WHY DO BANGLADESHI CATTLE YIELD HIGH POSITIVE RETURNS?

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Abstract

This study extends the recent debate on the rate of return of cattle rearing in India, triggered by Anagol et al (2017), Gehrke and Grimm (2018) and others, to the Bangladesh context and finds that the apparent paradox of widespread cattle rearing despite negative return in India absent. We use a nationally representative two-year panel data of rural Bangladesh and find that the average and marginal returns of cow and bullock are positive and high for both years. We show that appreciation of the value of cattle is the major contributing factor for positive returns. The existence of cattle market where they can be freely traded for slaughtering or production of milk or for any other purpose, that is constrained to various degrees in India, is the key to high positive return in Bangladesh.

Key words: Bangladesh, livestock, poverty, rural development
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1 INTRODUCTION

Anagol et al. (2017) unleashed a debate over raising livestock in India. They used survey data collected from Uttar Pradesh to estimate returns from raising livestock and found that the median return to cows was -7% and 51% and 45% of households earned negative returns on cows and buffaloes, respectively. When labor costs were included, they found that more than half of the milch cows had negative returns. This, they claimed, contradicts the fundamental tenets of capitalism where activities generating negative returns would have been given up. Anagol et al. (2017) discussed a comprehensive list of factors that could explain the puzzle of negative returns: measurement errors, preference for illiquid savings, insurance, variation of returns over years, labor market failures, milk market failures and social, cultural, and religious values.

Two subsequent papers joined the debate and added some interesting dimensions. Attanasio and Augsburg (2018) argued that the data used by Anagol et al. (2017) came from a drought year characterized by scarcity of fodder and lower milk production and as such returns were low. They used a three-year panel data to show that returns were positive in normal years (good rain, low fodder costs, higher milk production because of better nutrition) and negative in drought years (bad rain, high fodder costs). Subsequently, Gehrke and Grimm (2018) joined the debate to check the generalizability of the results and introduced an analysis of marginal returns and economy of scale. They also found that most households operated at unprofitable levels and returns to livestock varied by quality of cattle, size of the stock and annual rainfall. Those with cattle of better quality had higher returns and those with larger herd size enjoyed economy of scale due to decreasing labor costs. To summarize, the Indian debate has generated four main results: returns to raising livestock are predominantly negative, they vary from one year to another, there are scale economies with larger farms showing diminishing costs, and cattle of better quality generate higher returns. The fundamental puzzle of why there is widespread rearing of livestock in India despite negative returns remains, however, unresolved.

This study tries to contribute to the debate by extending the geographical horizon and tests the four results mentioned above in the context of livestock rearing in Bangladesh. This shift in geographical focus from India to Bangladesh involves a shift in religious and cultural beliefs that have relevance for the debate. Being predominantly a Muslim populated country, cow in Bangladesh is not "holy" but plays mainly an economic role in the economy. There are no restrictions on buying and selling of cows, slaughtering, movement across the country or on the consumption of beef. Thousands of cattle are sacrificed during the religious festival of Eid ul Adha all across the country and the meat distributed among poor households and relatives. Unrestricted and widespread markets for cattle imply that they can be sold at any time in their life cycle and their value as an asset is not constrained by trading restrictions.

Thus, Bangladesh provides a counterfactual to India where most states have restrictive cattle trading and slaughtering policies.

We use household level panel data of Bangladesh Integrated Household Survey (BIHS of International Food Policy Research Institute (IFPRI) which is representative of the rural areas of all administrative divisions of the country[2]. The key finding of this study is the predominance of positive and high rates of returns to raising cattle in Bangladesh.[3] We found that 17% of all households having negative returns in 2011 and 14% in 2015. We have also found that the average annual returns from raising livestock are 29.2 and 39.2 percent respectively in 2011 and 2015. We claim that appreciation of the value of cattle is the major contributing factor for the large positive returns. Over a period of 12 months, the value of bulls as well as cows appreciated by 55 percent in 2011. The corresponding figures for 2015 are 51% for bullocks and 28% for cows. In contrast, Anagol et al. (2017) estimated depreciation of -3.1% of the median value of cow and Gehrke and Grimm (2018) estimated it at -40% of the value of cattle. Such a high rate of appreciation of cattle in Bangladesh is also reported by Gisby (2010). We have found that average returns tend to decrease with herd size reaching a maximum with a herd size of one. Thus, unlike India, there are diseconomies of scale from livestock raising in Bangladesh. It is difficult to increase herd size possibly due to lack of space for cattle and declining access to grazing grounds. BIHS data do not provide information on breed of livestock but there is secondary evidence that shows that, similar to India, livestock of better variety generate higher returns in Bangladesh (Jabbar 2005, Kabir and Talukder 1999, Gisby 2010).

Higher returns from raising livestock in Bangladesh is more due to gain in value of livestock as an asset than to generation of a stream of incomes from sale of livestock products such as milk or manure. This is particularly true for bullocks that is particularly raised for its meat value. There is no reason to believe that Bangladeshi farmers are more "rational" than Indian farmers or they face more competitive markets for milk, fodder, and other inputs and outputs. The difference lies in the cultural and religious context that maximize the market value of cattle in Bangladesh but not in India. Article 48 of the Constitution of India mandates the state to prohibit the slaughter of cows and calves and other milch and draught cattle.[4] 20 out of 29 states in India currently have various regulations prohibiting the slaughter of cows. States like Kerala, Meghalaya, Mizoram, Nagaland have no restriction on cattle slaughtering.[5] It is not only the slaughter acts but also other acts and state level politics that constrain the cattle market. For example, in many ways slaughtering acts in Uttar Pradesh (surveyed by Anagol et al. 2017) and Andhra Pradesh (surveyed by Gehrke and Grimm (2018) are similar. In both states slaughter of cow is banned, bullocks and buffaloes can be slaughtered upon obtaining a "fit-for-slaughter" certificate that the cattle is "not

[2] The administration of Bangladesh is divided into eight major regions called divisions. Each division is comprised of several districts.
[3] Livestock includes cows and bullock (male and female) only. Buffalo is ignored because they represent only 6% of cattle population of Bangladesh. We use the term cattle as comprising of cows and bullocks only and use interchangeably with the word livestock.
[4] https://en.wikipedia.org/wiki/Cattle_slaughter_in_India
[5] *Ibid.*

economical or is not likely to become economical for the purpose of breeding or draught/agricultural operations."[6] However, transportation of cattle between and across Uttar Pradesh (without permit) is forbidden but not in Andhra Pradesh. Enforcement of these restrictions are often informally done by people known as "Gau Rakshak" or "Protector of Cows" that severely restricts movements of livestock and often lynching of suspects. Difficulty in disposing off cattle, particularly for slaughtering, implies that their value naturally depreciates over time as the animal becomes older and unproductive. Difficulty of disposing off cattle for slaughter has resulted in the existence of a large number of stray cattle that are accounted for in livestock census of India (GOI 2014). For example, there were 5.1 percent stray cattle in Uttar Pradesh (stricter slaughtering and transportation rules) and .4% in Andhra Pradesh (no transportation restrictions). Beef consumption is also very low in India and concentrated in some limited number of states (Meghalaya, Nagaland). In India 4% of rural households consumed beef as compared to 17.9% in Bangladesh.[7] In the absence of these restrictions, the return of cow, both milch cow and bullock, is high for Bangladesh where cattle are raised either for meat consumption only or sold for whatever purpose before or after they become unproductive. Thus, the apparent puzzle in India could be, at least partly, explained by the institutional and cultural factors that adversely affect the performance of the market for buying and selling of livestock.

The rest of the report is organized as follows: next section (section 2) describes data and present relevant descriptive statistics . Revenue and costs are estimated in section 3 while profit, average and marginal returns to raising livestock are estimated in section 4. In section 5 heterogeneity in returns are analysed and robustness checks are done in section 6. We discuss returns from other activities (i.e. small ruminants, poultry, rice and wheat) in section 7 and the overall finding is discussed in section 8 and section 9 draws the conclusions.

2 CONTEXT, DATA AND DESCRIPTIVE STATISTICS

2.1 LIVESTOCK SECTOR OF BANGLADESH

The livestock sector plays an integral part of the rural economy of Bangladesh. About 37.6 percent of rural households in Bangladesh had at least a livestock in 2015 (BIHS 2015) which is almost similar to the extent reported in HIES (2000)-36.2 percent. It is estimated that about 20% of employment is directly associated with livestock sub-sector and partly employment is about 50% (Bangladesh delta plan, p. 1).

[6] *Ibid.*

[7] Indian National Sample Survey Office data of 2011-12 as reported in https://www.livemint.com/Opinion/yZNoOJfmUdfx8t6Vvlj2qJ/Profile-of-a-meateating-Indian.html. Bangladesh data derived from HIES (2010).

Though the livestock sector has grown by 3.2% in 2016, its contribution to GDP has fallen from 2.2% in 2008 to 1.7% in 2016 (GOB 2016). The contribution of livestock sector to the overall agriculture sector has been almost static at around 13% during the same period. The number of bovine populations[8] has increased since 1960 but their growth could not match the growth of human population (Huque and Huda 2016). As a result, per capita bovine population in Bangladesh has declined from .38 in1960 to .18 in 2009.

Meat consumption in Bangladesh has steadily increased from 11.6 gms/p/d[9] in 1995 to 18.6 gms/p/d in 2010 (HIES 1995 and 2010). Beef consumption has increased by about 11% between 2010 and 2016 (HIES 2016). Per capita milk consumption in Bangladesh is 18 kg per year which is significantly lower than other countries in the region. India and Pakistan consume 90 kg and 190 kg of milk per capita respectively.[10] Deficiency in milk demand estimated at 38% by the Livestock Directorate of Bangladesh is met by imported powder milk and in meat production by cattle smuggled into the country. According to HIES 2010, 79% of Bangladeshi households eat meat no more than 2 days in a fortnight. Only about 63% of households drink milk and 60% eat eggs in a fortnight (Toufique and Belton 2014).

2.2 RATES OF RETURNS FROM LIVESTOCK IN BANGLADESH

Existing studies estimating returns from livestock rearing in Bangladesh have found them to be generally profitable. All these studies estimated returns without taking into consideration appreciation or depreciation of livestock asset except for the study undertaken by Gisby (2010). While only a few of these studies estimated economic returns by imputing labor or fodder costs, most of them estimated only financial returns (labor or fodder not paid for being excluded from total costs). Only Halim et al. (2010) found economic rates of return negative but nominal returns positive. There are several limitations of these studies. They are based on survey data that are specific to a small region or two and the sample size is very small (26 to 167 households). Therefore, the estimates of return suffer from regional peculiarities and are not nationally representative. There exists no study that covers more than one period. This paper removes all these drawbacks and estimates returns to livestock in Bangladesh by using a nationally representative two-period panel data.

[8] Farm animals of Bangladesh consist of cattle, buffalo, goat and sheep. The former two animals are called bovine animals or large ruminants, and the latter two are called small ruminants.
Chicken and ducks are termed as poultry.
[9] Grams per person per day.
[10] Milk Money, Dhaka Tribune, June 24, 2017

Table 01. Summary of the findings from survey of literature

Sl.	Paper	Methodology	Data	Summary of Results
1	Gisby (2010)	Asset plus return.	167 farmers from Bogra and Sirajganj. Crossbred and local variety distinguished	Asset value gain from crossbred double than local. Crossbred milk cattle are more profitable than local variety. Beef cattle only bring small incomes from dung sales outweighed by maintenance costs but this is outweighed by asset gain. Beef cattle owned for 3.8 months and milk cattle for about 13 months.
2	Kabir and Talukder (1999)	Financial returns.	26 dairy farms from Tangail	Dairy farms profitable for all types of cattle but crossbred cattle brought more profit.
3	Halim et al. (2010)	Financial returns.	100 Red Chittagong Cattle Farmers.	Benefit cost ratio (BCR) positive with cash costs but negative with full costs (labor and other costs included). Economic returns could have been positive if appreciation were considered. Accounting returns positive.
4	Islam et. al. 2010	Financial returns.	70 cattle from Dinajpur.	Positive profit
5	Rahman et. al. (2000)	Financial returns using a production function.	100 cows from Tangail and Madaripur	Profitable
6	Sarma et al (2014)	Financial returns using a production function.	150 HHs from Pabna and Sirajganj	Profitable at full labor costs
7	Pathan (2011)	Financial returns using a production function.	50 farmers from Mymensingh	Profitable at full labor costs
8	Mondal et al. (2010)	Financial returns using a production function.	60 HHs from Tangail	Profitable at full labor costs. Used imputed fodder cost but did not report.
9.	Khan, Baset, Fouzder, (2010)	Financial returns, no appreciation, included labor costs.	30 farmers from 8 Thana's of Mymensingh	Profitable at full labor costs
10.	Jabbar 2005	Returns, compares crossbred and local cows.	160 farms (120 crossbreeds, and 40 local) from Manikgonj, Pabna and Shirajgonj.	Crossbreed oversampled. Measured returns to milk production, all returns +ve, HYV higher.

2.3 DATA

There are several advantages of using the Bangladesh Integrated Household Survey (BIHS of International Food Policy Research Institute (IFPRI) dataset. First, the sample is statistically representative at following levels: (a) nationally representative of rural Bangladesh; (b) representative of rural areas of each of the seven administrative divisions of the country: Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, and Sylhet. Second, BIHS conducted two rounds of survey in 2011 and 2015 on the same households. We combine them to create a household level panel data which allows us to control for household level time-invariant heterogeneity in estimating marginal returns. Second, since the objective of the survey was to study agriculture, food security, nutrition, poverty, detailed data is collected on livestock raised by the households. It contains information on livestock ownership (large/small ruminants and poultry), their current and last year's values, revenues and costs. Moreover, it has very rich socioeconomic modules including income, employment, consumption, asset, education, health, etc., allowing us to explain the variations of rate of return of livestock due to socioeconomic factors.

Number of households included in the first (2011) and second rounds (2015) of BIHS are 4,423 and 4,419 respectively. Out of them, 41.1 percent (1,817) and 37.2 percent (1643) of the households owned cattle in the first and second rounds of the surveys respectively.. Farm animals of Bangladesh consist of cattle, buffalo, goat and sheep but in this study, we only considered cattle consisting of cows and bullocks. As buffalo is not a common livestock in Bangladesh, we dropped buffalo owning households from the analysis. Agricultural census of 2008 reported only 0.65% of rural households owning buffaloes (BBS 2010). In BIHS there are only 20 households in 2011 and 10 in 2015 that reported of having buffalo. In Bangladesh, cattle are raised not only for milk but also for the production of meat. BIHS data has therefore information on bulls and milk cows and we have included both. Accordingly, we categorized the households into those having only milk cows, only bullocks and milk cows and bullocks (see Appendix B for details). It may be mentioned that Anagol et al. (2017) and Gehrke and Grimm (2018) only considered milk cows and milk buffaloes.

BIHS data do not provide information on individual cattle except, obviously, for those households having only one cattle. It records the total number of cattle by types (cow, bullock) for each household and associated revenues and costs are also presented in the aggregate. Information on cattle have been collected for 'last 12 months' in both rounds of surveys. BIHS data recorded all transactions in cattle that resulted in either depletion or accumulation of the stock at the end of the reference period[11]. The size of the herd changed from the initial period for the following reasons: (i) sale of cattle, (ii) purchase of a

[11] BIHS data provides two data points (beginning and end of the reference period) for size and value of the cattle stock in both rounds of surveys.

cattle, (iii) exchange of cattle as gift, (iv) leasing of cattle from other households, (v) slaughtering of cattle for consumption of meat and (vi) loss of cattle due to theft or death. We could only account for cattle sales (case i) because the price of cattle sold was reported in the data. For the rest of the cases we had to drop the respective households because the value of the cattle transacted was not reported. Table 02 provides information on the distribution of the households by livestock categories actually considered for estimating the rates of returns.

Table 02: Selected households, households dropped and all households having livestock

Households having	No. of households included	No. of households dropped	No. of households with livestock in the survey	No. of households included	No. of households dropped	No. of households with livestock in the survey
	2011			2015		
Only bullock	322 (30.23)	319 (42.42)	641 (35.27)	236 (26.70)	357 (47.0)	593 (36.09)
Only milch cow	381 (35.77)	188 (25.00)	569 (31.31)	310 (35.07)	185 (24.4)	495 (30.12)
Both bullock and milch cow	362 (33.99)	245 (32.57)	607 (33.40)	338 (38.24)	217 (28.6)	555 (33.77)
All	1,065 (100.0)	752 (100.0)	1817 (100.0)	884 (100.0)	759 (100.0)	1643 (100.0)

Note: The numbers in the parentheses are column percentages

The highest proportion of households owned only milch cows in 2011 (35.8%) and bullock and milch cows in 2015 (38.2%) (see, Table 02). When we consider that a sizable number of households owns both bullocks and milch cows, we conclude that very large number of rural households raise bullocks.

2.4 DESCRIPTIVE STATISTICS

Table 03provides summary statistics of general household characteristics of households who own cattle and those who do not.[12] The demographic and socioeconomic characteristics of the cattle-owning households are significantly different from the non-cattle owning households. Cattle-owning households are more likely to be male-headed than non-cattle owning households. The heads of the households with cattle are also older by about 3 years. Household size is larger for households with cattle. Male-female ratio is significantly higher for the cattle-owning households. Households that raises cattle have higher amount of land. This is true for homestead as well as operated cultivated land. Average size of the land owned by the cattle owning households is more than 4 times higher than the non-cattle owning households. Households that raise livestock are relatively less well off. Their per capita food expenditure as well as total expenditures is lower than those who do not have livestock. The extent of extreme poverty is also higher amongst the owners of cattle. Interestingly, households raising cattle are located closer to shops than the households who do not have livestock.

[12] Households dropped for incomplete information are included.

Table 03: General household characteristics: cattle owners vs. non-owners

	2011					2015				
	No cattle		Cattle owners		Difference in mean	No cattle		Cattle owners		Difference in mean
	Mean	SD	Mean	SD	p value	Mean	SD	Mean	SD	p value
Male household head	0.74	0.43	0.92	0.26	0.000	0.73	0.44	0.91	0.27	0.000
Age of household head	42.36	14.28	45.58	13.19	0.000	44.15	14.05	47.13	12.89	0.000
Household size	3.98	1.55	4.59	1.76	0.000	4.13	1.67	4.68	1.80	0.000
Household head is literate	0.45	0.49	0.43	0.49	0.128	0.49	0.5	0.44	0.49	0.0016
Male female ratio	1.06	0.87	1.24	0.89	0.000	1.07	0.85	1.25	0.88	0.000
Per capita Food expenditure (monthly BDT)	1341	800.67	1061	654.38	0.000	1310	886.82	1028	650.51	0.000
Per capita total expenditure (monthly BDT)	2717	2318.72	2474	2312.6	0.000	3038	3479.64	2450	2811.33	0.000
Homestead land owned (decimal)	7.64	10.47	10.80	13.14	0.000	6.91	10.11	10.13	11.83	0.000
Total land owned (decimal)	36.10	84.76	89.04	154.82	0.000	38.97	98.61	95.41	170.22	0.000
Cultivated land (operated) (decimal)	34.72	81.73	148.38	195.79	0.000	39.02	92.39	142.84	195.71	0.000
Distance to local shop(km)	0.58	0.62	0.67	0.72	0.000	0.42	0.56	0.51	0.61	0.000
Observations	2,606		1,817			2,776		1,643		

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT). Cattle owner means a household is currently (at the end period) raising bullock and/or milk cow. "Only Buffalo" raising households have been excluded.

We present the main characteristics of cattle farming of the households in Table 04. BIHS data collected information on the current value of livestock as well as its value a year before as reported by the respondents.[13] Total value of stock of cattle is defined as total value of cattle of all the sample households divided by the number of sample households and average cattle value is defined as total value of the stock of the sample households divided by the number of cattle. The total value of the stock at the end of the reference periods were 32,848 BDT in 2011 and 16,411 BDT in 2015 on average per household respectively in real terms and the average values of the stock at the end of the reference period were

[13] The reference period for the first round was from December 1, 2010 to November 30, 2011 and the second round from December 1, 2013 and November 30, 2014.

15,581 BDT and 16,308 BDT also in real terms respectively. Thus, the total value of the stock decreased between the survey years but the average cattle value increased in real terms. The increase in average value of the stock indicates that the quality of cattle increased between the survey years. The decrease in the total value of stock cannot be easily explained. Perhaps a large number of households retained livestock of lesser quality and some small farms started to raise livestock on a more commercial basis. This happened in a situation when the percentage of households having livestock declined between the survey years. The herd size is the highest for those having both milch cows and bullocks. On the other hand, the herd size is slightly higher for those having only bullocks than those having only milch cows. This indicates a large number of households raise livestock for slaughtering for meat production. In both cases the herd size increased during the survey periods. The herd size of mixed farms has slightly declined. Table 04 also presents that, average appreciation (i.e. meat value), defined as the average of the change in the value of the stock between the initial and terminal periods, is Tk. 4,182 in 2011 and 6,356 in 2015. Average appreciation increased by 56% between the survey years. Average revenue from selling milk increased between the survey years; an increase by 6.4 percent in real terms. Thus, increase in milk revenue lags way behind the extent of increase in the appreciation of livestock. However, the contribution of manure as a source of revenue decreased over time. Fodder costs contributes the most in rearing livestock in Bangladesh. Average fodder cost was about 4,870 BDT in 2011 and 4,694 BDT in 2015. The decrease in fodder costs is not statistically significant. Wage labor is hired by only a few households. Family labor are mostly employed in these farms. We observe that family labor costs have declined in real terms and no clear explanation can be given. The gender wage gap in family labor exists. Female family members worked more hours on cattle rearing than the male members. In 2015, male members spent about 368 hours compared to 417 hours by the female members.

Table 04: Characteristics of cattle farming

	2011		2015		
	Mean (no. of observations)	SD	Mean (no. of observations)	SD	p-value
Total value of stock of cattle (BDT)	32848 (1065)	29546.95	16411 (884)	30294.17	0.026
Average cattle value (BDT)	15581 (1065)	8444.29	16308 (884)	8941.44	0.035
Herd size: Only Bullock	1.91 (322)	1.19	2.03 (236)	1.48	0.283
Herd size: Only Milk Cow	1.72 (381)	1.00	1.91 (310)	1.39	0.037
Herd size: Both Milk cow and bullock	2.87 (362)	1.66	2.73 (338)	1.52	0.250
Herd size: All	2.17 (1065)	1.41	2.26 (884)	1.51	0.181
Meat value (BDT)	4182 (1065)	12286.1	6356 (884)	12276.13	0.000
Milk revenue (BDT)	10164 (482)	23354.6	10811 (486)	18462.54	0.632
Manure revenue (BDT)	1974 (1053)	2190.70	1540 (765)	1692.97	0.000
Revenue from calves (BDT)	8467(391)	3088.34	8288(327)	3060.95	0.436
Fodder cost (BDT)	4870 (883)	10880.21	4694 (725)	6568.19	0.703
Value of the cattle lost (BDT)	29833 (15)	36941.88	16912 (06)	15183.65	0.422
Family labor cost (total) (BDT)	6974 (1055)	5371.44	3864 (882)	2026.66	0.000
Family labor cost (male) (BDT)	4348 (895)	5087.90	2552 (800)	1622.45	0.000
Family labor cost (female) (BDT)	3487 (994)	2254.42	1614 (846)	994.75	0.000
Total time spent on livestock (hours)	667(1060)	488.86	794(883)	397.72	0.000

Male family time spent on livestock (hours)	367 (895)	425.53	368 (884)	273.54	0.9380
Female family time spent on livestock (hours)	364 (994)	232.93	417(884)	277.41	0.000
Total family time spent on livestock (hours)	655(1055)	465.82	788(882)	395.40	0.000
Hired time spent on livestock (hours)	729(22)	599.37	851(07)	659.68	0.650
Quantity of calves	1.18(391)	.431	1.15(327)	.428	0.436
Value of the cattle sold (BDT)	27732(141)	19846.02	26389(153)	25062.7	0.612
Wage labor BDT (total)	8751 (22)	15038.26	3588 (07)	3053.30	0.380
Wage labor BDT (male)	8937(21)	15293.28	3588(07)	3053.30	0.372
Wage labor BDT (female)	2425(02)	813.17	--	--	--

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT). Total value of stock of cattle is defined as total value of cattle of all the sample households divided by the number of sample households and average cattle value is defined as total value of the stock of the sample households divided by the number of cattle. Numbers in the parentheses are no. of observations (households) with positive value of various cattle farming variables.

3 RETURNS TO CATTLE HOLDING

Returns to livestock comprises of two parts, (i) flow of profits from sale of livestock products such as milk or manure, and (ii) appreciation or depreciation of the value of livestock.

We follow the empirical specification given by Gehrke and Grimm (2018). Let the production function of a household from raising livestock be-

$Q = Af(K, L, X, F)$ ----------(1)

In this production function Q= milk, calves, manure; K = current/end period value of cattle; L= labor; X = land; F = fodder. Gehrke and Grimm (2018) lumped X and F together and noted that land entered into the production function through F. Since we have data on homestead land, we treat it separately. A= household and region-specific characteristics that influence the total factor productivity (TFP) of the inputs. Note that in case of bullock, the production function becomes trivial as Q includes only revenue from manure.

We estimate annual profit, average and marginal return to raising livestock in Bangladesh.

The profit function is given by,

$\pi = P.Q - cK - wL - gF - rX - S + \delta K$ ----------(2)

Where P = price vector of outputs; w= wage rate (both market and imputed); g= price of fodder; r= rent of land; c=other costs associated with K; S is the value of cattle lost; δ =rate of appreciation/depreciation[14]. Following Gehrke and Grimm, (2018), we assume the price of capital to be zero. We also assume that the rental value of land, r=0. Once we get a household level estimate of annual profit, we estimate average and marginal return of raising livestock in Bangladesh. The following equation clearly shows the separation of profit into returns from livestock products and from change in the values of the stock (δK).

[14] $\delta = \left({K - K_0}/{K_0}\right)$; where K_0 is the value of the cattle stock at the initial reference period and K is the end period value of the same stock of cattle.

Average return of raising livestock is given by,

$$\frac{\pi}{K} = P.\frac{Q}{K} - c - \frac{wL}{K} - \frac{gF}{K} - \frac{S}{K} + \delta \quad \text{.....(3)}$$

Following Gehrke and Grimm (2018), we estimate marginal returns in two different ways.
First, using a linear production function, where we estimate profit as a function of herd size (value of the livestock) and a number of household level characteristics after controlling for the fodder costs.

$$\pi_i = \alpha_0 + \alpha_1 K_i + \alpha_2 X_i + e_i \quad \text{---------- (4)}$$

Where, X_i= household level characteristics and α_1= marginal return of holding livestock of value K for one-year period.

Second, we use a CES production technology to estimate marginal return. The marginal return of this type of production function would be the first derivative of equation (2) with respect to K-

$$\pi'(K) = P.Q'(K) - c + \delta \quad \text{----------(5)}$$

If Q is a CES production function such that

$$Q = A.K^{\alpha_1} L^{\alpha_2} X^{\alpha_3} F^{\alpha_4} \quad \text{----------(6)}$$

Where, all parameters lie strictly between 0 and 1. The marginal return of this type depends on the shape of the production function. We get α_1 from the following logarithmic transformation of the CES production technology (i.e. equation (6))

$$Log(PQ) = \alpha_0 + \alpha_1 logK + \alpha_2 log\, L + \alpha_3 logX + \alpha_4 logF + \alpha_5 A + \in \quad \text{---------- (7)}$$

We then plug in the estimated value of α_1 into the equation (5) and get marginal return from raising livestock in the following form-

$$\pi'(K) = P.\alpha_1.\frac{Q}{K} - c + \delta \quad \text{----------(8)}$$

3.1 Appreciation/Depreciation

In Anagol et al. (2017), the price of a cattle, P (t), is reported by the farmer. They used these self-reported values of dairy animals to establish a relationship between cattle values and age. This helped them to estimate appreciation as the difference in cattle values over a period of one year (P(t)-P(t-1)). On the other hand, Attanasio and Ausburg (2018) could not estimate depreciation because their data did not contain information on the age of livestock although they had information on the value of livestock. Gehrke and Grimm (2018) did not follow Anagol et al. (2017) for the estimation of appreciation/depreciation of cattle also because they did not have information on age. They used information from secondary sources and assumed that cow depreciates by Indian Rupees, INR 1,240 (US$ 27) every year and the end-of-fertility value of a cow is INR 1,400 (US$ 27) which is based on an annual depreciation of 20%.

The approach taken by these papers for estimating appreciation reflects the institutional setup existing in the respective Indian states. "Since cattle cannot be sold for slaughter, this implies that the value of a cow will be 0 once it is no longer of reproductive age" (Gehrke and Grimm 2018, p. 682.) This rationalized use of age as an appropriate indicator for estimating appreciation (Anagol et a. 2017) or use of secondary source of information (Gehrke and Grimm 2018) or to ignore measurement of depreciation altogether (Attanasio and Ausburg (2018)).

Our method of estimating appreciation is similar to Anagol et al (2017) in the sense that we take the difference between initial and terminal values of cattle as appreciation but both these values are reported by the respondents. BIHS data reported, for each year, the current value of a cattle and its value before 12 months reported by the respondents. This is appropriate in Bangladesh context where there is no restriction on selling cattle for slaughter. The value of livestock depends not only on age but also on other factors such as weight of cattle, location, time, market conditions etc. These factors are incorporated by the respondent while reporting the value of her cattle. BIHS data do not present information either on age or on weight or the breed of cattle and hence we could not estimate the relationship between them and value of cattle. We would expect these to be incorporated by the respondent while valuing the livestock. Dependence on self-reported value of cattle involves likely overreporting by the sellers as they have private information on the quality of the cattle that is not available to the buyers. This problem is less acute when cattle is sold for slaughter as weight is more visible than the potential of producing milk by a cow. We also think that any bias that is generated from reported values of cattle by the respondents is carried over to the next period and cancels each other out in the estimation of appreciation of the stock. This asymmetric information is not handled adequately in existing studies and this study is no exception. As mentioned before we have information on the value of cattle sold during the reference period. We have considered that value as the end period value of the cattle.

3.2 Revenue

The BIHS data provides information on three items of revenue, milk, manure and calves.

Milk: Milk is an important source of revenue from cattle in Bangladesh. As expected, households having at least one calf in the herd produce more milk than other households. BIHS data provide detail information on milk that includes total production and also spoilt, among others. We considered the net milk production by accounting for the amount of spoil. We used two set of prices to determine the value of milk. For those who sold milk in the market, we estimated the price by dividing the value of the milk sold by the quantity of milk sold. About 53% and 55% of the households sold milk in the market in 2011 and 2015 respectively. For the households that consumed all the milk they produced, they provided information on the value of that milk consumed and this allowed us to determine the market price as reported by them. As mentioned by Anagol et al. (2017), this may overestimate the price of milk because the households may value their milk higher than the price it can fetch in the market.
BIHS data lumped together revenues from manure and milk by aggregating small ruminants such as goat and sheep and large ruminants. It is therefore not possible to separate milk and manure revenues for households that raise both cattle and small ruminants. About a quarter of households having cattle also have small ruminants. However, milk revenues from small ruminants are very small; 6% and 9% of average milk revenues for 2011 and 2015. Small ruminants, on the other hand, hardly have any relevance to manure revenue.

Calves: BIHS data provide information on number of calves born in last 12-month period, not their market price. We take the calf price to be BDT 7,151 in both 2011 and 2015. from the data collected for the Final Impact Evaluation Survey of Second Participatory Livestock Development Project (BIDS 2010).

3.3 Costs

Unlike revenue, cost data is presented by type of livestock. Three components of costs are recorded: feed/fodder bought, medicine or treatment costs, and labor.

Fodder: Fodder is the major component of costs of raising livestock in Bangladesh. With the gradual diminishing of grazing grounds and other common property resources, most of the cattle in Bangladesh are stall-fed. Common items of fodder are straw, green grass, and concentrate. Except some small number of commercial farms, small-holder farmers do not have land for growing fodder. BIHS data do not provide any information on collected or home-produced fodder and report the value of purchased fodder only. However, later in section 6.1 we check robustness of the profit found in this section by inflating fodder cost by a certain percentage, to see how sensitive the profit with inclusion of non-purchased fodder costs is.

Labor: BIHS data provide labor use and labor cost information by gender as well by source (family and hired). Labor use is presented in hourly terms. Family labour is unpaid but hire labour paid and information on hired labour cost is recorded. About 98-99% of labour time used in livestock farming is provided by family labour. Thus, we present labour cost by (i) assuming it to be zero for family labour and (ii) monetising family labour (see Appendix C for description of labor cost calculation.) Tables 05 and 06 present the breakdown of costs and revenue for four different types of households.

Table 05: Components of revenue and cost (2011)

	Revenue				Cost				
	Appreciation (%)	Milk (BDT)	Manure (BDT)	Calf (BDT)	Wage labor (BDT)	Family labor (BDT)	Fodder cost (BDT)	Medicine and other cost (BDT)	Value of the cattle lost
Households with only Bullock	55	0.00	1483	0.00	6058	6371	3444	365	41000
Households with only Milk cow	55	11163	1843	8126	4450	6942	4549	489	20062
Households with both Bullock and Milk cow	23	9393	2560	8747	11111	7542	6408	659	0.00
Full sample=1065	44	10164	1974	8467	8751	6974	4870	512	29833

Note: Appreciation (depreciation) means real rate of increase (decrease) of the cattle stock in last 12 months' period. BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT). All the revenue and cost components show average numbers for the sample households with positive amount of the respective components (i.e. 27732 = value of the cattle sold means the average value of a sold cattle of households with positive amount of 'cattle sales'). Wage labor (BDT) is the summation of the cost of hired male and female labors. Family labor (BDT) is the summation of the cost of male and female family labors.

As evident from the Tables 05 and 06, the highest appreciation of the stock is observed for the households who only raise bullocks; within a year the average value of their stock increases by more than a half in both years. These bullocks are likely raised for slaughter. Relative appreciation is similar (higher for bullocks) to those found by Gisby (2010) who found that bulls appreciated more than cows both for local variety (13% as compared to 6%) as well as for crossbred variety (21% as against 12%). For the full sample average annual appreciation at household level was 44 percent in 2011 and 33 percent in 2011.

As expected, the share of milk revenue is the highest for the households with only milk cow in 2011. Fodder and family labor are the major cost components for all household categories. Cost and revenue components are more or less similar in year 2011 and 2015.

Table 06 : Components of revenue and cost (2015)

	Revenue				Cost				
	Appreciation (%)	Milk (BDT)	Manure (BDT)	Calf (BDT)	Wage labor (BDT)	Family labor (BDT)	Fodder cost (BDT)	Medicine and other cost (BDT)	Value of the cattle lost
Households with only Bullock	51	0.00	1304	0.00	0.00	3518	4782	400	6546
Households with only Milk cow	28	10032	1419	7917	981	3670	4116	479	27277
Households with both Bullock and Milk cow	24	11379	1870	8565	4023	4284	5145	569	0.00
Full sample=884	33	10811	1540	8288	3588	3864	4694	496	16912

Note: Appreciation (depreciation) means real rate of increase (decrease) of the cattle stock in last 12 months' period. BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT). All the revenue and cost components show average numbers for the sample households with positive amount of the respective components (i.e. 26389 = value of the cattle sold means the average value of a sold cattle of households with positive amount of 'cattle sales'). Wage labor (BDT) is the summation of the cost of hired male and female labors. Family labor (BDT) is the summation of the cost of male and female family labors.

4 PROFITS, AVERAGE AND MARGINAL RETURNS

Estimates of annual profit, average and marginal returns are presented in Tables 07 and 08 for the years 2011 and 2015 respectively.

Table 07 : Average and marginal returns from raising livestock, 2011

	Total annual profit (BDT)		Average return		Marginal return
	With family L	Without family L	With family L	Without family L	
Households with only Bullock	-4598	1713	-25.13	8.11	.56
Households with only Milk cow	4359	11211	5.48	39.51	.66
Households with both Bullock and Milk cow	5045	12546	11.57	37.19	.36
Full sample=1065	1884	8793	-1.70	29.23	.53

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT). With family labour implies monetised value of family labour and without family labour implies only hired labour costs are considered and family labour considered free.

Table 08 : average and marginal returns from raising livestock, 2015

	Total annual profit (BDT)	Average return	Marginal

	With family L	Without family L	With family L	Without family L	return
Households with only Bullock	471	3989	-2.53	14.77	.51
Households with only Milk cow	8873	12531	29.22	46.01	.40
Households with both Bullock and Milk cow	13651	17923	36.14	49.95	.37
Full sample=884	8457	12312	23.39	39.18	.42

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT). With family labour implies monetised value of family labour and without family labour implies only hired labour costs are considered and family labour considered free.

Profit from raising livestock is found positive (excluding family labor cost) in all categories for all years. Once family labor is valued at market price, the profit reduces considerably and becomes negative for the households with bullocks only. Value of calf and the revenue from selling cattle (see table 04) increase the profits for households with only milk cow and for households selling cattle respectively.
In Bangladesh, both average and marginal returns are positive for the full sample in both years except for the average return (with family labor) in 2011. For all household category together, the average return (without family labor) from holding cattle for a year is 29.23 and 39.18 percent in 2011 and 2015 respectively. However, average return is sensitive to the inclusion and exclusion of family labor cost. The average return drops to -1.7 and 23.4 percent in the year 2011 and 2015 respectively, when we value family labor at market price. Average return is higher in 2015 than in 2011.

The marginal return (when CES production function is assumed) is positive and high in Bangladesh which is about 53 percent in 2011 and 42 percent in 2015. Intuitively, annual return from investing additional one dollar to the existing stock is about 53 cents in Bangladesh in 2011. We do not estimate marginal return without family labor cost, because, unlike average return, the marginal return does not vary much with the exclusion of family labor cost. Intuitively, the marginal return depends primarily on the capital elasticity of dairy-output (measured by α_1), not on labor used in the production process. Labor affects marginal return only through α_1 (see Appendix A2 for estimates of α_1). Another finding is that, although the average return has increased from 2011 to 2015, marginal return has slightly declined during this period. We present the results of marginal revenue found using linear production function in Appendix A1.

Thus, we find that average return from raising livestock in Bangladesh is more than 29% when family labour used in the farm is not valued at market price. It becomes slightly negative (-1.7%) in 2011 when labour is valued at market prices. But this happens due to the negative return from raising bullocks only. Those who raise only milch cow or milch cow along with bullocks continue to earn positive return but they are low (family labour valued at market prices).

5 HETEROGENEITY IN AVERAGE AND MARGINAL RETURNS

In this section we discuss the heterogeneity of returns from two aspects: (i) herd size and (ii) household food expenditure. For the first aspect, we explore if there are any economies of scale in herd size and for the second, we check whether rates of return change for different poverty groups as indicated by household food expenditure quintiles.

Table 09 : Herd size and returns, 2011

Herd size	average value of total stock(BDT)	average return (with family L)	average return (without family L)	marginal return	Observation
1	17097	-3.27	38.75	.62	418
2	14889	-1.68	26.47	.49	328
3	14150	1.40	22.88	.38	171
4	13995	-4.60	15.95	.67	84
>4	15127	3.89	15.63	.32	39

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT).

Table 10: Herd size and returns, 2015

Herd size	average value of total stock(BDT)	average return (with family L)	average return (without family L)	marginal return	Observation
1	17174	27.78	50.60	.52	324
2	16875	25.39	39.41	.47	280
3	14892	16.71	28.02	.30	146
4	15882	14.87	23.51	.22	68
>4	15733	25.20	31.99	.22	33

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT).

Tables 09 and 10 show that for both years, average return is maximized at herd size one and minimized at herd size of around four when we family labor cost is not monetized. Again, for both years, average return is maximized at herd size greater than four when family labor cost is monetised. Thus, it appears that there are no economies of scale in raising livestock in Bangladesh. In 2015, there is some sign of increasing returns at herd size larger than 4 but it still remains well below the return from unitary herd size. One main reason we conjecture for lower herd size is lack of space for small farmers in Bangladesh.

Table 11: livestock variables and per capita food expenditure quintiles (2011)

Per capita food exp quintiles	% of HHs with livestock	Average herd size (livestock sample)	Average value of total stock (BDT)	Average return (without family L)	Marginal return
Q1	61.58	2.25	14294	27.57	.56

Q2	44.86	2.15	14358	28.55	.46
Q3	36.31	2.19	15139	25.98	.52
Q4	32.20	2.14	16070	31.12	.64
Q5	30.43	2.11	18041	32.93	.46

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT).

Table 12: livestock variables and per capita food expenditure quintiles (2015)

Per capita food exp quintiles	% of HHs with livestock	Average herd size (livestock sample)	Average value of total stock (BDT)	Average return (without family L)	Marginal return
Q1	52.04	2.37	14415	33.03	.37
Q2	42.65	2.17	15655	38.85	.74
Q3	35.52	2.23	15568	36.21	.39
Q4	31.45	2.18	17641	45.68	.44
Q5	24.24	2.34	18787	42.12	.41

Note: BDT means constant 2011 Bangladeshi Taka. (1 USD= 74.2 BDT).

Poorer households raise more livestock. Tables 11 and 12 show that in both years, the incidence of livestock raising of the households in bottom 20th quintile is more than twice than the households in top 20th quintile[15]. Among the households who raises livestock, herd size is the maximum for the lowest quintile. For the rest herd size varies across quintiles in 2011 but has an increasing trend for higher quintiles in 2015. This may indicate that for higher quintiles herd size has increased over time. Average value of the stock increases over the food expenditure quintiles, i.e., richer households have higher valued livestock. If we compare average value of stock for the two years, we observe that it has increased for each quintile implying households having better stock at every quintile. We find that although poorer households raise more livestock, they earn a lower annual return than their rich counterparts (quintiles 4 and 5). The average rate of return is found highest in the fifth and fourth food expenditure quintile respectively in years 2011 and 2015.

6 ROBUSTNESS CHECK: IPMUTED FODDER COST FROM SECONDARY SOURCE

We have mentioned earlier that BIHS data has information only on purchased fodder. However, existing literature and anecdotal evidences suggest that non-purchased fodder also constitutes a non-trivial part of fodder cost. Due to lack of data, we rely on secondary information on non-purchased fodder. Halim et al. (2010) has found that home produced and collected fodder is about 20% of total purchased fodder, when

[15] We probe this issue further and regress the incidence of cattle rearing and herd size on the quintile of food consumption. The results show that the lowest quintile are more likely to raise cattle and have lower herd size, controlling for other socioeconomic variables (see Model AA4 and Table A4 in Appendix).

priced at market price. We used this information to inflate fodder costs and estimate average and marginal return again. The results are reported in tables A3-1 and A3-2 in Appendix . Even if we consider non-market fodder, the average return is still very high – more than 30 % when we do not consider family labor.

7 COMPARISON WITH RETURNS FROM SMALL RUMINANTS AND AGRICULTURAL ACTIVITIES

7.1 Return From Small Ruminants And Poultry

Who raises small ruminants and Poultry?

In this section we analyze the profitability of small ruminants (goat and sheep) and poultry (chicken, duck and other birds). According to BIHS 2015 data, around 15 percent of rural households in Bangladesh raise goat and/or sheep whereas, more than 64 percent raise chicken, duck or other birds. Incidence of small ruminants and poultry has decreased slightly between 2011 and 2015. Figures 01 and 02 decomposes the incidences of small ruminants and poultry by per capita food expenditure quintiles for both years. In case of small ruminants (Figure 01), we observe a clear trend that poorer households raise small ruminants more than their richer counterparts. For instance, in 2015, about 24 percent of bottom food expenditure quintile (Q1) households had at least one goat or sheep, whereas, only about 9 percent of the households in the top quintile (Q5) had goat(s) or sheep(s). Moreover, the incidence of small ruminants has increased during 2011 and 2015 among poorest households (Q1) and decreased among households in the subsequent quintiles (i.e. relatively rich households). One fifth of the households raise small ruminants for pure productive purpose and five percent do it for their household consumption only. Rest of the households (about 75 percent) use their goat/sheep for both purposes (i.e. consumption and production).

A large portion (66 percent in 2011 and 64 percent in 2015) of rural Bangladeshi households raise poultry. Only one (01) percent and seven (07) percent households raise poultry for pure production and pure consumption purposes respectively, whereas 92 percent raise for both home consumption and production purposes.

Figure 2 shows that relatively rich households raise less poultry than the poorer ones. Percentage of poultry raising households among top expenditure quintiles (Q5) has decreased sharply (from 62 percent to 55 percent) during 2011 and 2015.

Figure 01: Incidences of small ruminants in various food expenditure quintiles

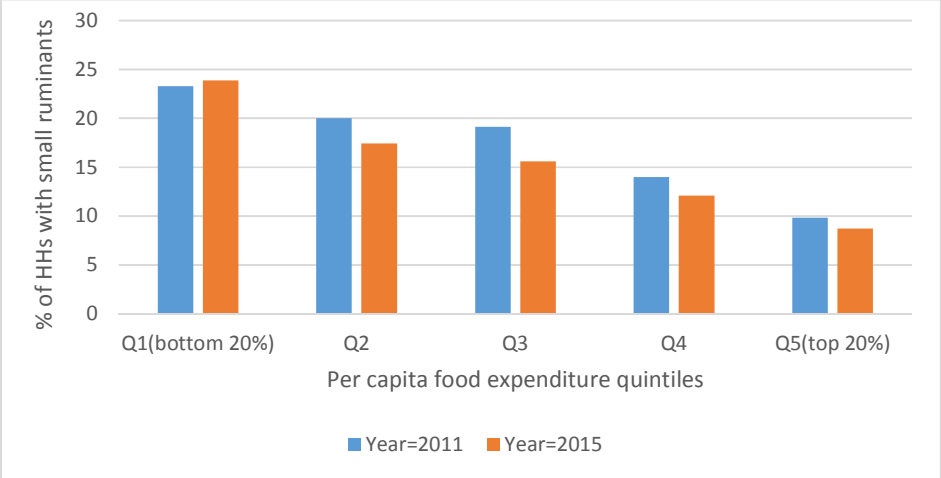
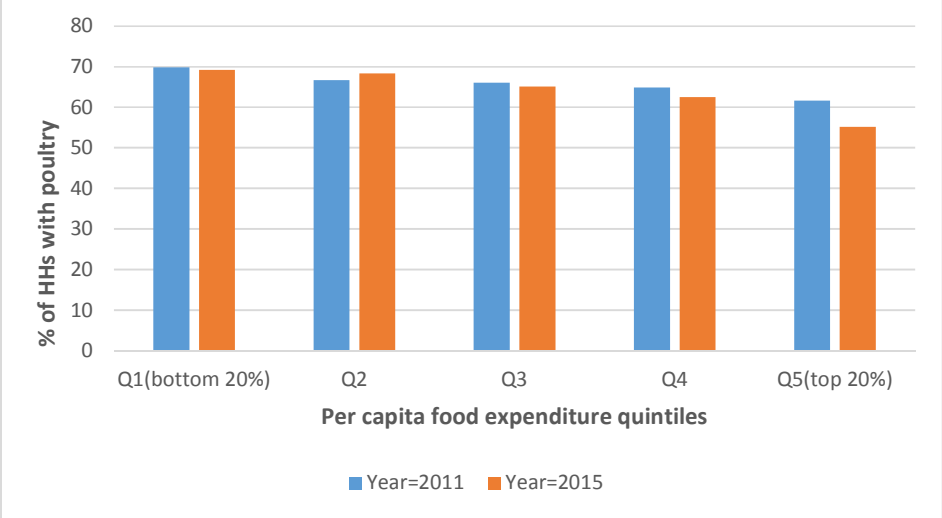


Figure 02: Incidences of poultry in various food expenditure quintiles



Are small ruminants and poultry profitable?

In order to estimate average and marginal returns for small ruminants and poultry we use the same methodology that has been used to estimate the return of large ruminants. We present the results of average and marginal returns of small ruminants in tables 13 and 14.

Average rate of return from raising small ruminants is very much sensitive to the inclusion of family labor cost into the calculation (Table 13). Average annual return for small ruminants with monetized family labor is negative (-91 percent in 2011 and -28 percent in 2015). If we do not monetize family labor costs, the return becomes positive (26 percent in 2011 and 35 percent in 2015). Both average and marginal returns are higher in 2015 than in 2011. With monetized family labor costs, only 16 percent and 38 percent of the households generate positive average returns in years 2011 and 2015 respectively (Table 14). However, the incidence of positive return increases substantially in both years if we do not value family labor costs.

Table 13 : Average and Marginal returns of small ruminants and poultry

	Year=2011 (N=160)	Year=2015 (N=156)	Year=2011 (N=471)	Year=2015 (N=537)
	Small Ruminants		Poultry	
average ror with family L	-91.38	-28.35	-255	-115
average ror without family L	26.46	34.65	56.18	82.47
marginal ror	0.42	0.53	0.62	0.82

Table 14 : Incidences of positive and negative returns from raising small ruminants and poultry

	Year=2011 (N=160)	Year=2015 (N=156)	Year=2011 (N=471)	Year=2015 (N=537)
	Small Ruminants		Poultry	
Share of HHs with positive average rate of return (with family labor)	16.25	37.82	15.71	29
% of non-positive average ror(with family L)	83.75	62.18	84.29	71
Share of HHS with positive average rate of return (without family labor)	73.75	76.92	78.56	83.64
% of non-positive average ror(without family L)	26.25	23.08	21.44	16.36
Share of HHs with positive marginal rate of return	76.25	83.97	85.99	91.08
% of non-positive marginal ror	23.75	16.03	14.01	8.92

In 2011, average annual return of poultry (without family labor cost) was 56 percent and in 2015 it had gone up to 82 percent per year (Table 13). Similar to the case of large and small ruminants, the return decrease as we include family labor cost into the estimation. Additional one-dollar investment in small ruminants generated 0.42 cents in 2011 and 53 cents in 2015. Marginal return from investing one dollar in poultry was 62 and 82 cents in years 2011 and 2015 respectively.

In 2011, average annual return from raising poultry and small ruminants without monetizing family labor is found maximum (81 percent for poultry and 59 percent for small ruminants) for the poorest segment of the rural population, i.e. Q1 (Figure 03). However, in 2015, bottom quintile populations' annual return from raising poultry and small ruminants is lowest compared to other food expenditure quintiles (Figure 04). Hence, we observe that although annual return for both poultry and small ruminants has increased sharply between 2011 and 2015, the return for poorer segment of the population has actually decreased.

Figure 03: Average returns and various food expenditure quintiles in 2011

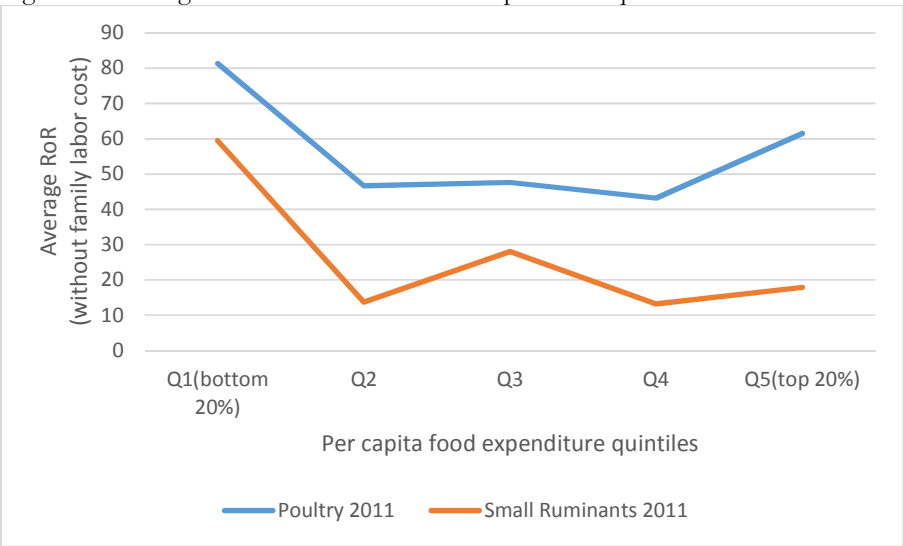
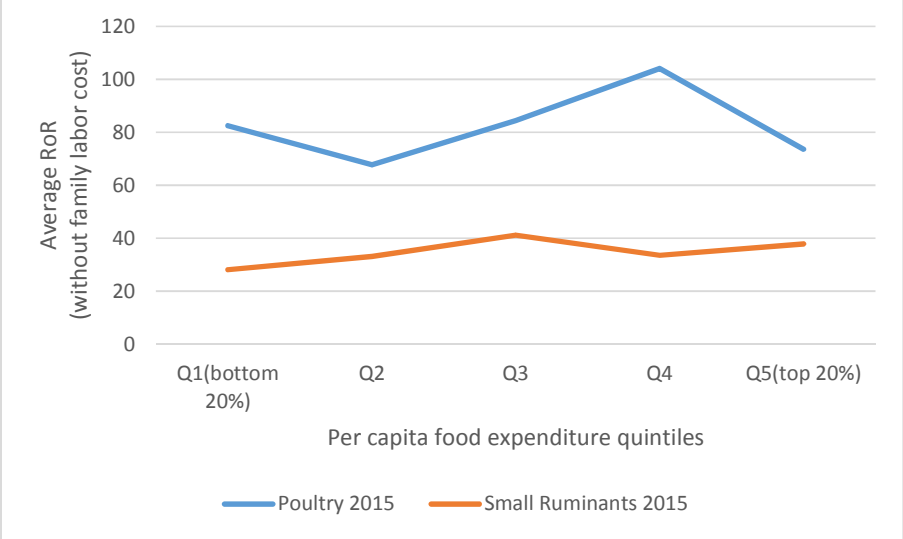


Figure 04: Average returns and various food expenditure quintiles in 2015



7.2 Return From Other Agricultural Activities

We collected secondary information on returns from agricultural activities other than livestock. In Haor areas of Bangladesh, the net return from cultivating modern variety (MV) and local variety (LV) boro rice is about 40,000 BDT/ha and 20,000 BDT/ha respectively (Alam et.al., 2010). They have calculated the

benefit cost ratio (BCR) to be 1.71 for MV boro and 1.59 for LV boro production. Kazal et. al. (2013) estimated net return inclusive of family labor cost for Hybrid (HYV) boro to be around 22,000 BDT/ha in haor areas, between 26,000 BDT/ha and 16,000 BDT/ha in other parts of the country and BCR is always greater than unit (01). Net return from HYV aman rice (after monetizing family labor time) is also found positive but lower than that of HYV boro. Net return for both HYV boro and HYV aman is greater in Southern part than in the North-eastern part of the country.

Using the data from a field survey in three norther districts of the country (i.e. Dinajpur, Rajshahi and Jamalpur), Rahman and Hasan (2011) has found that the wheat cultivation is profitable. Kazol et. (2013) has also estimated positive net return in wheat farming all over the country. Thus, in general returns from other agricultural activities are generally positive.

Therefore, we can say based on this secondary information that although there are differences in terms of paddy verities and regions, agricultural activities (rice and wheat production) are mostly profitable in Bangladesh. Positive return from rice production is evident even after monetizing the family labor time (Kazal et. al. 2013). However, livestock production is found to be profitable without monetizing family labors, which becomes negative if we take family labor costs into the calculation.

8 DISCUSSION ON THE DEBATE

This paper is motivated by the debate triggered by Anagol et al. (2017) and the availability of the nationally representative BIHS data that contained information on livestock holdings. This allowed us to estimate rates of returns from rearing livestock in rural Bangladesh and check whether these are similar to those found in India. The estimation of positive and high rates of return kept us pondering why, unlike India, this is the case in Bangladesh. We strongly believe that this happened due to two factors. **First**, a cow in Bangladesh has value not only for the attribute of having the capacity to produce milk but also for having the attribute of producing meat for consumption. **Second**, markets for buying and selling of cattle for meat consumption freely exist that help farmers dispose of their cattle whenever needed and for whatever purpose. As an asset a cow is therefore more liquid in Bangladesh than in India.

A cow gives milk and meat

A milch cow is an asset with two main attributes: it gives milk and it also gives meat, whereas a bull has only one major attribute, that of having meat. The relevance of livestock as draft power has severely diminished over time in Bangladesh due to mechanization of agriculture and other benefits such as manure are minor. In India, livestock are raised mainly for the production of milk and meat can be viewed as a by-product. This is not the case in Bangladesh where a cow can be sold not only for the attribute of having milk but also for producing meat. This is the basis of our classification of the

households into three categories, those having only bullocks, only milch cows and having both. About 35% of the households raise only milch cows. About 27-30% of the households rear only bullocks. Those who rear only cows do so mainly because of milk either for home consumption or for selling in the market or both. We do not have enough information about the extent of sale of cows for slaughtering. A survey carried out by Toufique et al. (2018) on the cattle markets established for the sacrificial Eid ul Adha found that about 8% of cattle sold for slaughter are cows. A cow is least preferred because of the common perception that a pregnant cow cannot be sacrificed and buyers do not take risk of buying a cow. BIHS data show that about 30% of cattle sold in a year comprise of cows. This figure includes cows bought for milk but a part of it do represent those sold for meat. Thus, a cow can be sold any time of its life cycle and has value for both milk and meat.

In both Uttar Pradesh and Andhra Pradesh, cows can never be slaughtered irrespective of its age[16] and therefore cows are traded only for the purpose of milk. The existence of a market for cattle, where they can be sold anytime either for milk or for meat or both, implies that the value of cattle is determined not only by age alone but also by its breed (recognized by Anagol et al. 2017), overall health, buyers' preference, condition of the market etc. When a bull or cow can be bought for slaughtering, the value of cattle includes the value of meat and this component is largely missing in most Indian contexts. Since a cattle market for meat consumption does not exist in many states of India or exist for a limited range of cattle (old, worn out, unproductive), the value of cattle is not maximized because the meat value is almost zero. India's beef industry is predominantly based on the slaughtering of water buffalo. As per existing meat export policy in India, the export of beef (meat of cow, oxen and calf) is prohibited.

A re-examination of depreciation of the value of livestock

Analog et al. (2017) justifiably used age as a determinant of the value of a cow in the context of restrictions on slaughtering or meat consumption in most states in India. In straight-line depreciation method, as used by Gehrke and Grimm (2018), the value of livestock always declines by a fixed amount each year as there is a finite period during which holding to it is useful. This observation makes Gehrke and Grimm (2018, p. 682) comment that "we assume that the market value of a cow approaches 0 with the end of its fertility."

When cattle can be slaughtered for meat consumption and there are competitive markets for buying and selling cattle, the price of cattle can be considered as a more reliable indicator of current value of cattle. In most likelihood the owner of a cattle will sell it, ignoring distress sales, when the value of the cattle is the highest and this may depend on many factors although age and number of lactations continue to play a major role. For example, in Bangladesh, cattle get the highest value before the Eid-ul-Adha when cattle

[16] In Andhra Pradesh, bullocks can be slaughtered when it is certified unproductive, normally at the age of 15.

are sacrificed for religious purposes. Many households buy and fatten cattle to get the most of their investment from this occasion. Appreciation of buffalo is also estimated by using the same method. But since there is no restrictions on transactions of buffalo, including for slaughtering, age may not be the only determinant of their value. In the case of buffalo, weight is likely to be a better determinant of asset value. We also observe a wide variation of values of both cows and buffaloes for any given age.

The BIHS data reported the value of cattle over a period of one year as reported by the respondents. This helped us to estimate appreciation or depreciation of cattle by taking the difference between the two. These values not only incorporated the age of the cow but also the value of meat or other factors that are relevant that influences price. We have found appreciation to be very high and mostly positive. For example, price of bullocks increased by more than half within a year. Such high appreciation is also reported by Gisby (2010). Gisby (2010) estimated asset gain as measured by the difference between buying and expected selling price of cattle. For bullocks, monthly asset gain is approximately 13% for local variety bull and 22% for crossbred. The corresponding figures for cows are respectively 6% and 12%.

We also notice that the rate of appreciation is very different in the two methods used by Anagol et al (2017) and Gehrke and Grimm (2018). In Anagol et al. (2017) appreciation for the full sample is around -3.1% of the median value of a cow. In the method used by Gehrke and Grimm (2018) cows depreciate by 20% each year. In the full sample depreciation is -40% of the value of the cattle. Attanasio and Ausburg (2018, P. 318) consider appreciation/depreciation to be a "minor source of costs, so the neglect is unlikely to introduce significant biases." Thus, there is a wide gap in the estimates of appreciation between Anagol et al. (2017) and Gehrke and Grimm (2018). The high incidence of negative returns from rearing livestock are found both with relatively low depreciation (Anagol et al. 2017) as well as from relative high depreciation (Gehrke and Grimm 2018). The reverse can be expected because compared to Uttar Pradesh, Andhra Pradesh has less restrictive slaughter act. We have already mentioned that unproductive bullocks can be slaughtered in Andhra Pradesh and there are various formal and informal restrictions on the movement of cattle in Uttar Pradesh. Besides, possession of beef is also illegal in Uttar Pradesh. The transport of cattle is important because there are incentives to move cattle to states where cattle trading and slaughtering is less restrictive. To cite Gehrke and Grimm (2018, p.682), “Of course, reports exist throughout the country of unproductive animals being sold off to other states in which cattle slaughter is not prohibited.”

The Indian context various restrictions on slaughtering has strong implications on returns to livestock. Negative returns imply that returns from sale of livestock product generally fails to account for the depreciation of livestock as an asset. If various restrictions on livestock trading were absent or less restrained, we could have observed relatively higher returns. Since cows cannot be slaughtered, a farmer

has to retain relatively older cattle for some time as it is difficult to dispose them of. For example, the National Dairy Development Board of India (NDDB) has recommended a 10 crossbred cow farm to dispose of cows that had 3 lactations period already to maintain the productivity of the herd.[17] This also indicates that cows, even if when they are allowed for slaughter before they attain the age of 15 or beyond, are not that productive. Allowing cow slaughter even at the age of 15 helps farmers to get some revenue that can be used to replenish the stock. This can be compared with part-exchange. The overall public opinion about cow slaughter also affects the price of cows as the traders find it difficult or risky to move cows across and within states with strong acts against transporting cows such as in Uttar Pradesh. The restrictions on cow slaughtering has already given rise to the problem of stray cows. These are mostly the cows abandoned by farmers as they became infertile and hardly get any buyer. These problems are more acute in states with more restrictive slaughtering acts. In Uttar Pradesh (more restrictive), 5.1% of cattle are stray cattle compared to .4% in Andhra Pradesh (less restrictive).[18] These restrictions on cattle trade or movement surely creates a black market for trading cows. This is recognized by Gehrke and Grimm (2018, p.682) but ignored. This shows that farmers are able of finding an informal avenue to dispose off their cows and this may have somewhat increased the rate of return.

9 CONCLUSION

By using a nationally representative panel dataset for rural Bangladesh, this paper found that, unlike India, the rates of returns from raising cattle in Bangladesh, are high and positive. Positive rates of return in India are either explained by a good year when fodder costs are low (Attanasio and Augsburg 2018) or by the existence of economies of scale where households with larger herd size only get positive returns (Gehrke and Grimm 2018). We have argued that positive/high rates of returns in Bangladesh is explained by the existence of market for cattle in an institutional setup where there is no moral or religious stigma attached to meat consumption or trading. Existence of this market adds a new dimension to the relationship between age and market value of a cattle because cattle has value beyond its property of giving milk and use as draught power. This increases the extent of appreciation of cattle of Bangladesh. A market that is missing in most states of India is present in Bangladesh to increase the value of livestock held by the smallholders.

Our findings have strong implications for livestock development and poverty reduction in Bangladesh. Higher rates of return for livestock rearing indicate that there is a scope for further development of the livestock sector. Since rates of return are higher for poorer households, the possibility to reduce poverty through livestock transfers still remains. There are, however, some worrying signs that should caution us. Though the returns from livestock are high but they are declining and the poorest households have

[17] See http://www.dairyknowledge.in/content/10-crossbred-cow-farm (last accessed on 3 October, 2019).
[18] Indian Livestock Census 2012 figures cited in https://thewire.in/politics/modi-government-cow-slaughter-stray-cattle (last accessed on 3 October, 2018.)

reduced livestock raising more than the rest and overall the extent of households rearing livestock has been falling. These may happen for factors that could not be analysed with available data. We think that inadequate livestock services, high costs of fodder etc. could have set this trend. It should be emphasized that successful asset transfer based anti-poverty programmes in Bangladesh are bundled up with provision of livestock services and transfer of cash.

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APPENDIX A

Table A1: Marginal returns to cattle: linear production function

	OLS		FE
	(1)	(2)	(3)
Value of the cattle	0.416***	0.443***	0.430***
	(0.023)	(0.032)	(0.053)
Value of the cattle(squared)		-0.000	
		(0.000)	
Labor cost	-0.982***	-0.968***	-0.944***
	(0.100)	(0.101)	(0.224)

Homestead land owned	172.543***	169.411***	160.890
	(38.901)	(38.979)	(213.623)
Fodder cost	-0.129*	-0.089	-0.369**
	(0.069)	(0.076)	(0.183)
Distance to local shop	252.113	276.559	-1,335.353
	(745.679)	(745.847)	(1,292.366)
Year	2,789.740***	2,803.082***	2,630.227*
	(1,045.808)	(1,045.728)	(1,451.905)
Observations	1,965	1,965	1,965
R-squared	0.200	0.201	0.218
Number of groups			1,545

Note: Linear production function assumed. Dependent variable is profit (with labor cost). Standard errors (clustered at household level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2: Marginal returns to cattle: CES production function

	OLS	FE
	(1)	(2)
Value of cattle (log)	0.722***	0.471***
	(0.054)	(0.130)
Labor cost(log)	0.109*	-0.073
	(0.062)	(0.121)
Homestead land (log)	0.145***	-0.198
	(0.040)	(0.315)
Fodder cost	0.000***	0.000***

	(0.000)	(0.000)
Distance to local shop	0.062	0.045
	(0.051)	(0.099)
Year	0.118	-0.107
	(0.075)	(0.113)
Observations	1,814	1,814
R-squared	0.161	0.064
Number of groups		1,435

Note: CES production function is assumed. Dependent variable is the log of sales revenue from dairy products, calves (if any) and revenue from cattle sales (if any). Standard errors in parentheses (clustered at household level). *** p<0.01, ** p<0.05, * p<0.1

Table A3-1: average and marginal return, 2011 (with non-purchased fodder)

	Average return				Marginal return (with cash and non-cash fodder)
	With family L		Without family L		
	Cash fodder	Cash and non-cash fodder	Cash fodder	Cash and non-cash fodder	
Households with only Bullock	-29.45	-32.34	16.20	13.31	.56
Households with only Milk cow	.76	-1.95	40.82	38.10	.62
Households with both Bullock and Milk cow	-15.09	-18.66	13.78	10.21	.57
Households sold cattle at the end period	36.95	35.27	58.89	57.21	.53
Full sample	-3.62	-6.33	34.82	32.12	.59

Table A3-2: average and marginal return, 2015 (with non-purchased fodder)

	Average return				Marginal return (with cash and non-cash fodder)
	With family L		Without family L		
	Cash fodder	Cash and non-cash fodder	Cash fodder	Cash and non-cash fodder	
Households with only Bullock	-4.91	-8.44	21.94	18.40	.61
Households with only Milk cow	28.74	26.22	50.96	48.44	.47
Households with both Bullock and Milk cow	23.17	20.91	39.84	37.58	.48
Households sold cattle at the end period	46.05	44.24	56.07	54.27	1.30
Full sample	23.06	20.43	44.19	41.56	.61

Model AA4: The determinants of the likelihood of raising livestock: is estimated using a Linear Probability Model for years 2011 and 2015 separately.

$$Y_i = \alpha_0 + \sum_{d=1}^{4} \alpha_d Q_{di} + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \sum_{j=1}^{49} \gamma_j District_{ji} + e_i$$

Where, i= HH (household), d= expenditure quintiles and j= districts

Y=0 if HH does not raise livestock

=1 if HH raises livestock

Q= Expenditure quintile dummy[19]

District= District level dummy[20]

X_1 = share of women member in the HH, X_2 = HH size, X_3 = education of HH head, X_4 = Homestead land of the HH, X_5 = distance to local shop and e= residual of model.

We also regress herd size on the same set of regressors using OLS for both 2011 and 2015 separately. Results are presented in table A4.

Table A4: Poverty and incidence of cattle rearing and herd size

	Dep. Var= Livestock Incidence	Dep. Var= Herd size	Dep. Var= Livestock Incidence	Dep. Var= Herd size
	(Year= 2011)		(Year=2015)	
Expenditure dummy:Q1	0.043*	-0.794***	0.060**	-0.655***
	(0.026)	(0.132)	(0.026)	(0.150)
Expenditure dummy:Q2	-0.025	-0.716***	0.020	-0.372**
	(0.025)	(0.132)	(0.025)	(0.147)
Expenditure dummy:Q3	-0.007	-0.458***	0.050**	-0.226
	(0.024)	(0.130)	(0.024)	(0.143)
Expenditure dummy:Q4	-0.013	-0.378***	0.022	-0.255*
	(0.023)	(0.130)	(0.023)	(0.149)
Female male ratio	-0.025***	-0.025	-0.022***	0.012
	(0.008)	(0.042)	(0.008)	(0.045)
Female labor*male labor		0.000***		0.000***

[19] We take the top 20% or the fifth quintile as reference category.

[20] We have total of 50 districts in BIHS data and there are 49 district dummies.

		(0.000)		(0.000)
HH size	0.056***	0.166***	0.041***	0.157***
	(0.005)	(0.024)	(0.005)	(0.025)
Education of HH head	-0.004*	-0.003	-0.007***	0.025**
	(0.002)	(0.011)	(0.002)	(0.011)
Homestead land owned	0.005***	0.017***	0.005***	0.011***
	(0.001)	(0.003)	(0.001)	(0.004)
Distance to local shop	0.013	-0.071	0.024*	-0.005
	(0.012)	(0.056)	(0.013)	(0.074)
Observations	4,134	1,752	4,144	1,594
R-squared	0.147	0.169	0.141	0.192

Note: ***, ** and * indicate 01%, 05% and 10% level of significance respectively. Model specifications control for regional (district) effects.

APPENDIX B: DEFINING VARIOUS HOUSEHOLD GROUPS OWNONG LIVESTOCK

Constant Herd Size

Case 01: Households with only Bullock (constant herd size)

This type of households satisfy two conditions: (i) HH raises only bullock, and (ii) herd size does not change during a one year period.

Case 02: Households with only Milk cow (constant herd size)

This type of households satisfy two conditions: (i) HH raises only milk cow, and (iii) herd size does not change during a one year period.

Case 03: Households with both Bullock and Milk cow (constant herd size)

This type of households satisfy three conditions: (i) HH raises bullock and milk cow, (ii) herd size is at least two in both beginning and the end of the year and (iii) herd size does not change during a one year period.

Average return for case 01, case 02 and case 03 is calculated using the following formula—

$$\pi = P.Q - cK - wL - gF + \delta K$$

π= profit

PQ= sales revenue (revenue from selling milk[21] and manure)

[21] Milk revenue is zero for Case 01.

c is the ratio of other costs to the value of the asset (K). We define 'other costs' as the summation of Medicine cost (K3_03) and Other cost (K3_10) in BIHS data.

cK= medicine and other costs

wL= labor cost

Labor cost has four components: (i) hired male labor cost, (ii) hired female labor cost, (iii) family labor cost (male) and (iv) family labor cost (female)

We take cost of hired labor (for both male and female) directly from BIHS data. We use average hourly hired labor cost of male as a proxy of hourly cost of all male family laborers. We use average hourly hired labor cost of female as a proxy of hourly cost of all female family laborers.

We calculate two set of average returns: (i) including both hired and family labor costs and (ii) excluding family labor costs.

gF= fodder cost (i.e. fodder that is purchased)

δK = value of appreciation/depreciation (i.e. rate of change of the stock over the year)[22]

K= value of asset at end period.

Once we calculate profit (π), we can get average rate of return by using the formula:

$averge\ RoR = (\frac{\pi}{K}) * 100$ for each Household.----------(A)

Finally, we drop few outlier households (i.e. HHs having unusual appreciation/depreciation, HHs having unusually high value of milk revenue etc.) For instance, in 2011 DATA, household id 4440 reports that it had two milk cows worth 18,000 taka at the beginning of the year. But at the end of the year that stock depreciates to only 2,000 taka.

In cases 01, 02 and 03, we have 5 or 6 HHs like this.

Case 04: $N_t > N_{t-1}$ (household with calf)

This type of households satisfy three conditions: (i) herd size is positive in both beginning and the end of the year and (ii) herd size at the end of the year is strictly higher than the herd size at the beginning of the year, (iii) Change in herd size is due to the born of new calf only.

BIHS data has information on the number of calves not their market price. Calf price/value is included into the end period asset value (K1_03b). Therefore, a straightforward calculation of the change in stock value will be the sum of two components: 1) appreciation/depreciation of the existing stock and 2) the value of calf. In order to separate these two components, we use average price of calf (below 12 months)

[22] We do not know the app/dep of a single livestock. Only the app/dep of the stock is known.

from a secondary source (PLDP2 database). Average price of a calf is BDT 7151 and BDT 9281 in year 2011 and 2015 respectively[23]. Therefore, we get true app/dep of the existing stock simply by using the formula—

$$net\ deltaK = total\ change\ in\ stock - average\ calf\ price$$

As the reported value of the asset at the end period is the value of appreciation plus calf value, we estimate actual end period value of the asset using the formula-

$$actual\ asset\ value\ at\ the\ end\ period = asset\ value\ at\ the\ initial\ period + net\ deltaK$$

Revenue comes from milk, manure and value of calf. Average return calculation follows Equation (A).

Finally, we drop few outlier households (i.e. HHs having unusual appreciation/depreciation, HHs having unusually high value of milk revenue etc.)

For instance, in 2015 data, HH id 5074 reports that it has sold 50,180 litre milk in one year and the value of the milk cow was only 24,000 taka.

For instance, let us assume that at the beginning period a HH had 3 cattle with value 40,000 taka. During a one year period a calf born. Then at the end of the year the herd size becomes 4 and value of all 4 cattle is 50,000 taka. If this is so, the net delta would be—

Net delta= change in stock – average calf value

Net delta= (50,000-40,000)- 7151 = 2849

Actual asset value at end period= asset value at initial period + net delta

Actual asset value at end period = 40,000+2849= 42849

Case 05: $N_t < N_{t-1}$ (household with cattle sold)

This type of households satisfy three conditions: (i) herd size is positive in both beginning and the end of the year and (ii) herd size at the end of the year is strictly negative than the herd size at the beginning of the year, (iii) Change in herd size is due to the sales only.

We have the information on both sales price of the cattle and the change in total stock for the given year. In BIHS data, the reported asset value at the end period is lower than the actual value by the amount of the value of the asset sold. Hence, the calculation of appreciation/depreciation is based on the formula—

$$deltaK = reported\ asset\ value\ at\ end\ period - (reported\ asset\ value\ at\ beginning\ period - value\ of\ the\ asset\ sold)$$

[23] Calf price has been adjusted for inflation.

$$delta = \frac{deltaK}{reported\ asset\ value\ at\ beginning\ period - value\ of\ the\ asset\ sold}$$

For example, a HH had 2 cattle of value 24,000 taka at the beginning of the year. HH sold one cattle of value 20,000 taka during a one year period. At the end of the year its herd size reduces to one and value of the herd reduces to 6,000 taka. Then based on the formula—

deltaK= 6,000-(24,000-20,000) = 2,000 taka

delta= 2,000/4,000= 1/2

Average return calculation follows Equation (A).

We calculate average return for 1065 and 884 households for year 2011 and 2015 respectively. After defining livestock households in six (06) above mentioned groups, in order to present livestock households in a simplified way, we finally compress six (06) basic groups into three groups namely (i) Households with only bullock, (ii) Households with only milk cow and (iii) Households with both milk cow and bullock.

Appendix C: Calculation of Labor Cost of Raising Livestock.

Labor cost of raising livestock in Bangladesh:

We define, total cost of labor of raising livestock as summation of (i) cost of hired labor and (ii) cost of family labor. BIHS data provide information on labor use in hourly terms by gender as well by source (family and hired). It provides information on labor cost (by gender) only for hired labor, not for the family labor. However, a major part (98 and 99 percent in 2011 and 2015 respectively) of total labor hours spent on livestock by a rural Bangladeshi household come from family labors. In order to value family labor in monetary terms, we follow several steps.

Step 01: We calculate hourly cost of hired male labor (for households having positive number of hired male labor hours) by dividing labor cost by hours worked as follows-

$$\boldsymbol{hourly\ cost\ of\ male\ hired\ labor = \frac{total\ cost\ of\ male\ hired\ labor}{hired\ male\ hours}}$$

Average (arithmetic mean) value of the above equation turns out to be 11.85 BDT and 7.66 BDT for years 2011 and 2015 respectively.

Step 02: We use these year specific average values to calculate cost of male family labor for livestock raising as follows-

$$\boldsymbol{cost\ of\ male\ family\ labor = (11.85 * male\ family\ hours\ spent\ on\ livestock)\ ;for\ year\ 2011}$$

$$\boldsymbol{cost\ of\ male\ family\ labor = (7.66 * male\ family\ hours\ spent\ on\ livestock)\ ;for\ year\ 2015}$$

Step 03: Given the BIHS data, we are constrained by the fact that the information on hired female labor for livestock raising is very limited[24]. However, according to the BIHS data, hourly cost (i.e. wage) of an average female worker in agricultural activities is 80.90% and 59% of male wage in years 2011 and 2015 respectively. We use this information and calculate hourly cost of female hired labor for livestock raising to be 9.6 BDT (80.90 % of 11.85) and 4.5 BDT (59 % of 7.66) for years 2011 and 2015 respectively.

Step 04: At this stage, we use these year specific average values of hourly hired female labor cost to calculate cost of female family labor for livestock raising as follows-

$$\boldsymbol{cost\ of\ female\ family\ labor = (9.6 * female\ family\ hours\ spent\ on\ livestock)\ ;for\ year\ 2011}$$

$$\boldsymbol{cost\ of\ male\ family\ labor = (4.5 * male\ family\ hours\ spent\ on\ livestock)\ ;for\ year\ 2015}$$

Step 05: Finally, we add cost of male and female family labor to get household level cost of family labor of raising livestock.

Once we get the cost of family labor, we add this with hired labor cost (both male and female) to get total cost of labor of a household for raising livestock.

[24] Only two (02) households in 2011 and none of the households in 2015 reported positive cost for hiring female labor for livestock raising.