-	-	0.66	0.33	0.33	0.33	0.66
Total	-	-	5.16	3.08	6.03	3.88	5.71
				Goat (in SAU)			
Adult	-	5.25	3.97	-	3.67	3.85	-
Kid	-	2.25	1.33	-	1.58	1.65	-
Total	-	7.50	5.30	-	5.25	5.50	-
				Sheep (in SAU)			
Adult	6.00	-	-	-	-	-	-
Kid	1.50	-	-	-	-	-	-
Total	7.50	-	-	-	-	-	-
				Poultry (in no.)			
Adult	7.80	9.00	-	7.50	7.20	-	6.90
Grower	3.90	1.50	-	3.75	1.20	-	3.45
Chicks	1.30	4.50	-	1.25	3.60	-	1.15
Total	13.00	15.00	-	12.50	12.00	-	11.50
Crop area (in acre)	-	-	1.10	0.75	1.60	1.80	1.50
Fishing area (in acre)	-	-	0.70	0.55	-	-	-

erosion increase the risk of salinity in this area. Thus, farmers are dependent on indigenous salt-tolerant varieties like Dudhersar, Lal Dhan, Rupsal, Patnai, etc. Fish is cultivated in the backyard pond.

In normal areas, all the sample households had a few acres of the cropped area. They mostly cultivate different types of high-yielding varieties (HYV) of rice such as Khitish, Swarna Mahsuri, Sada Swarna, etc. along with mustard and jute. The highest land under cultivation is under cattle-goat-crop (N2) farming system (1.80 acres), followed by cattle-goat-poultry-crop (N1) (1.60 acres) and cattle-poultry (N3) (1.50 acres).

Cost and return of different enterprises across different farming systems:

In saline areas, farmers mostly cultivated salt-tolerant indigenous rice varieties such as Dudhersar, Lal Dhan, Rupsal, Patnai etc. Labour cost had the major share of total cost. It's share under S3 and S4 farming systems were 58.74 and 57.87 per cent of total cost, respectively (Table 6). Rice was mainly cultivated for home consumption purposes. Rice bran and rice straw are used for cattle feed. For rice, market prices vary variety wise and at the end of the year net return obtained from crop enterprises under S3 and S4 farming systems were ₹ 6,771 per annum and ₹ 4,771 per annum, respectively.

Garole sheep rearing in S1 farming system is a unique feature in saline areas. Various authors (Ghalsasi and Nimbkar, 1993, Bose and Moitra, 1995, Singh and Bohra, 1996, Sharma et al. 1999 and Sahana et al. 2001) have reported that the breeding of Garole sheep is localized in the Sundarban regions of West Bengal and Bangladesh. Marginal and landless farmers from socially backward and underprivileged classes maintain this type of sheep. Total cost, gross return and net return from sheep rearing were ₹ 25,107.50 per annum, ₹ 51,900 per annum and ₹ 26,792 per annum, respectively. Sheep were sold in the market at 12 months of age with an average of 15 kg body weight at the rate of ₹ 300/kg of meat. Out of total cost, 75 per cent was variable cost and 25 per cent was fixed cost. Harvested grass, weeds, tree leaves, dry grass and rice straw are used as supplementary feed. The animals are even found to drink saline water for several days, as there are limited sources of fresh water on many islands (Mandal et al. 2017).

Under S2 farming system, the Black Bengal goat was reared by the landless farmers. This animal also required low inputs like Garole sheep but is more prone to diseases like diarrhea, parasitic infection, skin problem, anemia, etc. In saline zone, there is a scarcity of clean water and farmers used to provide pond water without any treatment. Farmers preferred their goats to be stall-fed as they fall sick due to consumption of poisonous weeds during grazing and also to protect them from stray dogs' attacks. Cereal by-products like mug chuni, bhusa of pulses, wheat husk, whole rice bean after harvesting, etc. are provided during stall-fed. The average gross and net return from goat rearing under S2 farming system were ₹ 69,200/annum and ₹ 36,486/annum, respectively, which was higher than the income received from sheep rearing. The higher return was due to the meat of the Black Bengal goat being delicate and highly demanded. Demand increases during festivals like Muharram and Durga Puja. Goats are sold in the market at 12 months of age with an average of 15-18 kg body weight at the rate of ₹ 400/kg of meat. Farmers prefer castrating male kids to be raised for meat purposes within one month of age. The average daily milk yield was around 150-200 g, which is used to feed the kids and not for selling purposes, however, goat manure is used in crop fields. Similar to sheep rearing, in case of goat rearing also variable cost and fixed costs were 75.83 and 24.17 per cent of total cost, respectively.

Landless farmers under S1 and S2 farming systems also engaged in non-farm activities like permanent labour in others' fields and MGNREGA labour. Net returns from non-farm activities were ₹ 9,735.55/annum and ₹ 11,512.68/annum for S1 and S2 farming systems, respectively.

Under S3 and S4 farming systems, the cattle were mostly indigenous cows. Share of total feed and fodder in livestock enterprise were 59.70 per cent and 62.00 per cent of total cost, respectively. The previous studies also indicated that about 60 to 80 per cent cost was estimated for feed and fodder (Lal and Chandel, 2016; Patil, 2010; Kumari, 2020). Most of the cattles depend on low-quality roughages like straw and locally available natural grasses to fill their stomach which cannot fulfil the actual nutrients requirement of the animals (Sarker et al. 2018). Farmers mostly depend on concentrate to provide sufficient nutrients to the cattle. Concentrates fed by the farmers were mostly bought from the market or prepared at home by mixing rice polish, wheat bran, pulse bran, broken rice and mustard oil cakes in the surveyed area. Share of variable and fixed costs for S3 farming system which includes both cattle and goats, were 86.72 per cent and 13.28 per cent of total cost, respectively. Net return for S3 farming system was ₹ 58,335.50 per annum. In S4 farming system, which includes only cattle generates a net return of ₹ 36,862 per annum. Due to less cooperative societies in the region, farmers mainly sell the milk either in sweet shops or sell them door to door, at a rate of ₹ 35-40/litre. Sandesh which is a popular Bengal sweet, is made from milk and has a high demand. Farmers usually get a higher rate for their milk if they sell it in sweet shops.

Chicken breeds like Vanaraja, Rhode Island Red along with domestic duck breed like Khaki Campbell were reared in the back yard of the household. Poultry birds were reared mainly for egg production, the net return from poultry for S1, S2 and S4 farming systems were ₹ 7,499/annum, ₹ 5,969/annum and ₹ 4,439/annum, respectively. The differences in net profit under different farming

Table 6: Cost and return of different enterprises across different farming systems under saline areas (₹ /hh/year)

Components	S1(Sheep-Poultry)	S2 (Goat-Poultry)	S3 (Cattle-Goat-Crop-Fish)	S4 (Cattle-Poultry-Crop-Fish)
		Crop		
1) Labour	-	-	10,500.00 (58.74)	8,000.00 (57.87)
2) Seed	-	-	950.00 (5.31)	900.00 (6.43)
3) Manure and fertilizer	-	-	1,694.00 (9.48)	1,270.00 (9.38)
4) Plant protection chemicals	-	-	400.00 (2.24)	300.00 (2.23)
5) Interest in working capital	-	-	462.50 (2.58)	347.00 (2.48)
6) Total variable cost (TVC) (1+2+3+3+4+5)	-	-	14,006.50 (78.35)	10,817.00 (78.39)
7) Depreciation	-	-	244.50 (1.36)	183.50 (1.37)
8) Land rent	-	-	3,225.00 (18.04)	2,418.50 (17.53)
9) Interest on fixed capital	-	-	400.00 (2.24)	380.00 (2.75)
10) Total fixed cost (TFC) (7+8+9)	-	-	3,869.50 (21.65)	2,982.00 (21.61)
11) Total cost (TC) (6+10)	-	-	17,876.00 (100.00)	13,799.00 (100.00)
12) Gross return (GR)	-	-	24,647.00	18,750.00
13) Net return (NR) (12-11)	-	-	6,771.00	4,771.00
		Livestock		
Total feed and fodder cost	13,461.00 (53.60)	17,811.00 (54.44)	61,776.00 (59.70)	50,300.00 (62.00)
1.a) Fodder cost	4,374.82 (17.42)	6,055.74 (18.51)	27,181.44 (26.26)	21,880.50 (26.97)
1.b) Feed/Concentrate cost	9,086.18 (36.19)	11,755.26 (35.93)	34,594.56 (33.44)	28,419.50 (35.03)
2) Labour	4,725.00 (18.80)	6,300.00 (19.25)	27,325.00 (24.48)	20,225.00 (25.91)
3) Miscellaneous cost	655.00 (2.60)	700.00 (2.14)	2,625.00 (2.53)	2,050.00 (2.52)
4) Total variable cost (TVC) (1+2+3)	18,841.00 (75.00)	24,811.00 (75.83)	89,726.00 (86.72)	72,575.00 (89.00)
5) Depreciation	6,266.50 (25.00)	7,903.00 (24.17)	13,738.50 (13.28)	8,563.00 (11.00)
6) Total fixed cost (TFC) (5)	6,266.00 (25.00)	7,903.00 (24.17)	13,738.50 (13.28)	8,563.00 (11.00)
7) Total cost (TC) (4+6)	25,107.50 (100.00)	32,714.00 (100.00)	1,03,464.50 (100.00)	81,138.00 (100.00)
8) Gross return (GR)	51,900.00	69,200.00	1,61,800.00	1,18,000.00
9) Net return (NR) (8-7)	26,792.00	36,486.00	58335.50	36,862.00
		Poultry		
1) Total cost	7,261.00	6,511.00	-	5,761.00
2) Gross return (GR)	14,760.00	12,480.00	-	10,200.00
3) Net return (NR) (2-1)	7,499.00	5,969.00	-	4,439.00
		Fish		
1) Total cost	-	-	57,600.00	44,200.00
2) Gross return (GR)	-	-	94,180.00	70,635.00
3) Net return (NR) (2-1)	-	-	36,580.00	26,435.00
		Non-farm activity		
1) Total cost	3,000.00	2,700.00	-	-
2) Gross return (GR)	12,735.55	14,212.68	-	-
3) Net return (NR) (2-1)	9,735.55	11,512.68	-	-

Note: Figures in parenthesis indicate percent to column total

systems were due to differences in average flock size. Eggs are sold at the rate of ₹ 6/egg and income from selling poultry birds for the income purpose was at the rate of ₹ 160/kg of meat in the local market.

Fish is an important component of S3 and S4 farming systems. Under S3 farming system total cost, gross return and net return were to the tune of ₹ 57,600/annum, ₹ 94,180/annum and ₹ 36,580/annum, respectively. Under S4 farming system, total cost (₹ 43,200/annum), gross return (₹ 70,635/annum) and net return

Table 7: Cost and return of different enterprises across different farming systems under normal areas (₹ /hh/year)

Components	N1 (Cattle-Goat-Poultry-Crop)	N2 (Cattle-Goat-Crop)	N3 (Cattle-Poultry-Crop)
	Crop		
1) Labour	14,000.00	15,000.00	13,500.00
	(56.82)	(56.95)	(58.87)
2) Seed	1,750.00	1,800.00	1,500.00
	(7.10)	(6.83)	(6.54)
3) Manure and fertilizer	2,350.00	2,541.00	2,117.50
	(9.53)	(9.65)	(9.23)
4) Plant protection chemicals	560.00	600.00	450.00
	(2.28)	(2.28)	(1.96)
5) Interest in working capital	630.00	694.00	578.50
	(2.56)	(2.64)	(2.53)
6) Total variable cost (TVC) (1+2+3+3+4+5)	19,290.00	20,635.00	18,146.00
	(78.29)	(78.35)	(79.13)
7) Depreciation	310.00	500.00	306.00
	(1.26)	(1.90)	(1.33)
8) Land rent	4,560.00	4,837.00	4,031.00
	(18.50)	(18.36)	(17.58)
9) Interest on fixed capital	480.00	500.00	450.00
	(1.95)	(1.90)	(1.96)
10) Total fixed cost (TFC) (7+8+9)	5,350.00	5,704.00	4,787.00
	(21.71)	(21.65)	(20.87)
11) Total cost (TC) (6+10)	24,640.00	26,339.00	22,933.00
	(100.00)	(100.00)	(100.00)
12) Gross return (GR)	32,500.00	34,500.00	30,250.00
13) Net return (NR) (12-11)	7,860.00	8,161.00	7,317.00
	Livestock		
Total feed and fodder cost	1,13,680.00	1,11,276.00	99,697.29
	(68.39)	(69.43)	(72.28)
1.a) Fodder cost	52,292.80	52,856.10	45,362.27
	(31.46)	(32.98)	(32.89)
1.b) Feed/Concentrate cost	61,387.20	58,419.90	54,335.02
	(36.93)	(36.45)	(39.39)
2) Labour	27,297.00	25,325.00	20,127.71
	(16.42)	(15.80)	(14.59)
3) Miscellaneous cost	2,568.00	2,625.00	2,250.00
	(1.54)	(1.64)	(1.63)
4) Total variable cost (TVC) (1+2+3)	1,43,545.00	1,39,226.00	1,22,075.00
	(86.36)	(87.00)	(88.50)
5) Depreciation	22,672.00	21,035.50	15,860.00
	(13.64)	(13.00)	(11.50)
6) Total fixed cost (TFC) (5)	22,672.00	21,035.50	15,860.00
	(13.64)	(13.00)	(11.50)
7) Total cost (TC) (4+6)	1,66,217.00	1,60,261.50	1,37,935.00
	(100.00)	(100.00)	(100.00)
8) Gross return (GR)	2,66,600.00	2,55,400.00	2,10,600.00
9) Net return (NR) (8-7)	1,00,383.00	95,138.50	72,665.00
	Poultry		
1)Total cost	5,965.00	-	6,911.00
2) Gross return	10,300.00	-	12,980.00
3) Net return (3-1)	4,335.00	-	6,069.00

Note: Figures in parenthesis indicate percent to column total

(₹ 26,435/annum) were lower than S3 farming system due to the lower size of the pond area (Table 6). Fishing enterprise is mainly backyard fish cultivation where farm-made feed was prepared by mixing mustard oilcake and rice bran at 1:1 ratio. The commonly cultivated fish in the region were Catla, Rohu, Mrigel, Common Carp, Silver Carp, Grass Carp etc.In normal areas, farmers prefer to cultivate high yielding varieties of rice such as Khitish, Swarna Mahsuri, Sada Swarna etc. Net returns under N1, N2, and N3 were accounted for ₹ 7,860/annum, ₹ 8,161/annum and ₹ 7,317/annum, respectively, which were higher than the saline areas (Table 7). Labour costs under all the farming systems accounted for almost half of total cost, it was 56.82 per cent, 56.95 per cent and 58.87 per cent for N1, N2 and N3 farming systems, respectively.

Under livestock enterprise, net returns were much higher than in saline areas because of the presence of crossbred cows. However, across different farming systems net return was different due to differences in herd size. Net returns from livestock under N1, N2, and N3 farming systems were ₹ 1,00,383/annum, ₹ 95,138/annum and ₹ 72,665/annum, respectively. Milk price did not vary between saline and normal areas. Although, there were few cooperatives present in normal areas, the farmer gets low price (₹ 28/litre) for selling milk in cooperatives due to it's low-fat content. Due to this, the majority of farmers sold their milk in sweet shops or door to door at the rate of ₹ 35-40 per litre. Due to the presence of fodder farms in this area, green fodders like hybrid napier, para-grass, lathyrus were easily available. In the wet summer season natural grasses are more available but farmers supply more concentrates in the winter season due to the shortage of green fodders.

Poultry breeds like Vanaraja, Rhode Island Red and Khaki Campbell were reared in backyards like in saline areas. Net returns from poultry enterprise under N1 and N3 farming systems were ¹ 4,335/annum and ¹ 6,069/annum, respectively.

Cost and return of different farming systems

Cost and return from different farming systems are presented in Table 8, which helps us to understand which farming system is more profitable than the other in both saline and normal areas. Output input ratios were computed by dividing gross return by total cost. These ratios indicate return per unit of investment, higher the ratio better is the profitability for each household (HH).

In saline areas, households under S1 and S2 farming systems were the poorest of the poor earning net return of ₹ 38,905.35/HH/year and ₹ 53,967.68/HH/year, respectively. Although, net return under these farming systems were lower than other farming systems in this area, but their output-input ratios were 2.10 and 2.28, respectively, which was higher than all other farming systems. This was due to the low maintenance cost of goats and sheep, which leads to total cost being lower than other farming systems. The study conducted by Kumar et al. (2012) also found similar results of lower production cost and higher output-input ratio. S4 farming system has the lowest output-input ratio of 1.45 in saline areas. The highest gross and net return were obtained under S3 farming system i.e., ≠ 2,80,627.00/HH/year and ₹ 1,01,686.50/HH/year, respectively. However, due to higher maintenance cost of cattle, total cost was also the highest (₹ 1,78,940.50/HH/year) which leads to drop in output-input ratio to 1.57. This indicates that farmers will receive ₹ 1.57 by investing ₹ 1 in S3 farming system.

In normal areas, N1 farming system has the highest net return and output input ratio of ₹ 1,15,578/HH/year and 1.58, respectively. This farming system includes more activities and is more integrated than other existing systems in the area. Kumar et al. (2011) also reported increase in net income through an integrated farming system due to the use of recycled products within the system. Output input ratios for other farming systems were 1.52 and 1.51 for N2 and N3 farming systems, respectively.

Share of labour was highest (56% to 58%) in total cost in crop enterprises and feed and fodder cost had a major share (53% to 72%) in total cost for livestock enterprises. Due to low maintenance cost Sheep-poultry (S1) and Goat-poultry (S2) farming systems had output-input ratios close to 2. In case of other farming systems, the output-input ratios were close to 1.5 in saline areas. In case of normal areas, Cattle-goat-crop-fish (1.58) had the highest output-input ratio. Goat-poultry (S2) farming

Table 8: Cost and returns of different farming systems

Code (1)	Farming systems (2)	Total cost (3)	Gross return (4)	Net return (NR) (5= 4-3)	Output input ratio (6=4/3)
S1	Sheep-Poultry	35,368.50	74,273.85	38,905.35	2.10
S2	Goat-Poultry	41,925.00	95,892.68	53,967.68	2.28
S3	Cattle-Goat-Crop-Fish	1,78,940.50	2,80,627.00	1,01,686.50	1.57
S4	Cattle-Poultry-Crop-Fish	1,43,898.00	2,08,652.10	64,754.10	1.45
N1	Cattle-Goat-Poultry-Crop	1,96,822.00	3,09,400.00	1,15,578.00	1.58
N2	Cattle-Goat-Crop	1,86,600.50	2,83,632.76	97,032.26	1.52
N3	Cattle-Poultry-Crop	1,67,779.00	2,53,830.00	86,051.00	1.51

system had the highest net return of ₹ 53,967.68/annum among landless farmers and cattle-goat-crop-fish (S3) with a net return of ₹ 1,01,686.50/annum among landholders in saline areas. Cattle-goat-poultry-crop (N1) farming system had highest net return of ₹ 1,15,578/annum) in normal areas.

Conclusions

Goat-poultry (S2) farming system had a higher output-input ratio (2.28) than Sheep-poultry (S1) (2.10). So, S2 farming system should be suggested for resource-poor land-less farmers. For other landholders, Cattle-goat-crop-fish (S3) should be recommended in saline areas. Whereas in case of normal areas, Cattle-goat-poultry-crop (N1) should be recommended as it had the highest output-input ratio than other farming systems in that area. Irrespective of saline and normal areas, variable cost had a king's share in total costs for both crop and livestock management. During survey it was found that, presence of cooperative societies in both saline and normal areas was very meagre. If cooperative societies are promoted and farmers obtain these variable inputs from those cooperatives then variable costs and hence total cost will be reduced.

References

Alam MZ, Boggs LC, Mitra S, Haque MM, Halsey J, Rokonuzzaman M, Saha B, Moniruzzaman M (2017) Effect of salinity intrusion on food crops, livestock and fish species at Kalapara Coastal belt in Bangladesh. J Food Quality 1-23

Bandyopadhyay BK, Maji B, Sen HS, Tyagi NK (2003) Coastal Soils of West Bengal- Their Nature, Distribution and Characteristics, Bulletin No. 1/2003, Central Soil Salinity Research Institute, Karnal, India

Banerjee R, Mandal PK, Kumar U, Ray K (2010) Productivity and genetic potential of garole sheep of India-a review. Asian J Anim Sci 4: 170-189

Bose S, Moitra DN (1995) Bengal breed of sheep in the Sundarban. Bangkok, Asian Livestock. Food and Agricultural Organization pp. 16–17

Clermont CD, Suwannang N, Grunberger O, Hammecker C, Maeght, JL (2010) Yield of rice under water and soil salinity risks in farmers' fields in northeast Thailand. Field Crops Res 118(3): 289–296

Crawford RD, Christman CJ (1992) Heritage Hatchery Networks in Poultry Conservation. Genetic Conservation of Domestic Livestock. CAB International Oxon, UK. 121-122

Das SK (2011) Problems and Prospects of Farmers in Sundarbans Delta (Mangrove Eco system) of India. Animal Resource Management 118-120

Ghalsasi PM, Nimbkar BV (1993) The Garole Microsheep of Bengal. India. Anim Genetic Resources Information 12: 73–79

Ghosh S and Mistri B (2020) Coastal Agriculture and Its Challenges: A Case Study in Gosaba, Sundarban, India. Space and Culture India 8(2): 140-154

GoW (2018) Coastal Zone Management Plan of West Bengal, Department of Environment, Government of West Bengal, India Khan SK, Mojumder S, Kovats, Vineis P (2008) Saline contamination of drinking water in Bangladesh. The Lancet 371: 385

Kumar P, Sharma PK (2020) Soil Salinity and Food Security in India. Frontiers in sustainable food systems 4: 1-15

Kumar S, Singh SS, Meena MK, Shivani and Dey A (2012) Resource Recycling and Their Management under Integrated Farming System for Lowlands of Bihar. Indian J Agric Sci 82(6): 504-510

Kumar S, Singh SS, Shivani, Dey A (2011) Integrated farming systems for Eastern India. Indian J Agronomy 56(4): 297–304

Kumari T, Chauhan AK (2021) Characterization of livestock-based farming systems in tribal areas of Odisha. Indian J Agronomy 66(1): 81-86

Kumbhare SL, Sharma KNS, Patel RK (1983) Standardization of bovine units. Indian J Anim Sci 53: 547.

Ladeiro, B. (2012) Saline Agriculture in the 21st Century: Using Salt Contaminated Resources to Cope Food Requirements. J Botany, 2012:1-7

Lal P and Chandel BS (2016) Economics of milk production and cost elasticity analysis in Sirsa district of Haryana. Econ Affairs 61(3): 405-411

Mandal A (2016) Comparative Study of Marginal Farms in India vis-à-vis West Bengal; Evidences from Last Decade. Econ Affairs 61(4): 589-598

Mandal A, Karmakar PK, Behera R and Pan S (2017) Prolific Garole Sheep: Pride of Bengal. Research & Reviews: J Dairy Sci Technol 6(2): 11–19

Mandal AK, Sharma RC, Singh G, Dagar JC (2010) Computerized Database on Salt Affected Soil in India. Technical Bulletin No. CSSRI/Karnal/ 2/2010, pp-28

Nimbkar C (2002) Gains from Garole the Wonder Sheep of West Bengal. Partners in Research for Development, ACIAR 15: 31–36.

Pal DK, Bhattacharya T, Srivastava P, Chandran P, Ray SK (2009) Soils of the Indo Gangetic Plains: their historical perspective and management. Current Sci 1193 1202

Patil V (2010) Cost of Milk Production: A Case Study of Maharashtra. Retrieve from www.afcindia.org.in

Rao VM (1991) Dairy Farming: Socio-economic Analysis of Milk Production. Reliance Publishing House, New Delhi, India

Sahana G, Gupta SC, Nivsarkar AE (2001) Garole, the Prolific Sheep of India. Anim Genetic Resource Information. 31: 55–63

Sarker NR, Habib MA, Amin MR, Yeasmin S, Tabassum F, Yeasmin D (2018) Feeds and Fodder Dynamics in Selected River Basin of Bangladesh. Bangladesh J Anim Sci 46(3): 206-214

Sharma RC, Arora AL, Narula HK, Singh RN (1999) Characteristics of Garole sheep in India. Animal Genetic Resources Information 26: 57–64

Shrivastava P, Kumar R (2015) Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi J Biol Sci 22(2): 123-131

Singh NP, Kumar R, Singh RP (2005) Dynamics of Bovine Economy in the Indo Gangetic Plain of India: Issues of growth, equity and sustainability. Agric Econ Res Rev 18(1): 51-70

Singh RN, Bohra SDJ (1996) Garole sheep a profile (Bengal breed of sheep known as Garole. Indian J Small Ruminants 2(2): 38–42.

Trivedi S, Zaman S, Chaudhuri TR, Pramanick P, Fazli P, Amin, G., Mitra A (2016) Inter annual variation of salinity in Indian Sundarban. Indian J Geo-Marine Sci 45(3): 410-415

WHO (2003) Public Health Initiatives-Health Impact of Highly Saline Water, World Health Organization, Geneva, Switzerland

Wistrand A (2003) Shrimp farming in Bangladesh, in The Blues of a Revolution: The Damaging Impacts of Shrimp Farming, D. Torre and D. Barnhizer, Eds.

Wongsomsak S (1986) Salinization in Northeast Thailand. Southeast Asian Stud 24(2): 133-153