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CONTINUED EXISTENCE OF COWS DISPROVES CENTRAL TENETS OF CAPITALISM?

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ABSTRACT

Continued Existence of Cows Disproves Central Tenets of Capitalism?*

We examine the returns from owning cows and buffaloes in rural India. We estimate that when valuing labor at market wages, households earn large, negative average returns from holding cows and buffaloes, at negative 64% and negative 39% respectively. This puzzle is mostly explained if we value the household's own labor at zero (a stark assumption), in which case estimated average returns for cows is negative 6% and positive 13% for buffaloes. Why do households continue to invest in livestock if economic returns are negative, or are these estimates wrong? We discuss potential explanations, including labor market failures, for why livestock investments may persist.

JEL Classification: E21, M4, O12 and Q1
Keywords: investment, labor markets, livestock, profits and savings

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Continued Existence of Cows
Disproves Central Tenets of Capitalism?

"In theory, the market should have done away with Edible Arrangements long ago," said American Economic Association president Orley Ashenfelter, who added that one of the crucial assumptions of capitalism is the idea that businesses producing undesired goods or services will fail. "That's how it's supposed to work".

(The Onion, a satire magazine, 2011)

Santosh Anagol, Alvin Etang and Dean Karlan

August 2013

Abstract

We examine the returns from owning cows and buffaloes in rural India. We estimate that when valuing labor at market wages, households earn large, negative average returns from holding cows and buffaloes, at negative 64% and negative 39% respectively. This puzzle is mostly explained if we value the household's own labor at zero (a stark assumption), in which case estimated average returns for cows is negative 6% and positive 13% for buffaloes. Why do households continue to invest in livestock if economic returns are negative, or are these estimates wrong? We discuss potential explanations, including labor market failures, for why livestock investments may persist.

Key words: Savings, Investment, Profits, Livestock, Labor markets
JEL Classification: E21, M4, Q1, O12

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I. Introduction

Despite the importance of livestock as an asset class in developing countries, we know less than we should about their economic returns. Understanding the profitability of these common household investments is important for several reasons.

First, if these types of investments are profitable, then it suggests that low take-up of formal financial savings products may in part be driven by profitable risk-adjusted returns to informal assets. If this is the case, then programs which encourage households to use formal sector savings are unlikely to succeed unless they provide higher, safer, or more flexible returns than those available on livestock assets. Second, estimates of the returns to livestock can inform lenders about whether there are profitable projects for them to finance. As pointed out in de Mel, McKenzie, and Woodruff (2009a) while the (albeit limited) demand for high interest rate loans suggests that some proportion of households earn high returns on investments such as dairy animals, it is difficult to estimate the average return for non-borrowing households without data on profitability. Third, understanding the returns to livestock can help us learn more about labor market failures. Households will only choose to spend time caring for livestock if the returns on livestock are greater than their opportunity cost of labor; if returns on livestock are found to be low, then this suggests that households' labor market opportunities (both formal, informal, and household production) are poor. Fourth, to the extent that some development organizations provide grants of livestock to alleviate poverty[1], this analysis provides plausible estimates of potential impact, or at least lower bounds (many such grant programs provide services alongside the grant). Randomized trials evaluating the impact of asset transfers on income and consumption have found considerable success in several instances (Innovations for Poverty Action 2013), but studies to date have evaluated bundled interventions which include the provision of savings accounts, health trainings, and consumption support as well as livestock grants, rendering it difficult to isolate the returns to livestock specifically.[2]

[1] Organizations which provide livestock grants include Heifer International, BRAC, Bandhan, and Fonkoze among others.

[2] See http://www.poverty-action.org/ultrapoor/about for information on ongoing randomized trials of an integrated intervention on asset transfers, typically livestock.

We use newly collected animal level survey data from northern India to estimate the returns to owning dairy cows and buffaloes. We are motivated to study dairy animals in India because of their importance as an asset among India's rural poor. India holds more than a sixth of the world's population and over one quarter of the world's estimated cattle population. The Rural Economic and Demographic Survey (REDS), a nationally representative survey of rural India, found that 45 percent of rural Indian households owned at least one cow or buffalo in 1999, and on average those who have a cow or buffalo have an adult female. Our survey data provides information on all the major inputs in the milk production function including the value of the animal, fodder costs, veterinary costs, and lactation periods, as well as detailed data on animal outputs including milk, calves, and dung. We estimate annual returns to owning a dairy animal based on estimates of accounting profits (excluding the opportunity cost of labor) and economic profits (including the opportunity cost of labor, but not including the opportunity cost of capital).

Our main finding is that, on average, households earn negative returns on their investments in cows and buffaloes if labor is valued at market wages: we estimate average returns of negative 64% and negative 39% for cows and buffaloes respectively. If we value the household's own labor at zero, estimated average returns increase, to negative 6% for cows and positive 13% for buffaloes. We conduct a variety of robustness checks to consider measurement error in the value of inputs and outputs as an explanation for our estimated low returns. For example, we replace self-reported values of fodder with estimated costs from a fodder production company in India and find that estimated returns still appear to be low. We also conduct sensitivity analyses by adjusting the data for outliers, but still find low estimated returns.

Estimates of low or negative returns present a puzzle similar to the "Edible Arrangements" satirical quote at the opening of this paper: if cows and buffaloes earn such low, even negative, economic returns, why would rural Indian households continue to invest in them? The second part of our paper puts forward theories as to why households might persist in investing in cows and buffaloes despite their low returns. While the data at hand do not allow us to distinguish conclusively between these various explanations, we present some evidence to suggest that some explanations appear more plausible than others.

The paper proceeds as follows. Section II describes the data and methods for calculating the returns to cows and buffalos. Section III presents the estimates. Section IV discusses potential explanations for why so many estimates are zero or negative, and Section V discusses further research questions and policy implications.

II. Data and Methods

Data

The data were collected from the 2007 Uttar Pradesh Household Survey, also used in Anagol (2010) and implemented by the Center for Financial Design at the Institute for Financial Management and Research in Chennai. The data were collected for a sample of households in two districts in the state of Uttar Pradesh in northern India: Lakhimpur Kheri and Sitapur.

The districts were split into two geographic regions, a smaller region called the "Ajbapur" area and a larger region called the "non-Ajbapur area". The distinction was relevant for this survey as Ajbapur is the location of a large sugarcane mill, and the survey collected detailed data on water trading among sugarcane farmers. A complete list of villages in the two districts was obtained from the Indian census of 2000, and seventy villages were randomly selected (with probability proportional to size), including twenty from the Ajbapur area and fifty from the non-Ajbapur area. Within each village in Ajbapur, we randomly sampled 10 households from the full village, and an additional 20 households among all households that were identified as selling water in the village in a household listing survey.[3] In non-Ajbapur villages we sampled 20 households randomly from the full village and two households that were identified as jointly owning a borewell in the village.[4,5] All households in the survey, including the water-seller respondents, were asked the same set of questions regarding their dairying behavior.

[3] We sampled a greater number of households that traded water within the Ajbapur area because the survey was also used to study the water trading behavior of households that lived near the sugarcane mill in Ajbapur.

[4] Due to unsatisfactory performance by the initially hired data entry firm, we switched data entry firms and re-entered all of the data. In the process of transferring the hard copies of surveys from the first data entry firm to the second, 11 percent of the original surveys were lost. Among the non-Ajbapur villages, we received 967 of the expected 1100 surveys. Three villages in the original non-Ajbapur sample frame were lost. Among the Ajbapur villages, we received 546 of the expected 585 surveys. We received surveys from all of the villages that were originally included in the Ajbapur sample frame. Overall, we are missing data from eleven percent of households in the original sample frame.

[5] The survey collected a larger number of observations from water sellers in the Ajbapur to study water trading amongst those living close to a sugarcane mill. In the non-Ajbapur area, the survey collected information on two households that jointly owned borewells as baseline information for a potential field experiment on joint ownership of borewells.

The survey asked detailed questions about livestock, farming practices, land holdings, assets, household consumption and income history, savings, borrowing, and shocks. The "animal details" section of the questionnaire (Section E) focused on one randomly chosen dairy animal owned by the household, asking if the animal was a cow or buffalo and other details about the animal.[6] For an adult female dairy animal, the survey asked how many liters of milk were given at different stages of the lactation period, including immediately after giving birth to a calf, three months after giving birth, six months after giving birth and nine months after giving birth. The survey also asked about the number of insemination attempts it would take to impregnate the animal, the number and value of male and female calves born to the animal, the number of dung cakes the animal produces per day, the number of times the animal had visited the veterinarian in the 12 months preceding the survey, the costs associated with these visits, and the costs of feeding the animal (including both purchased and home-produced fodder).

Estimating the Rate of Return

Our equation for the annual rate of return on a cow or buffalo is

$$\text{Rate of return (ROR)} = \frac{(P_t - P_{t-1} + \text{Profit}_t)}{P_{t-1}}$$

where P_t is the price at end of year, P_{t-1} is the price at the beginning of the year, and Profit_t is the profit generated by the animal over the year. We estimate the term $P_t - P_{t-1}$ as the average change in the value of animals that go from the animal's current age in our data to their current age plus one year. We estimate the flow profits (Profit_t) as the revenues from milk, calves and dung minus fodder, veterinary, and insemination costs.

The first calculation we need to perform to estimate the annual return to a dairy animal is how many lactations, on average, the typical animal has per year. Our survey asked households how many calves they expected the sampled dairy animal to have in the rest of its life (having a calf is a necessary and sufficient condition for having a lactation). We take this number and divide it by

[6] The dairy section of the questionnaire (Section D) asked if the household owned any female cows/buffaloes; if so, how many cows/buffaloes the household owned. For each cow or buffalo owned, households were asked to record, beginning with the most valuable cow/buffalo and then proceeding in order of declining value, the animal's breed, and what its selling price would be if the household wanted to sell the animal. The enumerator was then instructed to administer the detailed animal questions (Section E) regarding the animal in this list whose ID number appeared first on a sticker (unique to each survey) which contained a randomized ordering of all the Animal IDs.

an estimate of the number of years we expect the sampled animal to live.[7] For cows, the average number of calves expected per year is 0.89, and for buffaloes the average number of calves expected per year is 0.97. For simplicity, we assume that cows and buffaloes in our sample will produce one calf, and thus have one lactation period, per year.[8]

The annual input and output variables used in the calculations are as follows.

Inputs

1. *Fodder costs:* Dairy animals typically eat more during the time when they are giving milk versus the time when they are dry. For each cow or buffalo in our survey, we have separate estimates for the cost of feeding the animal when it is milking versus dry. We combine this information with previous estimates on the average amount of time Indian dairy animals spend dry versus milking per year. Dry periods for cows and buffaloes in India are estimated to be approximately 160 days per year (Anagol 2010). Since we are estimating returns over a one-year period, assuming a 365-day year implies that milking periods are 205 days per year (roughly seven months). The survey asked how many months the animal will give milk after it gives birth. The average response was seven months (but can go up to 10 months for some animals), which is consistent with the estimated 205 days we use to estimate annual fodder costs. To validate the fodder costs reported by our respondents, we also conduct a robustness test using a different measure of fodder costs developed by the Kisan Fodder Company, a livestock enterprise based in Uttar Pradesh. Kisan provides an estimate of the amount of fodder necessary for an animal to eat to produce a certain amount of milk.[9] We combine their estimates with our data on the amount of milk the animal gives per lactation to estimate the cost of feeding the animal during the year.

[7] We estimate a dairy's animals expected years to live as follows. We first take the observed age distribution of cows above the age of six years old in our sample, and estimate the probability of death at each age based on the proportionate decrease in the number of cows at each age level. We also assume that cows or buffaloes that reach the age of 15 will die in that year, as this is the oldest observed animal we see in our data. Using this estimate of a mortality table for cows, we can estimate an animal's expected to years to live conditional on obtaining its current age. For animals less than six years of age, we assume that they will make it to age six with probability one. We make this assumption as our data contains few observations of animals less than six years old so our estimated mortality table is not accurate for the younger ages.

[8] The assumption of one calf per year is likely an over-estimate, as even dairy cows in the US typically do not birth more than one calf per year on average.

[9] The exact mapping that Kisan Fodder uses between milk production and fodder consumption is described in the Appendix to this paper.

2. *Appreciation and depreciation of dairy animal value:* Consider an animal in our sample that was three years old at the time of our survey. To estimate the change in the value of this capital asset (i.e. $P_t - P_{t-1}$) we assume that this animal's value will change, on average, the same as the difference in value of all four-year-old animals and all three-year-old animals in our sample.
3. *Veterinary costs (costs of examinations and procedures during visits to a veterinarian)*: We have a direct survey question that asks how much the household spent on veterinary costs for the animal over the past year.
4. *Cost of insemination:* This is determined by the number of insemination attempts needed to impregnate the animal multiplied by the cost for one insemination. 78 percent of animals where we collected detailed information were inseminated using a breeding bull, and 13 percent were inseminated using artificial insemination, and 9 percent were inseminated using both methods (the households tried different methods). The survey did not include a direct question on the cost of using natural insemination, so we make the conservative assumption that natural insemination is as expensive as artificial insemination.[10] Insemination services are typically provided by either a government veterinary hospital or an NGO in our survey villages. Our village level survey suggests that the average cost of one insemination by a government hospital was 66 rupees. For an NGO, the corresponding figure was 70 rupees. As we are unable to distinguish between the services provided by the two providers, we assume the price is the average of the two, 68 rupees. Sensitivity analysis shows that the results are unchanged regardless of whether a price of 66, 68 or 70 rupees is used.
5. *Labor costs:* Our survey asked about the number of hours spent caring for animals per day in the household where the sampled animal lives. We estimate the cost per hour of this labor as follows. We observe that children and adults (both men and women) in the household are generally equally responsible for the care of the animal.[11] According to our village level survey, the daily wage rate for an adult (man or woman) is 60 rupees, and the child labor wage rate per day is 25 rupees. In our baseline estimates we thus assume that the cost of

[10] In reality we suspect that natural insemination is cheaper than artificial insemination, as local bulls are typically maintained in villages for insemination purposes. Nonetheless, given the low price of insemination in general it is unlikely our results are driven by measurement error in insemination costs.

[11] We do not know which household members take care of these particular animals. However, the survey asks whether a household has owned any female cows or buffaloes in the past five years and which members of this household are responsible for dairy animals. According to the data, it is common practice for household members (adult males and females as well as children) to share the responsibility of taking care of their cows and buffaloes.

taking care of the dairy animal is 42.5 rupees per day. Assuming an eight hour work day, this gives an hourly labor cost of approximately 5 rupees. [12] The average number of hours spent to tend the animal is 3.5 hours (with a standard deviation of 1.06), with the 25th percentile being 3 hours and the 75th percentile 4 hours. An important point to note is the possibility of multi-tasking when tending the animal. It is possible that the animal is taken out to pasture while the caretaker is doing something else (for example, working on the farm, doing something in the neighboring plot, etc.). Our survey did not ask any direct questions about multi-tasking so we cannot directly assess its importance. We account for the fact that multi-tasking might reduce the effective cost of labor by including return calculations where we assume the value of labor is zero (our "accounting" rates of return).

Outputs

1. *Value of milk*: Our survey asked the following questions to determine the value of milk produced by the animal per lactation. We asked for the number of liters of milk produced during the first three months after birth, from three to six months, from six to nine months, and from nine to ten months. We asked for potentially differing amounts of milk production based on months since birthing, as cows and buffaloes typically give the most milk around four to five months after giving birth and then reduce milk production as the calf switches to solid foods. We multiply the liters per day estimate by the household's response to a survey question on the average price of milk produced by the household.[13] The value of milk produced by the cow/buffalo when it is dry is assumed to be zero.
2. *Value of calves*: Given that we estimate dairy cows and buffaloes have approximately one lactation per year, this implies that they would produce one calf per year (on average). For each cow and buffalo in our sample, the survey asked the respondent to estimate what a new calf of this particular animal would be worth (separately for male and female calves) at the time of birth. Given that male and female calves are equally likely to be born, we take the average value of male and female calves as the expected value of a calf during its first year.

[12] According to The Times of India (2011), the average for the OECD nations is 8 hours a day, slightly below the figure for Indians at 8.1 hours (486 minutes). Accessed online at http://articles.timesofindia.indiatimes.com/2011-04-13/india-business/29413474_1_oecd-countries-cooking-indians-work

[13] The survey did not ask for specific price per liter estimates for each animal in the household as fieldwork during piloting suggested there was not substantial variation in the price per liter of milk within households.

3. *Value of dung cakes*[14]: Our survey asked the respondent to estimate the number of dung cakes the animal produces per day. We combine this information with the estimated value of a dung cake as provided in the village survey (1 rupee per dung cake), to estimate the value of dung cakes produced per year.
4. *Value of adult animal:* Our survey asked what the value of the animal would be if the animal were sold in the near future. This is the value we use to estimate P_t.

III. Estimates

The sample includes 300 cows and 384 buffaloes. Table 1 presents summary statistics of the sources of value and expenditure. Right after giving birth to a calf, a buffalo produces three and a half liters of milk per day, on average, and a cow produces three liters of milk per day, on average. Between three to six months after giving birth, the quantity of milk produced increases by half a liter for buffaloes and one-quarter of a liter for cows. Milk yield then declines between six to nine months after giving birth: buffaloes give three liters per day, and cows two liters per day. After this period, the animals get closer to becoming completely dry, with buffaloes yielding one liter per day and cows one-half of a liter per day. The trend in milk yield over the lactation is illustrated in a bar chart shown in Figure 1 and the distribution of milk produced per day is shown in Figure 2.

Table 1 shows that there are no differences between cows and buffaloes with regard to the remaining inputs: labor hours, veterinary expenses, and insemination expenses. A typical animal visits the veterinarian once per year. Four labor hours are spent each day tending the animal; and it takes two insemination attempts to get it pregnant during a 12-month cycle. On average, the animal produces four units of dung cakes per day.

Our estimates of the accounting profits to owning a cow or buffalo (i.e., labor valued at zero) are presented in Table 2a-d. In Table 2a the top row shows the mean values of inputs and outputs, total costs, profits, and rates of return for the cows whose rates of return fall within the top

[14] Cow dung can be used in several ways. First, dung cakes are a source of domestic fuel in many rural households in India (Aggarwal and Singh 1984). Second, dung is often used as agricultural fertilizer (Aggarwal and Singh 1984). Third, due to its insect repellent properties for some types of insects (such as mosquitoes), dung is used to line the floor and walls of buildings (Mandavgane, Pattalwar, and Kalambe 2005). Dung is therefore important, allowing households to save money that would otherwise be spent on alternatives such as firewood, fertilizer and insecticides.

twenty percent of rates of return overall; the next row shows the mean values of inputs and outputs for cows whose rates of return fall between the 20th and 40th percentile. The second panel shows the same calculations for our sample of buffaloes.

The results in Tables 2a show negative accounting profits (-6%) for cows, and positive profits (13%) for buffaloes. A Mann-Whitney test indicates that the difference between the two means is statistically significant at 1%. The tables also show the distribution of returns for both cow and buffaloes. There is substantial variation in the calculated rates of return across our groups, and thus it is important to determine to what extent our mean estimates of rates of return are influenced by outliers.

The quintile based mean estimates show that the adult value of animals (Column C) and value of fodder costs (Column F) have the most substantial amount of variation across the quintiles and therefore may be driving a lot of the variation in rates of return. We now evaluate how sensitive our mean estimates of rates of return are to outliers in the adult value of animals and fodder costs.

Table 2b presents estimates of the accounting returns to owning cows and buffaloes assuming all cows/buffaloes had an adult value equal to the median adult value in the data. Replacing a cow's/ buffalo's survey-based adult value with the median value in the data mechanically removes any outliers on adult values. The results remain similar for cows (the rate of return is -9% on average), but higher returns are obtained for buffaloes (about 20% on average).

Table 2c examines the sensitivity of our mean estimate of returns to fodder costs. This table is the same as Table 2a, except now for each animal we replace the household's estimate of fodder costs with our estimate of the animal's fodder cost based on the amounts of fodder recommended by the Kisan fodder company. Given that the Kisan fodder company uses a simple linear formula for fodder based on the liters of milk an animal gives, this will mechanically remove any major outliers in the household's estimates of fodder costs. We find that, overall, cows earn an average rate of return of 15% per year and buffaloes earn an average return of 5% per year.

Table 2d reports our estimates after both adjusting for outliers in the mean values of animals (as in Table 2b) as well as adjusting for outliers in fodder costs (as in Table 2c). After removing these outliers, we find that cows have an average return of 21% per year and buffaloes have an average return of 7% per year.

The annual interest rate paid to saving accounts by many formal banks in India ranges between 4-10%. As another point of comparison, the nominal yield on ten-year Indian government bonds in 2007 (the year of our survey) was 8.5% (Campbell, Ramadorai, and Ranish 2012). Accounting profits from the Kisan calculation suggest that the rate of return from cows and buffaloes are not substantially higher than these low risk financial assets. For cows our return estimates range from -9% to %21, and for buffaloes our estimates range from -38 percent to 20 percent. While both of these ranges include returns that are higher than formal savings products, it is important to note that these ranges are calculated *before* we include the cost of any labor spent on caring for animals or adjust for the fact that livestock investments are likely more risky than formal financial products (livestock can get sick, die or have problems getting pregnant). Given that labor costs and animal risk are likely to reduce the real returns experienced by households, we argue that it is unlikely that livestock investments offer better returns than formal savings products.

In Tables 3a, 3b, 3c, and 3d we explore the possible impact of labor costs on the estimated returns to Indian dairy animals. As expected, including labor costs drives all of our return estimates to be negative, with the average return to a cow equal to -64% and to a buffalo equal to -39% when calculated with self-reported fodder costs and using the mean animal values (Table 3a). These large and negative results remain when we adjust for outliers in animal values (Table 3b), adjust for outliers in fodder costs (Table 3c), and when we adjust for both outliers in animal values and fodder costs (Table 3d). While we do not have panel data to allow us to estimate the impact of animal risk on returns, we believe that incorporating animal risk in to our return estimates would also lead to low returns relative to formal savings products. Overall, these results raise an important question: if these estimates are correct and cows and buffaloes are not economically profitable, why do households hold onto these animals instead of selling them?

IV. Potential Explanations

1. Measurement Error

The first explanation of our finding is the simplest: our data or assumptions on production of cows are wrong. Our estimates ultimately rely on household self-reports on the costs and revenues of dairy animal production, and so if households misstate revenues or costs our findings of low returns might not reflect true returns. Indeed, in Sri Lanka, de Mel, McKenzie, and Woodruff (2009a) find that firms systematically under-report revenues by about 30% and over-report costs. They conclude that simply asking firms how much profit they make provides a more accurate measure of profits than detailed questions on revenues and expenses.

Previous work in labor economics has found that workers in formal employment settings typically do over-state the amount of hours worked (Bound et al. 1994; Carstensen and Woltman 1979; Duncan and Hill 1985; Hamermesh 1990; Mellow and Sider 1983; Robinson and Bostrom 1994; Stafford and Duncan 1977). Nonetheless, the fact that we find modest average returns even when we assume that labor costs are zero suggest that over-stating the amount of time spent on dairying is not the sole driver for our low estimated returns.

2. Preference for Home -Produced Milk

Anecdotal evidence suggests that Indian households believe, and perhaps rightly so, that home produced milk is of higher quality than purchased milk. Reuters (2012) recently reported that much of the country's milk is either diluted or contaminated with chemicals, including bleach, fertilizer or detergents. A government survey also found that 68.4% of milk sold in India does not meet basic health standards (FSSAI 2011). This implies that households may value home-produced milk at a rate higher than the market value, and therefore may be willing to receive low financial returns on dairy investments in exchange for the guarantee of having high quality milk available for household consumption. Consistent with this hypothesis, we find that only 12% of our sample households actually sold milk in the past year.[15] If the value of self-produced milk was 20% higher than the market price, the average accounting return to cows would rise from negative 6% to a positive 10%.[16]

3. Preference for Illiquid Savings

[15] There are other potential explanations for why so few households sell milk. Another plausible explanation is that there is limited external demand for the milk produced in our sample villages; only 23% of our sample villages are visited by milk buyers, and only 8% have a milk cooperative.

[16] If further evidence showed that households primarily hold low return cows as a way to guarantee clean milk supply, then inspection policies or business innovations (i.e., quality verification markets) that reveal the hidden information in milk markets could be welfare enhancing.

In developing countries, low-income individuals and small businesses are generally excluded from conventional financial institutions (Rutherford 2000). de Mel, McKenzie, and Woodruff (2009b) document that few poor households have formal savings accounts. However, as Rutherford (2000) emphasizes, low income households do typically have some savings. This has led to the proliferation of a variety of forms of semiformal or informal savings channels, including deposit collectors,[17] savings clubs, postal accounts, accumulating savings and credit associations (ASCAs), rotating savings and credit associations (ROSCAs), or saving at home. These savings channels may help to meet the needs of the poor by offering convenient services in their neighborhoods (as in the case of deposit collectors), allowing them access to loans (ASCAs and ROSCAs), and providing them with incentives to save (in the form of the social pressure present in savings clubs, ROSCAs and ASCAs).

However, there are also disadvantages associated with these types of informal savings. The use of deposit collectors entails a negative interest rate. Interpersonal conflict or lack of trust may inhibit the creation of savings clubs, ROSCAs and ASCAs, and keeping money in the home offers no shield against inflation, and may lead to temptation spending. In the face of these shortcomings, households may find it desirable to save a portion of their income close to home in illiquid assets such as livestock, even if the returns to this means of saving are low, or even negative.

4. Labor Market Failures: True Value of Marginal Time is Zero

If labor markets are missing or imperfect, particularly for women[18], then the true opportunity cost of labor may actually be zero or close to zero (Basu 1997; Dasgupta 1993; Bardhan 1984; Mammen and Paxson 2000). In many locations, the formal labor market for women is essentially non-existent (Emran and Stiglitz 2006). Mammen and Paxson (2000) note that "there may be costs associated with women working outside of the domain of the family farm or non-farm family enterprise. Custom and social norms may also limit the ability of women to accept paid employment, especially in manual jobs. Further, off-farm jobs may be less compatible with child rearing, creating fixed costs of working off-farm" (p. 143). This implies that the household

[17] In West Africa *susu* (deposit) collectors are paid up to 40% interest for providing a means of saving for rural households (Rutherford, 2000).
[18] For about half the households analyzed, women are responsible for tending the animals.

optimization treats the female labor endowment as effectively non-traded. One would expect that as the costs of women's time increases as they enter the workforce, the opportunity cost of tending a cow would also rise. However, if there are no opportunities for people to enter the workforce, then the opportunity cost of raising an animal is effectively zero, or at best the value of other home production opportunities.[19]

5. Preference for Positive Skewness in Returns

Garrett and Sobel (1999) document theoretical and empirical evidence that positive skewness of prize distributions explains why risk averse individuals may play the lottery. Similarly, skewness of returns distributions may explain why people may hold female cows and buffaloes, given that there is a small probability of making huge profits, although on average the animals yield negative economic returns. Our estimates provide evidence for positive skewness in returns. For example, Table 2a shows that the top 20% cows and buffaloes generated huge profits of 378% and 322%, respectively. At the same time, the bottom 40% of cows and buffaloes make substantial losses. This is consistent with the model of learning and types of enterprise presented in Karlan, Knight, and Udry (2012), which predicts that a majority of entrepreneurs will have low marginal returns to capital as they are not capable of running a larger business, but that a small proportion of entrepreneurs may have the skills to run large firms profitably.

6. Social and Religious Value

In Hinduism, the cow is a symbol of wealth, strength, abundance, selfless giving and a full earthly life.[20] As almost all the sampled households reported that they were Hindu, they may also derive spiritual returns from cattle ownership. The foregone returns compared to their next best investment alternative would effectively be the cost of religiosity in this context. This of course does not explain the results for buffaloes. It also requires believing that the long term social evolution of a religion could find an equilibrium in which individuals worship a loss-inducing investment; most economic models of religion predict that customs derived from religion are either beneficial or strengthen the group, and this seems to do neither (Bainbridge and Iannaccone 2010).

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[19] Based on the traditional assumption made in the literature that the value of an individual's time spent in any activity is equal to his or her wage rate.

[20] For a general review of the debate on why cows evolved to become holy in Hinduism see Korom (2000).

V. Further Research Questions and Policy Implications

Our goal here is not to determine conclusively why Indian households invest in cows and buffaloes despite the fact that economic returns to such investments seem to be frequently negative. Our goal, rather, is put forward a puzzle, with the aim to motivate either better data, or better understanding of these markets or behavioral decisions, in order to explain the puzzle. With a better understanding of the driving market or behavioral failures, if any, one can then focus policies on specific market problems.

Evidence suggests that the poor are often willing to earn negative interest in order to access reliable saving services (see Dupas and Robinson (2012) for evidence on savings accounts with negative interest rates in Kenya and Rutherford (2000) for deposit collectors in west Africa). If livestock ownership is seen as a form of savings, the observed negative returns to cows and buffalo provide additional evidence of the high demand for savings, and perhaps specifically for illiquid savings in order to avoid temptation spending. The question then turns to the supply side of savings: what are the constraints on the supply side that make cows and buffalos better savings alternatives than what banks offer? With technological innovations such as mobile money, the transaction costs are plummeting for offering deposit accounts to consumers in developing countries, even in highly rural areas. Thus this is an area where improvements in ability to store cash outside of the home may lead to more efficient allocation of capital, away from risky or low return home investments. If the introduction of high quality savings accounts leads to a reduction in cow and buffalo ownership, this would be evidence for the commitment to save explanations discussed above.

If indeed, as we find, owning cows yields low or negative returns, this is of critical importance for NGO and government programs that promote investment in cows with an aim of poverty alleviation. In particular, the results here are critical for programs that engage in livestock grants to help households start or expand income generating activity from raising livestock (this is common amongst "graduation" programs, cited earlier, as well as many NGOs, such as Heifer International or other livestock grant programs). Our results suggest that merely transferring an asset alone may not be sufficient to generate higher income (beyond the value of the transferred asset). The heterogeneity in returns we observe may of course be due to heterogeneity in skills and knowledge on how to raise dairy animals profitably; this suggests potential for training and monitoring to improve the returns for households.

Our results are also consistent with the finding in de Mel, McKenzie, and Woodruff (2009b) that female owned enterprises in Sri Lanka have a marginal return to capital equal to zero. Fafchamps et al. (2011) also find that the returns to capital are equal to zero for female enterprises with less than the median level of profits prior to the capital infusion. Given that in our context the maintenance of dairy animals is managed by the women and children of the household, a similar mechanism or failure may drive the results in both our analysis and that of de Mel, McKenzie, and Woodruff (2009b) and Fafchamps et al. (2011)

Looking beyond cattle ownership, future research should analyze the returns from other assets, such as trees, tubers and small livestock (Undurragaa et al. 2013). Anecdotal evidence suggests that a variety of low-performing assets are commonly held across the developing world, but more systematic analysis across countries and asset types, and with a focus on unpacking the mechanisms driving ownership and returns of such assets, would further our understanding of household finance for the poor.

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Table 1 – Summary Statistics
Mean
(Standard deviation)

	Buffaloes (N=384)	Cows (N=300)
Average liters of milk per day: 0-3 months after giving birth	3.57 (1.27)	2.86 (1.23)
Average liters of milk per day: 3-6 months after giving birth	4.09 (1.41)	3.26 (1.39)
Average liters of milk per day: 6-9 months after giving birth	2.95 (1.21)	2.22 (1.07)
Average liters of milk per day: 9-10 months after giving birth	0.85 (1.06)	0.46 (0.82)
Average liters of milk per day for the whole lactation period	3.27 (0.98)	2.54 (0.98)
Average units of dung cakes produced per day	4.98 (2.02)	4.19 (1.80)
Average labor hours per day	3.55 (1.06)	3.52 (1.05)
Average insemination attempts per year	1.52 (1.43)	1.57 (1.42)
Average number of times the animal visits the Veterinarian per year	0.90 (1.02)	0.82 (0.92)

Table 2a – Accounting Profits:

(Mean values for all variables)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Total Cost **J = F+G+H**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginning of year **M=C-K**	Rate of Return (%) **N = (K+L)/M**
Cows													
Top 20%	9050	1085	3235	1570	11705	6033	135	76	6243	1414	5462	1821	377.61
Top 40%	8935	1036	6314	1527	11498	6812	128	91	7031	1071	4467	5243	105.61
Middle 20%	7500	1018	17665	1655	10172	10240	237	120	10597	742	-425	16923	1.87
Bottom 40%	6428	898	8004	1466	8792	14319	105	115	14540	-1452	-5748	9455	-76.14
Bottom 20%	6330	813	4542	1460	8603	16460	107	113	16680	-2159	-8078	6701	-152.76
All	7645	977	9260	1528	10150	10500	141	107	10748	-4	-597	9264	-6.49
Buffaloes													
Top 20%	10930	1284	2361	1887	14102	5180	215	94	5489	-239	8613	2600	322.09
Top 40%	10718	1274	4423	1930	13921	5932	190	103	6225	-119	7696	4542	166.82
Middle 20%	10011	1114	15328	1782	12907	8152	111	98	8360	-287	4547	15615	27.28
Bottom 40%	8797	1225	13817	1728	11750	18310	177	106	18593	565	-6843	13252	-47.37
Bottom 20%	8199	1166	9958	1723	11088	23223	208	114	23546	899	-12458	9059	-127.60
All	9802	1222	10373	1819	12844	11368	169	103	11640	124	1204	10249	12.96

Notes: Each row presents the average value of the variable given in the Column for a given rate of return quintile. All values are Indian rupees.

Table 2b – Accounting Profits:
(Mean values, except adult value fixed at the median)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Total Cost **J = F+G+H**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginning of year **M=C-K**	Rate of Return (%) **N = (K+L)/M**
Cows													
Top 20%	9580	1149	6600	1618	12347	5627	123	83	5832	1633	6515	4967	164.07
Top 40%	8795	1085	6600	1560	11441	6620	142	88	6851	1241	4590	5359	108.81
Middle 20%	7955	934	6600	1448	10337	9609	110	130	9849	-308	488	6908	2.60
Bottom 40%	6340	891	6600	1536	8767	14826	156	113	15094	-1097	-6327	7697	-96.46
Bottom 20%	5875	858	6600	1612	8345	17809	230	118	18157	-1602	-9812	8202	-139.16
All	7645	977	6600	1528	10150	10500	141	107	10748	-4	-597	6604	-9.10
Buffaloes													
Top 20%	12288	1354	6900	1887	15530	4533	178	86	4797	-285	10732	7185	145.41
Top 40%	11208	1239	6900	1920	14367	5452	198	97	5747	-374	8620	7274	113.35
Middle 20%	9225	1312	6900	1782	12319	9202	97	101	9400	463	2919	6437	52.54
Bottom 40%	8698	1163	6900	1738	11599	18269	176	110	18555	449	-6956	6451	-100.87
Bottom 20%	8028	1137	6900	1714	10879	23558	180	113	23851	1158	-12972	5742	-205.76
All	9802	1222	6900	1819	12844	11368	169	103	11640	124	1204	6776	19.60

Notes: Each row presents the average value of the variable given in the Column for a given rate of return quintile.

Table 2c – Accounting Profits:

(Mean values, fodder costs using Kisan estimates)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Total Cost **J = F+G+H**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginning of year **M=C-K**	Rate of Return (%) **N = (K+L)/M**
Cows													
Top 20%	9075	1154	3223	1612	11841	9105	179	80	9364	3002	2477	222	2473.42
Top 40%	8845	1098	5626	1573	11515	9013	123	86	9221	2444	2294	3182	148.93
Middle 20%	7690	1054	18322	1466	10210	8551	108	104	8764	1029	1447	17293	14.31
Bottom 40%	6423	818	8364	1515	8756	8044	176	129	8348	-2968	407	11332	-22.60
Bottom 20%	5965	712	3322	1381	8058	7861	118	144	8123	-3610	-65	6932	-53.01
All	7645	977	9260	1528	10150	8533	141	107	8780	-4	1370	9264	14.75
Buffaloes													
Top 20%	12474	1668	3880	2075	16216	13537	193	66	13797	-69	2420	3949	59.53
Top 40%	11898	1483	7044	2056	15437	13249	139	77	13465	234	1972	6811	32.38
Middle 20%	10157	1217	18770	1830	13203	12378	136	89	12603	107	601	18663	3.79
Bottom 40%	7560	968	9542	1580	10108	11080	215	136	11431	24	-1323	9517	-13.64
Bottom 20%	7322	907	4361	1520	9749	10961	271	144	11375	-70	-1627	4431	-38.29
All	9802	1222	10373	1819	12844	12201	169	103	12473	124	371	10249	4.83

Notes: Animals are sorted in order of decreasing rate of return, ROR (.i.e. top ones are those with the highest ROR, etc.).

Table 2d – Accounting Profits:

(Mean values, except adult value fixed at the median and fodder costs using Kisan estimates)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Total Cost **J = F+G+H**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginning of year **M=C-K**	Rate of Return (%) **N = (K+L)/M**
Cows													
Top 20%	9480	1310	6600	1618	12408	9267	133	76	9476	3911	2932	2690	254.42
Top 40%	8828	1133	6600	1576	11536	9006	114	84	9204	2897	2332	3703	141.24
Middle 20%	7570	962	6600	1454	9986	8503	129	110	8742	260	1244	6340	23.72
Bottom 40%	6500	829	6600	1518	8847	8075	174	128	8376	-3037	471	9637	-26.63
Bottom 20%	5395	715	6600	1424	7534	7633	124	136	7893	-3753	-360	10353	-39.73
All	7645	977	6600	1528	10150	8533	141	107	8780	-4	1370	6604	20.69
Buffaloes													
Top 20%	13480	1570	6900	2228	17279	14040	154	58	14253	512	3026	6388	55.39
Top 40%	12092	1530	6900	2040	15662	13346	133	65	13545	243	2117	6657	35.46
Middle 20%	9774	1155	6900	1844	12773	12187	144	115	12446	65	327	6835	5.74
Bottom 40%	7556	952	6900	1590	10097	11078	216	135	11430	35	-1332	6865	-18.89
Bottom 20%	6813	838	6900	1603	9254	10706	324	139	11169	340	-1915	6560	-24.02
All	9802	1222	6900	1819	12844	12201	169	103	12473	124	371	6776	7.30

Notes: Animals are sorted in order of decreasing rate of return, ROR (.i.e. top ones are those with the highest ROR, etc.).

Table 3a – Economic Analysis: Labor Costs included

Regular calculation (Mean values)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Labor cost **I**	Total Cost **J = F+G+H +I**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginnin g of year **M=C-K**	Rate of Return (%) **N = (K+L)/ M**
Cows														
Top 20%	9645	1176	9935	1563	12384	6022	148	73	4450	10692	1613	1692	8322	39.72
Top 40%	8418	1082	12410	1597	11096	7590	185	92	4675	12542	1668	-1446	10742	2.06
Middle 20%	7335	1008	12333	1545	9889	11072	124	108	5575	16878	-504	-6989	12837	-58.37
Bottom 40%	7028	858	4574	1451	9336	13125	105	120	5750	19101	-1426	-9765	5999	-186.53
Bottom 20%	6460	819	2334	1411	8691	13670	106	129	5825	19730	-2182	-11040	4516	-292.78
All	7645	977	9260	1528	10150	10500	141	107	5285	16033	-4	-5882	9264	-63.54
Buffaloes														
Top 20%	11424	1334	3532	1806	14564	4575	194	89	4974	9833	-383	4731	3915	111.07
Top 40%	11157	1284	10242	1889	14330	5680	165	95	5039	10979	-271	3351	10513	29.30
Middle 20%	9561	1263	14927	1806	12629	10379	180	102	5309	15971	-278	-3341	15205	-23.80
Bottom 40%	8584	1142	8270	1757	11482	17467	167	112	5603	23349	711	-11867	7559	-147.59
Bottom 20%	8282	1201	6067	1709	11193	20388	161	122	5772	26443	720	-15250	5347	-271.75
All	9802	1222	10373	1819	12844	11368	169	103	5320	16960	124	-4116	10249	-38.95

Notes: Animals are sorted in order of decreasing rate of return, ROR (.i.e. top ones are those with the highest ROR, etc.).

Table 3b – Economic Analysis:
Labor included
Regular calculation (Mean values, except adult value fixed at the median)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Labor cost **I**	Total Cost **J = F+G+H +I**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginnin g of year **M=C-K**	Rate of Return (%) **N = (K+L)/ M**
Cows														
Top 20%	9645	1176	6600	1563	12384	6022	148	73	4450	10692	1613	1692	4987	66.28
Top 40%	8653	1083	6600	1560	11296	6777	135	93	4775	11780	1335	-483	5265	16.17
Middle 20%	8180	923	6600	1430	10533	10015	112	125	5425	15677	-22	-5144	6622	-78.01
Bottom 40%	6370	898	6600	1545	8814	14467	161	111	5725	20464	-1334	-11650	7934	-163.66
Bottom 20%	5925	835	6600	1576	8336	17899	229	126	5925	24179	-1262	-15843	7862	-217.58
All	7645	977	6600	1528	10150	10500	141	107	5285	16033	-4	-5882	6604	-89.13
Buffaloes														
Top 20%	12008	1264	6900	1916	15188	4547	174	93	5013	9827	-465	5361	7365	66.47
Top 40%	11133	1275	6900	1899	14308	5594	185	96	5078	10953	-234	3355	7134	43.75
Middle 20%	9612	1142	6900	1878	12632	9536	124	98	4895	14652	-482	-2020	7382	-33.89
Bottom 40%	8582	1209	6900	1712	11503	17965	176	113	5768	24022	774	-12519	6126	-191.72
Bottom 20%	7986	1157	6900	1654	10797	23308	160	113	6076	29657	1218	-18860	5682	-310.47
All	9802	1222	6900	1819	12844	11368	169	103	5320	16960	124	-4116	6776	-58.92

Notes: Animals are sorted in order of decreasing rate of return, ROR (.i.e. top ones are those with the highest ROR, etc.).

Table 3c – Economic Analysis:
Labor included

(Mean values, fodder costs using Kisan estimates)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Labor cost **I**	Total Cost **J = F+G+H +I**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginnin g of year **M=C-K**	Rate of Return (%) **N = (K+L)/ M**
Cows														
Top 20%	9275	1232	11632	1624	12131	9185	111	85	4175	13556	3592	-1425	8039	26.95
Top 40%	8658	1146	14038	1566	11370	8938	190	84	4875	14087	2547	-2717	11491	-1.48
Middle 20%	7235	1009	10957	1472	9716	8369	67	109	5050	13595	-1130	-3878	12086	-41.44
Bottom 40%	6838	793	3635	1518	9148	8210	129	128	5813	14279	-1992	-5131	5626	-126.61
Bottom 20%	6565	796	1917	1393	8754	8101	124	136	5900	14261	-2591	-5507	4508	-179.63
All	7645	977	9260	1528	10150	8533	141	107	5285	14065	-4	-3915	9264	-42.30
Buffaloes														
Top 20%	11795	1420	21896	1993	15208	13197	157	68	4421	17844	180	-2636	21716	-11.31
Top 40%	10631	1329	18513	1937	13898	12616	150	88	4951	17804	384	-3907	18129	-19.43
Middle 20%	9561	1188	8564	1811	12559	12080	211	115	5447	17853	-145	-5293	8710	-62.44
Bottom 40%	9103	1134	3225	1707	11944	11851	168	113	5623	17754	-1	-5810	3226	-180.15
Bottom 20%	8897	1139	2084	1709	11746	11749	220	128	5962	18059	122	-6313	1962	-315.56
All	9802	1222	10373	1819	12844	12201	169	103	5320	17794	124	-4950	10249	-47.08

Notes: Animals are sorted in order of decreasing rate of return, ROR (.i.e. top ones are those with the highest ROR, etc.).

Table 3d – Economic Analysis:
Labor included

(Mean values, except adult value fixed at the median and fodder costs using Kisan estimates)

	Milk Value **A**	Calf Value **B**	Value of adult animal at end of year **C**	Dung Value **D**	Total Revenue **E = A+B+D**	Fodder Cost **F**	Veterinary Cost **G**	Insem-ination Cost **H**	Labor cost **I**	Total Cost **J = F+G+H +I**	Change in value of animal **K**	Profits **L = E-J**	Value of adult animal at beginning of year **M=C-K**	Rate of Return (%) **N = (K+L)/ M**
Cows														
Top 20%	9285	1213	6600	1630	12129	9189	108	87	4225	13609	3655	-1481	2945	73.84
Top 40%	8840	1154	6600	1527	11521	9011	111	83	4663	13867	2632	-2346	3968	7.20
Middle 20%	7745	920	6600	1545	10210	8573	122	107	5575	14377	202	-4166	6398	-61.96
Bottom 40%	6400	829	6600	1521	8750	8035	180	130	5763	14108	-2743	-5358	9343	-86.71
Bottom 20%	5545	744	6600	1515	7804	7693	146	135	5950	13924	-3656	-6120	10256	-95.32
All	7645	977	6600	1528	10150	8533	141	107	5285	14065	-4	-3915	6604	-59.34
Buffaloes														
Top 20%	12328	1542	6900	2214	16084	13464	195	84	3711	17453	563	-1370	6337	-12.73
Top 40%	11445	1421	6900	2030	14897	13023	147	85	4235	17490	67	-2593	6833	-36.97
Middle 20%	9939	1311	6900	1796	13046	12270	137	85	5605	18097	-116	-5051	7016	-73.64
Bottom 40%	8114	983	6900	1622	10719	11357	207	130	6252	17945	297	-7226	6603	-104.94
Bottom 20%	7337	901	6900	1594	9831	10968	287	139	6684	18078	363	-8246	6537	-120.60
All	9802	1222	6900	1819	12844	12201	169	103	5320	17794	124	-4950	6776	-71.22

Notes: Animals are sorted in order of decreasing rate of return, ROR (.i.e. top ones are those with the highest ROR, etc.).

Figure 1: Trend of milk produced per day at different stages of lactation

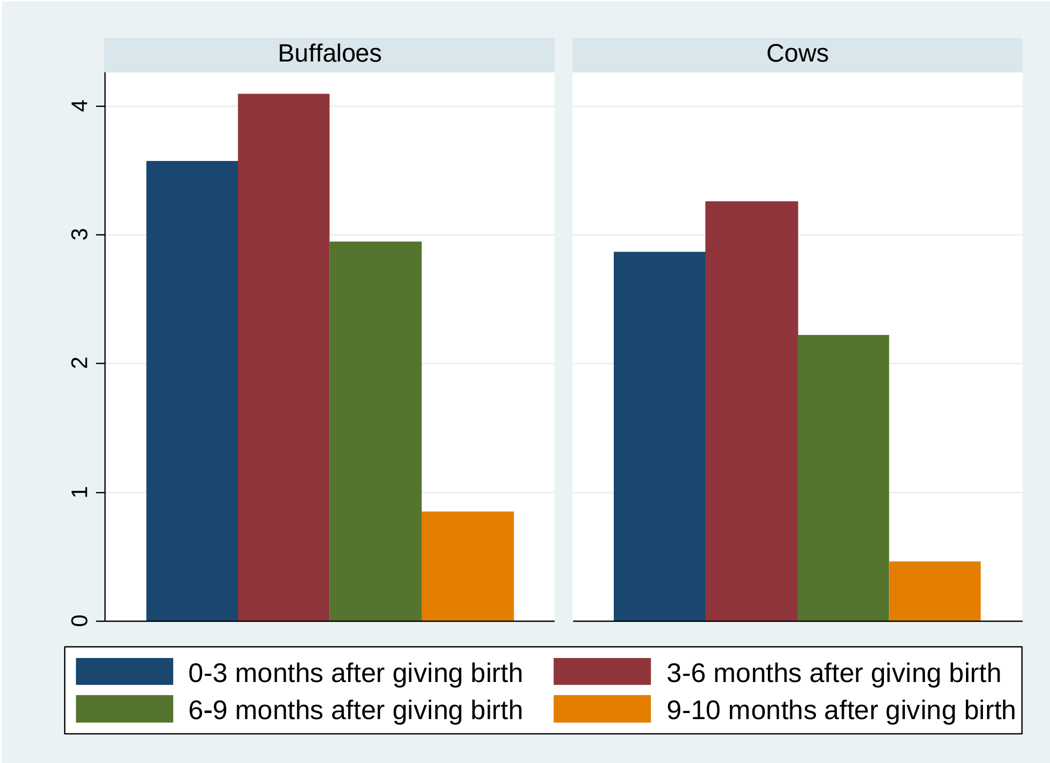
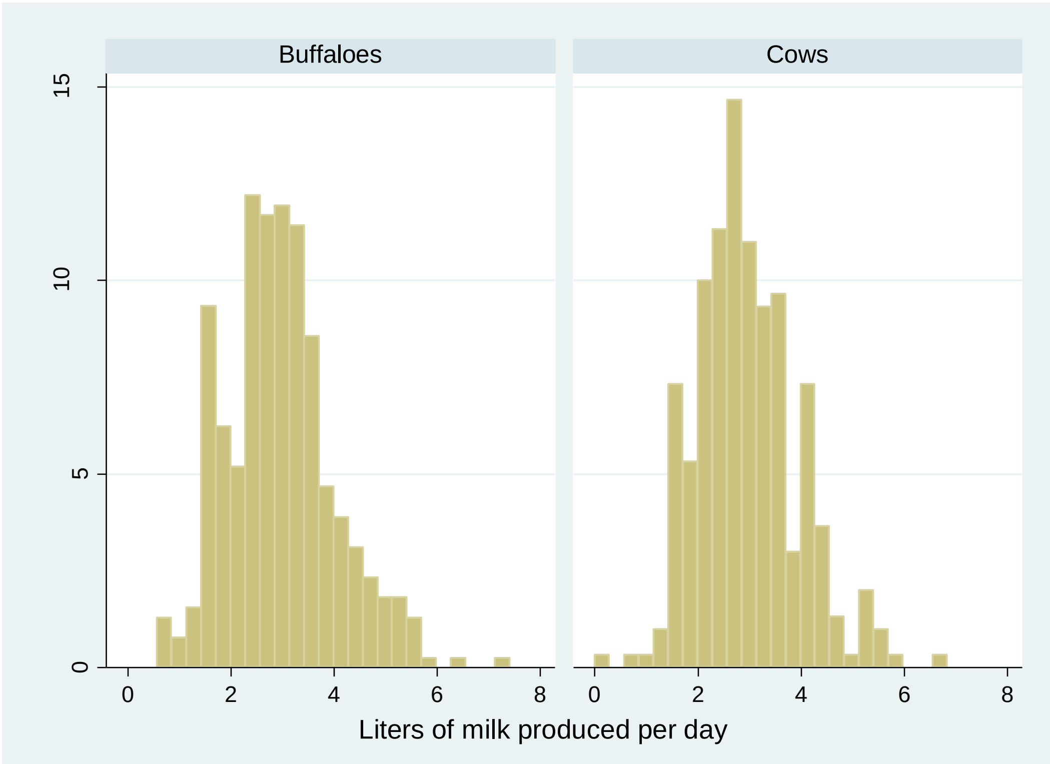


Figure 2: Distribution of liters of milk produced per day (averaged across 10 months)



Appendix

Fodder Costs Based on Kisan Fodder Company

According to the Kisan Fodder Company, the more milk an animal produces the more food it consumes and hence, the higher the fodder costs. This implies that every animal incurs some fodder costs. The Kisan way of cattle feeding is as follows[21]:

(i) cows, 1.5kg for body maintenance and 1kg food for each 2.5kg of milk.

(ii) buffaloes, 2kg for body maintenance and 1kg food for each 2kg of milk.

Calculation of fodder costs using Kisan numbers:

1 kg of milk = 1 liter of milk

1kg of food = 10 rupees (Financial Express, 2010)

Cow = [1.5kg × 10 rupees × 365days]+[total milk produced in 300 days/2.5kg × 1kg × 10 rupees]

Buffalo = [2kg × 10 rupees × 365days]+[total milk produced in 300 days/2kg × 1kg × 10 rupees]

[21] Kisan Fodder Mill: Accessed online at http://www.eindiabusiness.com/kisanfoddermill/. Accessed on March 15, 2012.