

## **Livestock, Women, and Child Nutrition in Rural India**

**Jaya Jumrani\* and P.S. Birthal**

ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi – 110 012

### **Abstract**

The importance of women in livestock production is though widely acclaimed, the issues relating to their control over income from livestock activities and its outcomes on children's health, nutrition and education have not received much attention in the empirical literature. This paper assesses the role of livestock in improving women's bargaining power in intra-household resource allocation and its effects on children's nutritional status using the India Human Development Survey (IHDS) data of 26,734 rural households for 2004-05. The study finds that both males and females participate in animal husbandry, but with an additional illiterate female worker a household realizes more than 7 per cent higher income from livestock activities. The paper finds evidence that nutritional outcomes might be affected by livestock ownership in rural India, although with differing patterns across age groups of children. A strong association is observed between ownership of large ruminants and child nutritional status, specifically on the probability of being underweight (limited to children between 2 and 5 years of age). Further, these nutritional outcomes are affected by an interplay of various factors such as child and parental characteristics, dwelling characteristics, etc. The study suggests that it is now critical to put on a gendered lens to all the livestock-related interventions and activities. Such interventions would help in directly enhancing the diet quality of the household members besides providing more livelihood opportunities and enhanced incomes.

**Key words:** Livestock, women empowerment, nutritional outcomes, rural India

**JEL Classification:** I15, J16, Q1, Q18

### **Introduction**

Livestock have considerable potential to contribute towards improving food and nutritional security, enhancing agricultural growth, reducing rural poverty and mitigating farm households' vulnerability to production shocks (Ashley *et al.*, 1999, Pica-Ciamarra, 2005, Akter *et al.*, 2008, Kristjanson *et al.*, 2010, Alary *et al.*, 2011, Birthal and Negi, 2012). Besides, they could also be one of the pathways of reducing gender disparities in the countries where land ownership is often biased in favour of men. Livestock are the assets not bound by any property rights, and can be owned and used by women to consolidate their bargaining

power in intra-household resource allocation decisions. Duflo (2003) and Villa *et al.* (2010) argue that as women are mainly responsible for household welfare; their stronger bargaining power may lead them to spend more on nutrition, health and education of children. From an empirical study in Bangladesh, Das *et al.* (2013) find that a greater contribution of women to household income leads to better nutritional outcomes for children.

Livestock have some unique characteristics which make them a desirable component of the strategies targeting women empowerment and children's welfare. Livestock can be easily acquired with a small initial investment and being a reproductive asset these can be multiplied to accumulate wealth and savings (Alary *et al.*, 2011). They also generate a range of products

---

\* Author for correspondence  
Email: jumrani@ncap.res.in

and services, almost on a continuous basis, and the earnings from their sales can be utilized to meet households' daily consumption needs and other expenditures. Further, livestock production is less prone to external shocks such as droughts and floods (BIRTHAL and NEGI, 2012), and therefore, they serve as a form of self-insurance for farm households (Barrett *et al.*, 2001). Moreover, in mixed farming systems, livestock are largely raised on low-value crop residues or by-products and common grazing lands, and thus livestock production is relatively less expensive.

Livestock can impact a household's nutritional status via the family member who controls the income generated from livestock activities. Okike *et al.* (2005) and Ayele and Peacock (2003) have reported that in Africa, ownership of livestock by women could lead to higher consumption of animal products. And, also higher income from the sale of animal products enabled the households to improve their dietary diversity and children's health and nutritional status. In another study from Ethiopia (Hoddinott *et al.*, 2014), cow ownership has been reported to improve children's milk consumption and reduce their stunting rates. Malapit *et al.* (2013) have found improved maternal and child nutrition in the Nepalese households where women had a control over income from livestock production.

In India, livestock are mainly raised as a component of mixed farming systems and they produce outputs worth 30 per cent of the agricultural gross domestic product utilizing largely female workforce — approximately three-fourths of the labour required in livestock production is contributed by women (BIRTHAL and TANEJA, 2012). Though the importance of women in livestock production is widely acclaimed, the issues relating to their control over income from livestock activities and its outcomes on children's health, nutrition and education have not received much attention in the empirical literature.

In this paper, making use of household-level data, we empirically assess the role of livestock in improving women's bargaining power in intra-household resource allocation and its impacts on children's nutritional status. We hypothesize that (i) if women have a greater engagement in livestock production, then there should be a strong positive relationship between the number of adult women workers in a household and the ownership of livestock; and (ii) if (i) holds, then the

number of women in a household should positively influence the household income, which in turn should lead to an improvement in their children's nutritional outcomes.

This paper adds to the literature on the relationship between livestock, women empowerment and child nutrition. This issue to the best of our knowledge has not been put to a rigorous empirical analysis, especially in the context of developing countries such as India where women are the main suppliers of labour for livestock rearing and management. The available evidence is scanty and anecdotal, largely based on observations and perceptions.

## Data

To study the inter-relationships between livestock, women empowerment and child nutrition, we have used data from a nationally representative survey 'India Human Development Survey (IHDS)' conducted jointly by the University of Maryland (USA), and the National Council of Applied Economic Research (NCAER), New Delhi (India) in 2004-05 (<http://www.ihds.umd.edu/>). Our analysis focuses only on rural households that control about 95 per cent of the livestock population of any of the species (BIRTHAL *et al.*, 2006). The rural sample in IHDS survey comprises 26,734 households spread over 1503 villages across the country, with an average of about 18 households per village.

The survey contains comprehensive information on multiple aspects of rural economy. It contains information on households' income sources, consumption patterns, assets and liabilities, family size and its composition, caste, religion, ownership of land and livestock, occupational profiles, sanitary conditions, marriage practices, education, etc. The survey also contains information on children's anthropometric status. In view of the recommendation of the new Child Growth Standards provided by the World Health Organization in 2006, we have trimmed the height-for-age, weight-for-age, and weight-for-height z-scores prior to calculating stunting, underweight, and wasting prevalence rates. For this, the height-for-age z-scores below -6 and above 6, weight-for-age z-scores below -6 and above 5, and height-for-weight z-scores below -5 and above 5 were replaced with missing values. A child was then

identified as stunted (severely stunted) if his or her HA z-score was between -2 and -6 (-3 and -6), underweight (severely underweight) if the WA z-score was between -2 and -6 (-3 and -6), and wasted (severely wasted) if the WH z-score was between -2 and -5 (-3 and -5)<sup>1</sup>.

**Empirical Strategy**

With their share of more than three-fourths in the total workforce in livestock sector, we assume women to have a sizeable share in the income from livestock activities and also in its spending decisions regarding children’s health. With this assumption, we have tested for the hypothesis of a positive association between the number of female workers in a household and its ownership of livestock by estimating Equation (1) using the ordinary least squares (OLS) method:

$$L_{it} = \alpha_t + \delta^m M_{it} + \delta^f F_{it} + X_{it}\beta + \epsilon_{it} \dots(1)$$

where, *i* denotes the household and *t* denotes the village. *L<sub>it</sub>* denotes the ownership of livestock; it takes a value 1 if the household owns one or the other species of livestock, 0 otherwise.  $\alpha_t$  is the village-specific fixed effects. *M<sub>it</sub>* and *F<sub>it</sub>* are the numbers of adult males and females between 15 and 60 years, respectively. *X<sub>it</sub>* is a vector of other personal and household characteristics, i.e., age and educational status of the household-head, operated area, area under cultivation of cereals, pulses and fodder, social status and household type dummies that influence the household’s decision to own or not to own a livestock. For the hypothesis to be accepted,  $\hat{\delta}^f$  should be positive and statistically significant. We tested the null hypothesis of equality of coefficients of *M<sub>it</sub>* and *F<sub>it</sub>*, i.e. ( $H_0: \hat{\delta}^m - \hat{\delta}^f = 0$ ). Ideally, Equation (1) should also contain household fixed effects to control for the heterogeneity among households as there could be a possibility of household-specific factors being correlated with *M<sub>it</sub>* and *F<sub>it</sub>* that may bias  $\hat{\delta}^f$  and  $\hat{\delta}^m$ . However, the same has not been incorporated in Equation (1) due to cross-sectional nature of the analysis.

The OLS estimation of Equation (1) represents the linear probability model (LPM). Assuming  $\epsilon_{it} \sim N(0, \sigma^2)$ , Equation (1) can be written as:

$$P(L_{it} = 1 | \alpha_t, M_{it}, F_{it}, X_{it}) = \Phi \left( \frac{\alpha_t + \delta^m M_{it} + \delta^f F_{it} + X_{it}\beta}{\sigma} \right) \dots(2)$$

where,  $\alpha_t$  are the district-level fixed effects and  $\Phi(\cdot)$  is the standard normal distribution. Equation (2) now represents the Probit model which is estimated using the maximum likelihood approach. The advantage of Probit over LPM is that it generates predicted probabilities bounded between 0 and 1. The LPM is only a convenient approximation of the underlying response probability. However, a drawback of the Probit model is that it cannot accommodate a large number of village-level fixed effects; hence we included district dummies in Equation (2).

The hypothesis ‘share of livestock in total household income should be positively related with number of women in the household’ was tested by estimating a truncated Tobit regression:

$$y_{it}^* = \alpha_t + \delta^m M_{it} + \delta^f F_{it} + X_{it}\beta + \epsilon_{it} \dots(3)$$

where, all the variables were the same as defined in Equation (2) and  $\epsilon_{it} \sim N(0, \sigma^2)$ . *y<sub>it</sub><sup>\*</sup>* is a latent variable observed by the following rule:

$$y_{it} = \begin{cases} 0 & \text{if } y_{it}^* \leq 0 \\ y_{it}^* & \text{if } 0 < y_{it}^* < 100 \\ 100 & \text{if } y_{it}^* \geq 100 \end{cases} \dots(4)$$

Here, *y<sub>it</sub>* is the observed share of livestock in household income that ranges between 0 and 100. The null hypothesis:  $H_0: \hat{\delta}^m - \hat{\delta}^f = 0$  was tested to see whether the women have a larger positive effect on livestock income as compared to men. Similar to the Probit model, here also the non-linear nature of the model did not permit the use and interpretation of village-level fixed effects. We, however, estimated the robust standard errors clustered at village-level for all the variables.

Finally, assuming that the livestock income is positively associated with the number of women workers in a household, we analysed the effect of livestock ownership on the key nutritional outcomes (*Z<sub>it</sub>*), viz. stunting, underweight and wasting of children (<5 years of age) by employing a Probit model:

<sup>1</sup> The kernel density distributions of z-scores for children from households with differential livestock ownership status are displayed in Figures 1-3 of the Appendix.

$$\Pr(Z_i = 1 | X_i) = \varphi(X_i\beta) \quad \dots(5)$$

where,  $\varphi(\cdot)$  is the standard cumulative distribution function and  $X_i$  is a vector of personal and household characteristics. Equation (5) was estimated separately for each of the nutritional outcome, which takes a value of 1 if a child is either stunted, underweight or wasted; 0 otherwise.  $X_i$  includes child characteristics (age, age squared and gender of the child, and a dummy indicating whether the child suffered from any illness particularly fever, cough and diarrhoea in the previous month); parental characteristics (age and education level<sup>2</sup>), and household characteristics (dependency ratio, number of females aged between 15 and 60 years, monthly per capita expenditure (MPCE), number of large ruminants, small ruminants and poultry, dummy for animal care by females, dummies for the types of toilet facilities and house roofs).

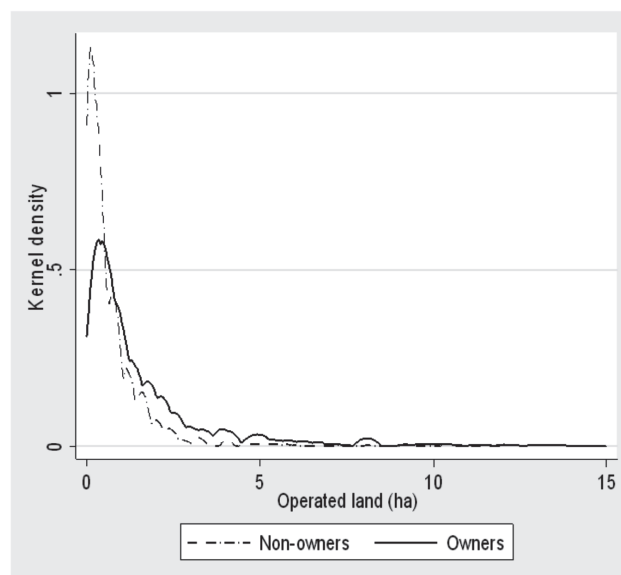
It is well known from the nutrition studies (Garrett and Ruel, 1999; FAO-WHO, 2004) that the causes underlying children's under nutrition differ across age groups. Hence, we estimated separate regressions for the children who were of less than 2 years, and for those between 2 and 5 years of age.

## Results

### Women and Ownership of Livestock

Amongst a constellation of factors, ownership of land is supposed to exert considerable influence on a household's decision to acquire or own livestock, their species as well as number, especially in the mixed farming systems. Figure 1 reinforces that land is an important determinant in a household's decision to own livestock. The kernel density of non-owners is higher to that of owners at smaller land sizes, but goes below that of non-owners at relatively higher land sizes. This indicates that livestock ownership is biased towards larger landowners.

This relationship was probed further by analysing the distribution of livestock by landholding classes (Table 1). On the whole, 64 per cent of the households in rural India possess one or the other species of livestock, and the incidence of livestock ownership increases with landholding size. For example, only 36 per cent of the landless households own livestock as



**Figure 1. Kernel density distribution for owners and non-owners of livestock**

compared to 88 per cent of the large farm households (> 4 ha). The share of landless households in livestock population is much less than their share in rural households. However, across land classes, the difference in the incidence of livestock ownership is not stark. The smaller landholders, by virtue of their dominance in agrarian society, account for a sizeable share of livestock population. For example, the marginal farm households (< 1ha) control 47 per cent of poultry, 40 per cent of sheep, and more than 35 per cent of cows, goats and draught animals, as against their share of 16 per cent in land. Their share in ownership of buffaloes, however, is relatively less. Notably, the preference for smaller animals (sheep, goat and poultry) is stronger towards the lower-end of land distribution. This is because these can be easily acquired with a smaller start-up capital, have shorter gestation periods and higher prolificacy rates.

Table 2 compares the key characteristics of households that own livestock with those that do not. Livestock-owning households have larger landholdings, and 63 per cent of them have reported agriculture (crop production) as their main occupation. And, as expected, livestock-owning households allocate a larger share of their land to cereals, pulses and fodder crops. The non-owning households, on the

<sup>2</sup> From the dataset it is not possible to link each child's characteristics to its mother. Hence, we have used the characteristics of an ever-married woman between 15 and 49 years as proxies for mother's characteristics.

**Table 1. Ownership and distribution of livestock across landholding size classes**

Landholding-size class	Share in land area	Number (% share) of households	Households owning (%)							
			All or any livestock species	Cow	Buffalo	Draft animal	Sheep	Goat	Poultry	Other livestock
Landless	0.00	6989 (35.57)	36.47	12.94	13.95	7.18	20.22	16.41	17.31	14.51
Marginal (<1 ha)	15.66	7044 (35.85)	74.93	37.49	28.51	35.87	40.86	35.32	47.34	33.21
Small (1-2 ha)	17.43	2633 (13.40)	82.72	17.99	18.67	22.20	14.57	17.58	16.36	18.42
Medium (2-4 ha)	23.15	1806 (9.19)	86.21	16.60	18.46	19.36	13.06	15.02	11.08	16.66
Large (>4 ha)	43.76	1178 (5.99)	88.20	14.98	20.41	15.39	11.28	15.68	7.90	17.20
Total		19650	64.13							

**Table 2. A comparison of key characteristics of owners and non-owners of livestock**

Characteristics	Don't own livestock	Own livestock	Test of difference in means / proportions (z-scores)
Operated land (ha)	0.81	1.61	-16.71***
Gross cropped area (ha)	0.76	1.98	-20.53***
<i>Household composition</i>			
Household size	4.58	6.08	-29.15***
No. of members between 0 and 14 years	1.43	2.00	-17.83***
No. of males between 15 and 60 years	1.44	1.85	-20.15***
No. of females between 15 and 60 years	1.47	1.83	-19.25***
No. of illiterate males between 15 and 60 years	0.32	0.41	-7.07***
No. of illiterate females between 15 and 60 years	0.67	0.91	-15.66***
<i>Earnings and income</i>			
Total household income per capita (₹)	10068	8454	4.34***
Monthly per capita consumption expenditure (₹)	871	792	4.87***
Total income from farm (₹)	12534	22271	-7.08***
Total income (₹)	40593	47649	-4.47***
Below poverty line (%)	17.1	20.4	-4.52***
Per cent area under cereals	41.10	63.27	-30.80***
Per cent area under pulses	4.57	7.07	-8.63***
Per cent area under green fodder	0.21	1.22	-9.23***
<i>Characteristics of household-head (%)</i>			
Age of household-head (years)	48.28	49.39	-4.37***
Household-head is literate	62.2	60.5	1.83*
Household-head schooling	62.8	61.2	1.71*
Household-head schooling (≤5 grade)	21.3	23.1	-2.21**
Household-head schooling (>5 & ≤10 grade)	28.9	29.3	-0.43
Household-head schooling (>10 & ≤12 grade)	6.5	4.6	4.51***
Household-head education (graduate)	5.1	3.2	5.52***
<i>Household type by main income sources (%)</i>			
Cultivation	46.1	62.9	-18.18***
Allied agriculture	0.9	1.4	-2.54**
Agricultural wage labour	15.6	9.9	9.71***
Non-agricultural wage labour	10.7	9.4	2.21**

Contd...



**Table 2.... contd.**

Characteristics	Don't own livestock	Own livestock	Test of difference in means / proportions (z-scores)
Artisan/independent work	3.0	2.0	3.59***
Petty shop/other trade	2.7	1.4	5.13***
Organized trade/business	3.3	1.6	6.53***
Salaried employment	10.9	8.0	5.56***
Profession (not elsewhere classified)	0.9	0.4	3.51***
Pension/rent/dividend, etc.	3.3	2.0	4.57***
Others	2.5	0.9	7.97***
<i>Social group (%)</i>			
Brahmin and other	27.5	31.7	-4.81***
Other backward classes (OBC)	41.5	41.7	-0.18
Scheduled castes (SC)	19.6	15.3	6.22***
Scheduled tribes (ST)	11.4	11.3	0.03
<i>Child-level statistics</i>			
Mother's education (max. years)	3.61	3.31	3.88***
Presence of cash in hand (%)	80.2	75.8	5.86***
<i>Household has: No toilet facility (open fields) (%)</i>	73.8	79.9	-8.05***
Traditional pit latrine	10.7	8.0	5.15***
Ventilated improved pit latrine	4.3	3.2	3.30***
Flush toilet	11.2	8.9	4.25***
Household has piped water source (%)	32.5	21.5	14.07***
<i>Household has: Grass/thatch/mud/wood roof (%)</i>	30.3	30.5	-0.23
Tile/slate/plastic roof	32.1	30.9	1.50
Gi metal/asbestos roof	9.2	7.9	2.63***
Cement roof	10.6	13.4	-4.71***
Brick/stone roof	17.7	17.3	0.63
Child illness during past 30 days	30.3	29.4	1.08
<i>Nutritional outcomes for children (%)</i>			
Stunting	48.7	48.4	0.29
Severe stunting	31.0	29.6	1.48
Underweight	35.3	34.9	0.47
Severe underweight	15.4	15.0	0.56
Wasting	15.5	15.1	0.60
Severe wasting	6.3	5.8	0.87

Notes: \*\*\*, \*\* and \* denote significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively. Operated land = (owned land - leased out land + leased in land).

other hand, because of their smaller land sizes, are more engaged in non-farm occupations — 54 per cent of them have reported non-farm activities (wage labour, salaried jobs, artisan, petty business, etc.) as their main income sources. The heads of livestock-owning households are relatively older and less-educated compared to their counterparts in the non-owning households. Animal husbandry is a labour-intensive activity, and that the livestock owners also have a

larger endowment of family labour, both males and females.

The ownership of livestock can be also differentiated by the social status of households. Caste is an important indicator of social status/hierarchy in rural India, with scheduled castes and scheduled tribes being at the bottom, followed by the other backward castes and upper castes. Some of the studies examining the asset distribution indicate that upper caste

**Table 3. Participation of males and females in animal care**

Participation	Percentage of males among overall animal caretakers	Percentage of illiterate males among overall animal caretakers	Percentage of females among overall animal caretakers	Percentage of illiterate females among overall animal caretakers
Never	61.18	12.94	38.82	16.67
Sometimes	53.32	12.67	46.68	25.65
Usually	43.67	13.66	56.33	34.25
Total	47.79	13.25	52.21	30.55

households have a larger share in the assets (Mistri and Das, 2014; Deshpande, 2002). Our results point toward a higher proportion of upper caste households (32%) among livestock owners than their counterparts among non-owners (28%). On the other hand, the incidence of livestock ownership seems to be lower at the bottom of social hierarchy as only 15 per cent of the livestock owners belong to scheduled castes as compared to 20 per cent among non-owners. Nevertheless, other backward castes remain dominant among owners as well as non-owners of livestock.

On an average, the presence of hygienic toilet facilities, quality roof tops and piped water source was more in the case of non-owning households. The nutritional status of children was observed to be better in the case of livestock-owning households, but the differences observed were not significant. This comparison suggests that the owners of livestock are significantly different from the non-owners in terms of many of the personal and household characteristics.

In order to examine the engagement of women in livestock rearing, we have presented self-reported participation in animal care by adult females and adult males in Table 3. The female workers outnumbered male workers. And, amongst females, it was the illiterate ones who were more engaged in animal husbandry. Of the total adult workers engaged in animal husbandry, 52 per cent were females and of them, 59 per cent had no formal education. Given a higher engagement of illiterate women, we included both illiterate adult females and males in our regression models to see if there was a relationship between literacy and livestock ownership. Therefore, we estimated two specifications, one with total adult males and females; and the other with illiterate adult males and females.

Table 4 presents regression results of the linear probability (Equation 1) and Probit (Equation 2) models. The landless and land-owning households differed considerably in their resource endowments, and therefore we estimated livestock ownership equations separately for these two groups. The results confirmed some of our earlier observations. The ownership of livestock has been found to be positively associated with the age of household-head, but the probability of owning a livestock declines with his/her educational attainment. A person with a higher educational status is expected to be more engaged in non-agricultural occupations. The regression coefficients associated with occupational profiles of households have also indicated the same. In comparison to farm households, the households which are more engaged in non-farm activities have a lower likelihood of owning livestock. The social status of a household also influences its decisions about owning livestock – our results have indicated towards a dominance of backward castes in animal husbandry.

The key issue of interest in this paper is the relationship between livestock, women and child nutrition. In all the specifications, the regression coefficients on adult females are highly significant and positive, but not much different from that on adult males. This implies that both males and females are important in animal husbandry in rural India. Nonetheless, in terms of literacy, the coefficient on illiterate adult females is significantly positive and different from the coefficient associated with illiterate males. The literate women rarely prefer labour-intensive activities such as animal husbandry, leaving these to the illiterate ones. Further, greater engagement of illiterate women in animal husbandry compared to illiterate men is because the latter undertake strenuous works demanding more of physical labour.

Table 4. Regression estimates of linear probability model and Probit model

Variables	(1)		(2)		(3)		(4)	
	LPM: coefficients	Some operated land	Probit: marginal effects	Some operated land	LPM: coefficients	Some operated land	Probit: marginal effects	Some operated land
	Land-less	operated land	Land-less	operated land	Land-less	operated land	Land-less	operated land
(a) No. of males between 15 and 60 years	0.0331*** (0.0059)	0.0287*** (0.0032)	0.1015*** (0.0172)	0.1520*** (0.0151)	-	-	-	-
(b) No. of females between 15 and 60 years	0.0405*** (0.0069)	0.0306*** (0.0035)	0.1279*** (0.0197)	0.1722*** (0.0174)	-	-	-	-
(c) No. of illiterate males between 15 and 60 years	-	-	-	-	0.0212** (0.0098)	0.0082 (0.0055)	0.0422 (0.0274)	0.0583** (0.0257)
(d) No. of illiterate females between 15 and 60 years	-	-	-	-	0.0525*** (0.0091)	0.0346*** (0.0045)	0.1925*** (0.0253)	0.1999*** (0.0204)
Age of household-head (years)	0.0020*** (0.0004)	0.0012*** (0.0003)	0.0047*** (0.0013)	0.0021* (0.0011)	0.0028*** (0.0004)	0.0019*** (0.0003)	0.0075*** (0.0013)	0.0058*** (0.0011)
Household-head's education (years)	-0.0053*** (0.0014)	-0.0017* (0.0009)	-0.0266*** (0.0044)	-0.0173*** (0.0035)	-0.0009 (0.0015)	0.0009 (0.0010)	-0.0117** (0.0048)	-0.0009 (0.0040)
<b>Social group dummy (base category: brahmin and others)</b>								
Other backward classes (OBC)	0.0360** (0.0170)	0.0271** (0.0113)	0.0573 (0.0520)	0.0874** (0.0394)	0.0342** (0.0169)	0.0250** (0.0114)	0.0454 (0.0516)	0.0800** (0.0387)
Scheduled castes (SC)	-0.0131 (0.0178)	-0.0422*** (0.0132)	-0.0898* (0.0525)	-0.1842*** (0.0455)	-0.0199 (0.0179)	-0.0466*** (0.0133)	-0.1105** (0.0523)	-0.1950*** (0.0451)
Scheduled tribes (ST)	0.0303 (0.0259)	0.0111 (0.0207)	0.0979 (0.0733)	0.0796 (0.0740)	0.0198 (0.0261)	0.0052 (0.0208)	0.0529 (0.0730)	0.0414 (0.0742)
<b>Household type dummy (base category: cultivation)</b>								
Allied agriculture	-0.0629 (0.1819)	-0.0176 (0.0304)	-0.1642 (0.4830)	-0.0325 (0.1400)	-0.0641 (0.1794)	-0.0224 (0.0300)	-0.1207 (0.4836)	-0.0516 (0.1340)
Agricultural wage labour	-0.2712 (0.1716)	-0.0983*** (0.0135)	-0.8131* (0.4567)	-0.3475*** (0.0460)	-0.2679 (0.1693)	-0.1040*** (0.0137)	-0.7725* (0.4577)	-0.3723*** (0.0465)
Non-agricultural wage labour	-0.3258* (0.1721)	-0.1094*** (0.0140)	-1.0010** (0.4570)	-0.4644*** (0.0531)	-0.3203* (0.1699)	-0.1134*** (0.0142)	-0.9449** (0.4582)	-0.4771*** (0.0532)
Artisan/independent work	-0.3773** (0.1726)	-0.1177*** (0.0247)	-1.1395** (0.4598)	-0.4769*** (0.0826)	-0.3665** (0.1704)	-0.1189*** (0.0249)	-1.0712** (0.4611)	-0.4682*** (0.0821)
Petty shop/other trade	-0.3801** (0.1732)	-0.1610*** (0.0284)	-1.2382*** (0.4608)	-0.6522*** (0.0926)	-0.3654** (0.1711)	-0.1572*** (0.0283)	-1.1466** (0.4624)	-0.6019*** (0.0919)

Contd...



Table 4.... contd.

Variables	(1)		(2)		(3)		(4)	
	LPM: coefficients		Probit: marginal effects		LPM: coefficients		Probit: marginal effects	
	Land-less	Some operated land	Land-less	Some operated land	Land-less	Some operated land	Land-less	Some operated land
Organized trade/business	-0.3552** (0.1722)	-0.1511*** (0.0282)	-1.2225*** (0.4587)	-0.5904*** (0.0891)	-0.3340** (0.1699)	-0.1394*** (0.0285)	-1.1110** (0.4597)	-0.5095*** (0.0878)
Salaried employment	-0.3333* (0.1723)	-0.1173*** (0.0138)	-1.0820** (0.4576)	-0.4928*** (0.0494)	-0.3193* (0.1700)	-0.1120*** (0.0140)	-0.9959** (0.4590)	-0.4485*** (0.0484)
Profession (n.e.c.)	-0.3847** (0.1782)	-0.1591** (0.0636)	-1.2433*** (0.4787)	-0.6617*** (0.1827)	-0.3751** (0.1760)	-0.1571** (0.0639)	-1.1679** (0.4795)	-0.6301*** (0.1850)
Pension/rent/dividend, etc.	-0.3728** (0.1751)	-0.1104*** (0.0256)	-1.1520** (0.4679)	-0.4619*** (0.0914)	-0.3758** (0.1730)	-0.1198*** (0.0261)	-1.1307** (0.4696)	-0.4997*** (0.0914)
Others	-0.2772 (0.1738)	-0.1718*** (0.0356)	-0.8516* (0.4611)	-0.6660*** (0.1081)	-0.2855* (0.1717)	-0.1837*** (0.0360)	-0.8338* (0.4627)	-0.7106*** (0.1072)
Percent area under cereals	-	0.0019*** (0.0001)	-	0.0058*** (0.0004)	-	0.0020*** (0.0001)	-	0.0059*** (0.0004)
Percent area under pulses	-	0.0017*** (0.0003)	-	0.0048*** (0.0011)	-	0.0017*** (0.0003)	-	0.0049*** (0.0011)
Percent area under green fodder	-	0.0043*** (0.0007)	-	0.0213*** (0.0054)	-	0.0044*** (0.0007)	-	0.0215*** (0.0055)
Operated land (ha)	-	0.0126*** (0.0021)	-	0.1281*** (0.0188)	-	0.0164*** (0.0025)	-	0.1460*** (0.0201)
Village dummies	Yes	Yes	No	No	Yes	Yes	No	No
District dummies	No	No	Yes	Yes	No	No	Yes	Yes
Constant	0.4369** (0.1750)	0.5166*** (0.0210)	0.5398 (0.5906)	0.6919** (0.2688)	0.4370** (0.1733)	0.5349*** (0.0216)	0.4222 (0.6077)	0.7582*** (0.2674)
<i>Test of hypotheses</i>	F(1, 1362)		$\chi^2(1)$	$\chi^2(1)$	F(1, 1362)	F(1, 1429)	$\chi^2(1)$	$\chi^2(1)$
H0: (a)-(b)=0 in (1) or H0: (c)-(d)=0 in (3)	0.55	0.12			4.95**	11.06***		
Prob > F	0.4588	0.7304			0.0262	0.0009		
H0: (a)-(b)=0 in (2) or H0: (c)-(d)=0 in (4)			0.82	0.68			14.16***	16.03***
Prob > $\chi^2$			0.3663	0.4084			0.0002	0.0001
Observations	10244	15720	10145	15693	10244	15720	10145	15693
Clusters	1363	1430	1343	1426	1363	1430	1343	1426
Adjusted R <sup>2</sup>	0.2289	0.2512			0.2234	0.2420		
Pseudo R <sup>2</sup>	-	-	0.1458	0.2237	-	-	0.1421	0.2110
F-stat	14.35	47.77	-	-	12.55	39.12	-	-

Notes: Figures within the parentheses are village-level clustered standard errors. \*\*\*, \*\* and \* denote significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively. N.e.c. represents not elsewhere classified.

### Women and Income Share of Livestock

Since women chiefly bear the animal-rearing responsibilities, an increase in the animal holdings gives them a greater control over resources within the household (McPeak and Doss, 2006). In Table 5, we present the results of the income share equation that examines the effect of women workers on livestock income. The effect of total number of adult males on livestock income was not found to be statistically significant, but it was positive and significant in the case of adult females. The contribution of livestock to a household's income turned out to be higher for households with more number of illiterate female workers. The impact was bigger compared to that of adult male workers and this difference is statistically significant. On an average, with an additional illiterate female worker, a household realizes more than 7 per cent higher income from livestock activities, whereas an additional illiterate male worker would have no effect and this difference is statistically significant.

The contribution of livestock to household income declined with land size. This is possibly due to the fact that after a threshold herd size, labour becomes a

binding constraint on its expansion on larger landholdings. Nonetheless, the negative relationship between livestock income and land size has clearly established that livestock are relatively a more important income source for small landholders. The regression coefficients associated with occupational profiles of households have also shown that the households with allied agricultural activities as their main occupation realize higher income from livestock than those involved in non-farm activities because of the synergistic relationship between the two. Note that livestock in India are raised in mixed farming systems obtaining their energy requirements from agricultural residues and by-products, and in turn provide draught power and dung manure for cropping activities besides the food products for human consumption.

The available information in the dataset enabled us to examine whether the higher contribution of women to household income also provides them a control over it. In terms of the frequency of the ever-married women (between 15 and 49 years) reporting cash availability with them, it was observed that there was not much wide gap. The incidence of cash availability with women was only slightly lower among

**Table 5. Regression estimates of Tobit model**

Variables	Model (1)	Model (2)
No. of females between 15 and 60 years	3.6744** (1.7863)	-
No. of males between 15 and 60 years	0.7332 (1.7246)	-
No. of illiterate females between 15 and 60 years	-	7.3368*** (2.5106)
No. of illiterate males between 15 and 60 years	-	-0.6814 (2.8287)
Number of large ruminants	18.1697*** (4.1813)	18.3269*** (4.2233)
Number of small ruminants	1.9548*** (0.6419)	1.9334*** (0.6418)
Number of poultry	2.7550*** (0.8633)	2.7625*** (0.8727)
Operated land (ha)	-0.9616* (0.5250)	-0.7687 (0.5332)
Age of household-head (years)	0.1991 (0.2072)	0.2367 (0.2210)
Education of household-head (years)	-0.4619 (0.5184)	-0.1304 (0.6168)

Contd...

Table 5.... contd.

Variables	Model (1)	Model (2)
<b>Social group dummy (base category: brahmin and others)</b>		
Other backward classes (OBC)	4.0708 (4.4529)	2.9652 (4.5268)
Scheduled castes (SC)	-19.2418*** (7.0926)	-20.6525*** (7.3107)
Scheduled tribes (ST)	16.2878* (9.0613)	14.1494 (8.9068)
<b>Household type dummy (base category: cultivation)</b>		
Allied agriculture	64.4171 (70.4805)	64.2749 (70.2908)
Agricultural wage labour	-29.3087*** (7.2610)	-29.9008*** (7.3773)
Non-agricultural wage labour	-36.6753*** (6.2425)	-36.9055*** (6.2895)
Artisan/independent work	-49.9970*** (11.8085)	-49.9385*** (11.7981)
Petty shop/other trade	-50.7455*** (11.3223)	-49.9510*** (11.1628)
Organized trade/business	-50.8983*** (12.7568)	-49.2435*** (12.4359)
Salaried employment	-39.4167*** (9.4615)	-38.1655*** (9.2999)
Profession (n.e.c.)	-38.6018** (15.8633)	-38.2221** (15.7425)
Pension/rent/dividend, etc.	-44.8713*** (10.5371)	-44.1689*** (10.6326)
Others	-56.8001*** (16.5272)	-57.0332*** (16.7384)
Per cent area under cereals	0.5202*** (0.1422)	0.5147*** (0.1415)
Per cent area under pulses	0.4759*** (0.1586)	0.4671*** (0.1577)
Per cent area under green fodder	2.1708** (1.0390)	2.1710** (1.0377)
District dummies	Yes	Yes
Constant	-83.5348* (46.2918)	-88.3963* (47.5319)
Sigma constant	187.3200*** (45.8498)	187.2620*** (45.8284)
<i>Test of hypotheses</i>	F(1, 10980)	F(1, 10980)
H0: (a)–(b)=0 for (1) and H0: (c)–(d)=0 for (2)	1.08	4.28**
Prob > F	0.2977	0.0386
Observations	11277	11277
Clusters	1410	1410
Pseudo R <sup>2</sup>	0.0149	0.0149

Note: Figures within the parentheses are village-level clustered standard errors. \*\*\*, \*\* and \* denote significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively. N.e.c. represents not elsewhere classified.

livestock-owning households — 76 per cent women from livestock-owning households have reported having cash in hand as compared to 80 per cent in the non-owning households.

### Children's Nutritional Outcomes

The gender pattern in terms of the control over economic resources, particularly income, impacts a household's decision to spend more money on food items and human capital formation (Thomas, 1997; Tangka *et al.*, 2000). With women contributing more to the household income via animal husbandry, they are expected to have a greater role in the household decisions, particularly those relating to food and nutrition. Rogers (1996) has reported that with a greater control over household resources, the consumption preferences of women generally favour basic needs and child welfare.

Tables 6(a) and 6(b) present the Probit regression estimates for the nutritional outcomes, viz. stunting, underweight and wasting among children in the age groups of less than 2 years and 2-5 years. The results for the severer forms of these nutritional outcomes are reported in Tables 1(a) and (b) of the Appendix. The endogeneity tests for the nutritional outcomes, except severe wasting, indicate the presence of sufficient information in the sample to reject the null hypothesis of exogeneity. Hence, the instrumental variables (IV) Probit regressions provide unbiased and consistent estimates.

While assessing the children's nutritional outcomes, we controlled for the MPCE, an important determinant of the nutritional outcomes. However, MPCE can be potentially endogenous as malnourished children require more of their parents' time for care, and thus, may lead to lower monetary resources for spending. Also, there is a possibility of existence of a reverse causality between the expenditure and nutritional status as malnourished children would turn out to be less productive individuals in future. Hence, we used the household's assets scale that measured a household's possessions and housing quality as an instrument for MPCE. The scale is provided in the dataset and ranges between 0 and 30. It was ensured that this instrument fulfilled all the conditions of instrumental relevance and exogeneity, and was not related to the outcome variables. Besides the endogeneity tests, various other tests of instrumental

relevance were performed and these can be made available on request.

In general, the ownership of livestock has mixed effect on nutritional status of children. The regression coefficient on poultry is negative for stunting and underweight, irrespective of the children's age group. The effect of number of large ruminants (cows and buffaloes) on stunting and wasting is mixed. However, the probability of a child being underweight is lower among those households that own dairy animals, particularly in the case of children in the age group of 2-5 years. Note that dairy animals and poultry generate a stream of outputs, a large proportion of which is consumed at home. On the other hand, there is a positive association between ownership of small ruminants and children's underweight and wasting. Similar trends were also observed for the IV Probit estimation. This might be happening as the small ruminants are mostly raised by the poor households mainly for marketing purposes and are rarely slaughtered for home consumption. Once these animals attain a slaughtering age, they are sold to itinerant traders or butchers in distant urban markets.

The regression coefficients for dairy animals and poultry indicate a tendency of children being nutritionally better in the households that own these animals. It may, however, be noted that ownership of livestock is not a sufficient condition for enhancing nutrition. It is the intra-household distribution of consumption that matters. Alternatively, the nutritional outcomes of livestock ownership may depend on the person who controls the output or income from livestock activities. To test for this, we have included two variables: (i) participation of women in animal care, and (ii) the availability of cash with women.

The availability of cash with women reduces the likelihood of kids being stunted or severely stunted. Its effects are mixed in the case of underweight, and adverse on wasting. Wasting is a consequence of acute weight loss and thus might not be affected much by the existence of liquidity in the household. On the other hand, nutritional outcomes are positively influenced by women's participation in animal husbandry. The chances of being stunted, underweight and wasted are lower among children, particularly those between 0 and 2 years, in the households with higher women participation in animal care.

**Table 6(a). Probit regression estimates on stunting, underweight and wasting**

Variables	Stunting		Underweight		Wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
Female child	-0.0176 (0.017)	0.0220** (0.011)	-0.0198 (0.014)	0.0060 (0.010)	0.0080 (0.019)	-0.0178** (0.008)
Age of child (in years)	-	-0.0512*** (0.011)	-	0.0010 (0.009)	-	-0.0161** (0.008)
Presence of cash in hand	-0.0250 (0.021)	-0.0078 (0.015)	-0.0231 (0.018)	0.0061 (0.014)	0.0075 (0.023)	0.0160 (0.011)
Age of child squared (in years)	-0.0795*** (0.004)	0.0131** (0.006)	-0.0952*** (0.005)	-0.0001 (0.005)	0.0179*** (0.005)	0.0093** (0.004)
<i>Household has</i>						
Traditional pit latrine	-0.0151 (0.033)	-0.0688*** (0.023)	-0.0702** (0.030)	-0.0639*** (0.022)	0.0045 (0.037)	0.0154 (0.018)
Ventilated improved pit latrine	-0.0833 (0.052)	-0.0550* (0.033)	-0.1415*** (0.048)	-0.1201** (0.047)	-0.1169* (0.063)	0.0165 (0.040)
Flush toilet	-0.0167 (0.032)	-0.0438* (0.023)	-0.1048*** (0.029)	-0.0523** (0.022)	-0.0634 (0.039)	-0.0021 (0.017)
Household has piped water source	-0.0324 (0.023)	-0.0182 (0.015)	-0.0396** (0.017)	-0.0090 (0.015)	-0.0506** (0.024)	0.0020 (0.011)
<i>Household has</i>						
Tile/slate/plastic roof	-0.0501** (0.023)	-0.0348** (0.015)	-0.0449** (0.019)	-0.0281* (0.015)	-0.0080 (0.025)	0.0049 (0.012)
Gi metal/asbestos roof	-0.0872** (0.038)	-0.0545** (0.026)	-0.0579** (0.029)	-0.0205 (0.025)	0.0110 (0.035)	-0.0056 (0.017)
Cement roof	-0.0869*** (0.031)	-0.0171 (0.021)	-0.0257 (0.027)	-0.0274 (0.021)	-0.0426 (0.037)	-0.0313* (0.017)
Brick/stone roof	-0.0168 (0.028)	-0.0177 (0.019)	-0.0034 (0.022)	-0.0675*** (0.020)	-0.0119 (0.031)	-0.0438*** (0.015)
Age of mother	0.0015 (0.001)	-0.0017* (0.001)	0.0012 (0.001)	-0.0019** (0.001)	0.0003 (0.002)	-0.0013* (0.001)
Number of females in-between 15-60 years	0.0072 (0.009)	0.0044 (0.006)	-0.0012 (0.009)	0.0084 (0.006)	0.0016 (0.011)	-0.0046 (0.005)
Number of large ruminants	0.0060 (0.007)	-0.0025 (0.004)	0.0076 (0.006)	-0.0096** (0.004)	0.0069 (0.006)	-0.0025 (0.003)
Number of small ruminants	0.0015 (0.002)	-0.0010 (0.001)	0.0025** (0.001)	0.0002 (0.001)	0.0002 (0.002)	0.0018** (0.001)
Number of poultry birds	-0.0022 (0.002)	-0.0033 (0.002)	-0.0017 (0.001)	-0.0009 (0.002)	-0.0003 (0.001)	0.0030* (0.002)
Mother's education (max. years)	-0.0076*** (0.002)	-0.0109*** (0.002)	-0.0068*** (0.002)	-0.0093*** (0.002)	-0.0025 (0.002)	0.0005 (0.001)
Child illness during past 30 days	-0.0209 (0.019)	0.0204 (0.013)	-0.0054 (0.015)	0.0311*** (0.012)	0.0127 (0.019)	-0.0122 (0.009)
Dependency ratio	-0.0001 (0.000)	0.0001 (0.000)	0.0001 (0.000)	-0.0000 (0.000)	0.0001 (0.000)	-0.0001 (0.000)

Contd...



**Table 6(a).... contd.**

Variables	Stunting		Underweight		Wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
Livestock care by females	-0.0344* (0.018)	0.0040 (0.013)	-0.0365** (0.016)	-0.0009 (0.012)	-0.0341* (0.020)	-0.0045 (0.009)
MPCE	-0.0000 (0.000)	-0.0000** (0.000)	-0.0000 (0.000)	-0.0001*** (0.000)	0.0000 (0.000)	-0.0000*** (0.000)
Number of observations	2,572	8,193	2,854	9,084	1,700	8,232
Number of clusters	1015	1347	1059	1385	833	1347
$\chi^2$	298.94	201.83	355.80	213.70	33.39	58.33
Probability	0.0000	0.0000	0.0000	0.0000	0.0421	0.0000
Pseudo R <sup>2</sup>	0.1143	0.0190	0.1691	0.0224	0.0211	0.0120

Notes: Standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 6(b). Instrumental variables (IV) Probit regression estimates on stunting, underweight and wasting**

Variables	Stunting		Underweight		Wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
MPCE	-0.0001** (0.000)	-0.0001*** (0.000)	-0.0002*** (0.000)	-0.0003*** (0.000)	-0.0002** (0.000)	-0.0001*** (0.000)
Female child	-0.0176 (0.017)	0.0199* (0.011)	-0.0200 (0.014)	0.0030 (0.010)	0.0057 (0.019)	-0.0187** (0.008)
Age of child (in years)	-	-0.0505*** (0.011)	-	0.0004 (0.009)	-	-0.0162** (0.008)
Age of child squared (in years)	-0.0784*** (0.004)	0.0132** (0.006)	-0.0918*** (0.005)	0.0005 (0.005)	0.0177*** (0.005)	0.0095** (0.004)
Presence of cash in hand	-0.0196 (0.021)	-0.0043 (0.015)	-0.0159 (0.018)	0.0126 (0.014)	0.0179 (0.023)	0.0175 (0.011)
<i>Household has</i>						
Traditional pit latrine	0.0122 (0.036)	-0.0478** (0.024)	-0.0235 (0.034)	-0.0290 (0.023)	0.0445 (0.043)	0.0243 (0.019)
Ventilated improved pit latrine	-0.0570 (0.056)	-0.0312 (0.033)	-0.0877* (0.051)	-0.0799* (0.044)	-0.0862 (0.061)	0.0263 (0.041)
Flush toilet	0.0023 (0.033)	-0.0190 (0.024)	-0.0656** (0.032)	-0.0099 (0.023)	-0.0236 (0.043)	0.0084 (0.018)
Household has piped water source	-0.0275 (0.023)	-0.0105 (0.015)	-0.0319* (0.018)	0.0036 (0.014)	-0.0468* (0.025)	0.0054 (0.011)
<i>Household has</i>						
Tile/slate/plastic roof	-0.0513** (0.022)	-0.0381** (0.015)	-0.0451** (0.019)	-0.0340** (0.015)	-0.0100 (0.025)	0.0031 (0.012)
Gi metal/asbestos roof	-0.0894** (0.039)	-0.0564** (0.026)	-0.0588** (0.029)	-0.0259 (0.024)	-0.0017 (0.036)	-0.0071 (0.017)
Cement roof	-0.0733** (0.032)	0.0020 (0.021)	0.0013 (0.028)	0.0014 (0.021)	-0.0084 (0.041)	-0.0234 (0.017)
Brick/stone roof	-0.0016 (0.030)	-0.0037 (0.019)	0.0212 (0.023)	-0.0449** (0.020)	0.0140 (0.035)	-0.0383*** (0.015)

Contd...

**Table 6(b).... contd.**

Variables	Stunting		Underweight		Wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
Age of mother	0.0015 (0.001)	-0.0015 (0.001)	0.0013 (0.001)	-0.0016* (0.001)	0.0003 (0.002)	-0.0012* (0.001)
Number of females in-between 15-60 years	0.0015 (0.010)	-0.0002 (0.006)	-0.0117 (0.009)	0.0011 (0.006)	-0.0069 (0.011)	-0.0066 (0.005)
Number of large ruminants	0.0097 (0.007)	0.0001 (0.004)	0.0144** (0.006)	-0.0051 (0.004)	0.0101* (0.005)	-0.0013 (0.003)
Number of small ruminants	0.0014 (0.002)	-0.0010 (0.001)	0.0024** (0.001)	0.0002 (0.001)	0.0004 (0.002)	0.0018** (0.001)
Number of poultry birds	-0.0025 (0.002)	-0.0032 (0.002)	-0.0024 (0.002)	-0.0010 (0.002)	-0.0006 (0.001)	0.0030* (0.002)
Mother's education (max. years)	-0.0048 (0.003)	-0.0082*** (0.002)	-0.0014 (0.002)	-0.0047*** (0.002)	0.0022 (0.003)	0.0016 (0.001)
Child illness during past 30 days	-0.0181 (0.019)	0.0234* (0.013)	-0.0023 (0.015)	0.0348*** (0.012)	0.0197 (0.020)	-0.0109 (0.009)
Dependency ratio	-0.0002 (0.000)	0.0000 (0.000)	-0.0000 (0.000)	-0.0001* (0.000)	-0.0001 (0.000)	-0.0001* (0.000)
Livestock care by females	-0.0328* (0.018)	0.0089 (0.013)	-0.0315** (0.016)	0.0093 (0.012)	-0.0321 (0.021)	-0.0021 (0.009)
Number of observations	2,572	8,193	2,854	9,084	1,700	8,232
Number of clusters	1015	1347	1059	1385	833	1347
$\chi^2$	306.28	210.77	383.43	265.21	43.86	60.84
Probability	0.0000	0.0000	0.0000	0.0000	0.0024	0.0000
$\chi^2$ for exogeneity	3.26	10.36	14.95	31.17	5.29	3.87
Probability for exogeneity	0.0710	0.0013	0.0001	0.0000	0.0215	0.0492

Notes: Standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Both the child and parental characteristics are critical factors in determining the nutritional status of a child. The likelihood of being stunted reduces with increase in the child's age and is higher for a girl child aged between 2 and 5 years. The probability of being severely stunted among children of more than 2 years increases with a sharper increase in the age of the child and also due to illness. Similar patterns are observed from IV Probit estimates for stunting and severe stunting. A sharper increase in the age of children between 0 and 2 years reduces the likelihood of their being stunted (severely stunted) and underweight (severely underweight). On the other hand, sick children in the age group of 2-5 years have a higher probability of being underweight. The likelihood of wasting reduces with a child's age, but only up to a

certain level. For kids between 2 and 5 years, the chances of being wasted are lower for females than males. For older children (2-5 years), age has a negative association with severe wasting. Similar results were observed from the IV Probit estimates for wasting.

The probability of a kid being stunted declines with an improvement in the mother's formal education. It also declines with mother's age, possibly due to their becoming more experienced and aware about nutritional practices. Similar results have been observed from IV Probit regressions for stunting and severe stunting. The chances of children being underweight are lower among households with more experienced and educated mothers. The impact is higher in the case of severely underweight children. Mother's age has a

significant impact on the weight status of a child, particularly of 2-5 years age. The likelihood of a child being wasted declines with age or experience of the mother, particularly among children between 2 and 5 years. The IV Probit results also indicate that chances of severe wasting of kids less than 2 years of age decline with advancement of mother's age.

As expected, the monthly expenditure reduces the likelihood of children being nutritionally inferior. The dwelling characteristics could be as important determinants of children's nutritional status as are the parental characteristics. The likelihood of stunting of children is less in the households having quality roof tops (tile, slate, plastic, metal/asbestos and cement) as compared to those with thatched/mud/grass/wooden roof tops. The existence of a good toilet facility in the dwelling also leads to a significant decline in the prevalence of stunting, but not of severe stunting. The availability of piped water reduces the likelihood of children being severely stunted. Similar results are obtained from IV Probit regressions.

The likelihood of a kid being underweight is also less in the households with improved roof structure, toilet facilities and piped water source. The toilet facilities also cause a reduction in the probability of young kids being severely underweight. For older children, improved toilet facilities and modern roof structures lead to a reduction in the chances of their being severely underweight.

The likelihood of young kids being wasted reduces with the availability of a piped water source, good hygienic toilet facilities and quality roof structures. Also for older children, the existence of a bricked or stoned roof structure reduces the chances of their being wasted. But, the existence of good toilet facilities has an adverse effect on the likelihood of severe wasting.

These findings lead us to interpret that there exists a relationship between livestock ownership and child nutrition, although we have noted some differing patterns across age groups of children. For instance, livestock ownership and mother's characteristics (e.g., age and education) influence the nutritional status of older children more than those of infants who are mainly breastfed. The effect of livestock ownership, particularly of dairy animals, has been observed to be strongest in the case of underweight. We also observed an unexpected adverse association between children's

nutritional outcomes and some livestock species. These are probably due to the fact that the benefits of owning livestock such as an increase in animal source food (ASF) consumption and consequent nutritional benefits were not shared equally among all the members of the household. It might also be a consequence of an interaction of factors such as those relating to livestock-borne diseases, hygiene problems of livestock and a competition for food commodities between humans and animals.

This paper is not free from limitations. We have not been able to capture the effects of livestock ownership on other age groups and other key nutritional outcomes such as anaemia, micronutrient deficiencies, etc. The regressions estimates may suffer from an omitted variable bias, and also there is a possibility of a reverse causality between livestock ownership and illiterate females in a household. Since females contribute significantly to household income through their involvement in animal husbandry, their efforts may be diverted towards taking care of livestock at the cost of schooling and education with an increase in the herd size. This may cause simultaneity bias in the estimates. On the other hand, an increased bargaining power through higher contribution to household income may lead to greater schooling and better educational outcomes for children. It is difficult to answer such questions using a cross-sectional dataset like ours.

## Discussion

The role of a woman as producer of food and caretaker of household food and nutritional security is widely acclaimed in the development literature. According to Thornton *et al.* (2003), there has been little research on the role of women in livestock production, i.e., ownership of livestock and, control and use of income from livestock activities, despite the fact that two-thirds of the world's 600 million poor livestock keepers are rural women. Some studies from developing countries (Galab and Rao, 2003; Shicai and Jie, 2009) have also shown that livestock are not bound by any property rights, still only a small proportion of livestock belongs to women. They usually have a limited right of use for service and input delivery systems in livestock production (Sinn *et al.*, 1999; Shicai and Jie, 2009). Nevertheless, the evidence pretty much indicates that women are the primary caretakers

of livestock. In India, more than three-fourths of the labour requirement of livestock production is met by women (BIRTHAL and NEGI, 2012). In many government programmes aimed at women empowerment, livestock production is one of the preferred activities. For example, women comprise 28 per cent of the total members of villages' dairy cooperatives in India (NDDDB, 2014).

The literature on intra-household dynamics also shows that it is not just the household assets that influence developmental outcomes, but also who controls those assets. It has been proven that women's access to and control of assets lead to an improvement not only in their own welfare but also in household food security and child nutrition and education (World Bank, 2010; Quisumbing and Maluccio, 2003; Smith *et al.*, 2003).

It is also important to mention that agricultural assets such as livestock influence the nutritional outcomes via the income pathway. However, in the presence of incomplete markets, the livestock play a direct role in nutrient intake and growth. The direct health benefits of livestock ownership prevail in the greater availability and consequently, consumption of animal source foods (ASFs). Such foods provide complete protein, energy and a wide variety of micronutrients, which are usually absent from the rural diets (Scrimshaw, 1994). Besides these essential nutrients, they also provide dietary diversity and curb the seasonal variations in food crop availability (Murphy and Allen, 2003; Wilson *et al.*, 2005). Ownership of livestock also results in an enhanced household income that can be further used to purchase nutritious food items and better healthcare facilities, ultimately leading to an increased nutrient availability to the family members (Senauer, 1990; Kennedy, 1994). Similar findings were observed in our study as well but with specific reference to women workers.

A number of studies show positive nutritional benefits of livestock ownership for children. Neumann *et al.* (2002) have highlighted the role of ASF in enhancing the diets of women and children due to the availability of certain forms of micronutrients in them. Hitchings (1982, cited by Nicholson, 2003) found a positive relationship between child height and ownership of a milk cow, conditional on milk being used for family consumption. Leegwater *et al.* (1991)

provide evidence that the nutritional status of pre-school children in the households participating in a dairy development project in Kenya, was better than that of children from non-participating households. Biomedical evidence has validated that the consumption of dairy products has a strong marginal effect on child nutrition. These effects are particularly stronger for children between 6 and 24 months of age who are no longer exclusively breastfed and have high physical growth potential (Bhutta *et al.*, 2013).

Malapit *et al.* (2013) have found a highly significant and positive effect of women's autonomy in agricultural production decisions and children's nutritional outcomes in Nepal. In Uganda, Kabunga (2014) has observed that children who were younger than age 5 in households owning improved dairy cows, have a significant positive effect on reducing stunting. In China, similar improved household food security and nutrition resulted from income generated from the sale of goat kids, meat and hides (Sinn *et al.*, 1999).

The study (Hoddinott *et al.*, 2014) from rural Ethiopia has shown that cow ownership is important for enhancing milk consumption by children and reduces their stunting rates by 7-9 percentage points. Azzari *et al.* (2014) in their work on rural Uganda, have investigated whether ASF consumption translates into better nutritional outcomes, focusing on children under 5 years of age. Similar to our results, they also find significant relationship only among some nutritional outcomes and certain adverse associations among certain livestock species. They find only a weak association between livestock ownership and child nutritional status, specifically on the probability of being underweight and wasted (limited to children between 2 and 5 years of age), but no association to stunting. Jin and Iannotti (2014) have also highlighted the significance of gender aspects in designing interventions to increase child ASF consumption and improve child nutrition.

## Conclusions

This study reports that ownership of land plays a critical role in determining livestock ownership. The preference for small ruminants is stronger among the small landholders. Livestock owners are chiefly involved in agriculture and have larger landholdings.

Livestock ownership follows the social pecking order with the other backward castes being the dominant group. Female workers, particularly the illiterate ones, outnumber the male workers involved in animal care. This has been observed from the regression estimates as well wherein the coefficient on illiterate adult females is significantly positive and different from the coefficient associated with illiterate males. On an average, with an additional illiterate female worker, a household realizes more than 7 per cent higher income from livestock activities whereas an additional illiterate male worker will have no effect and this difference is statistically significant.

A negative relationship exists between livestock income and land size, which clearly establishes that livestock are relatively a more important income source for small landholders. It has been noted that in comparison to farm households, the households with allied agricultural activities as their main occupation realize higher income from livestock than those involved in non-farm activities because of the synergistic relationship between the two.

The study has attempted to establish whether livestock ownership translates into better nutritional outcomes for children. It has been found that there exists a weak relationship between livestock ownership and child nutrition, although with differing patterns across age groups of children. The likelihood of a child (particularly in the age group of 2-5 years) being underweight is lower among those households that own large ruminants. The effect of number of large ruminants owned on stunting and wasting is mixed. Small ruminants, on the other hand, lead to an adverse impact on underweight and wasting. It may, however, be noted that ownership of livestock is not a sufficient condition for enhancing nutrition. It is the intra-household distribution of consumption that matters. Also, such adverse effects are probably due to the fact that the benefits of owning livestock, i.e. an increase in ASF consumption and consequent nutritional benefits are not shared equally among all the members of a household.

The likelihood of children being malnourished reduces with an increase in mother's age, improvement in her educational status and household's monthly expenses. Availability of cash in the hands of women also reduces the chances of kids being stunted. It has

adverse effects on wasting – a consequence of acute weight loss – and thus might not be affected by the existence of liquidity in the household. Children, particularly those below 2 years, in the households with higher women participation in animal care, are nutritionally superior. It has been observed that dwelling characteristics such as good toilet facilities, quality roof tops and access to piped water source also play a significant role in determining the nutritional status of children.

There has been an emerging body of research which shows that women's role in livestock husbandry and agriculture can affect a household's food security. But this role is most often threatened by the women's limited control over resources and income. Our findings affirm that it is now critical to put on a gendered lens to all the livestock-related interventions and activities. Such interventions would help in directly enhancing the diet quality of the household members besides providing more livelihood opportunities and consequently enhanced incomes. It would help not only in the development of livestock sector but would also lead to empowerment of women in terms of their workloads, control over resources, better intra-household bargaining power besides widening of their knowledge base.

### Acknowledgements

The authors are grateful to Digvijay Negi and an anonymous referee for their valuable suggestions. The views expressed are those of the authors only.

### References

- Akter, S., Farrington, J., Deshingkar, P. and Freeman, A. (2008) *Livestock, Vulnerability, and Poverty Dynamics in India*. Discussion Paper No.10. International Livestock Research Institute, Nairobi, Kenya.
- Alary, V., Corniaux, C. and Gautier, D. (2011) Livestock's contribution to poverty alleviation: How to measure it? *World Development*, **39**(9): 1638-1648.
- Ashley, S., Holden, S. and Bazeley, P. (1999) *Livestock in poverty-focused development*. Crewkerne, UK. Livestock in Development.
- Ayele, Z. and Peacock, C. (2003) Improving access to and consumption of animal source foods in rural households: The experiences of a woman-focused goat development program in the highlands of Ethiopia. *The Journal of Nutrition*, **133**: 3981S-3986S.



- Azzarri, C., Cross, E., Haile, B. and Zezza, A. (2014) *Does livestock Ownership Affect Animal Source Foods Consumption and Child Nutritional Status?* Evidence from Rural Uganda. World Bank Policy Research Working Paper 7111. November.
- Barrett, C.B., Reardon, T. and Webb, P. (2001) Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food Policy*, **26**: 315-331.
- Bhutta, Z.A., Das, J.K., Rizvi, A., Gaffey, M.F., Walker, N., Horton, S., Webb, P., Lartey, A. and Black, R.E. (2013) Evidence based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *Lancet*, **382**(9890): 452-477.
- Birthal, P.S., Taneja, V.K. and Thorpe, W. (Eds) (2006) *Smallholder Livestock Production in India: Opportunities and Challenges*. National Centre for Agricultural Economics and Policy Research, New Delhi, India; and International Livestock Research Institute, Nairobi, Kenya.
- Birthal, P.S. and Negi, D.S. (2012) Livestock for higher, sustainable and inclusive agricultural growth. *Economic and Political Weekly*, **47**(26/27): 89-99.
- Birthal, P.S. and Taneja, V.K. (2012) Operationalizing the pro-poor potential of livestock: Issues and strategies. *Indian Journal of Animal Sciences*, **82**(5): 441-447.
- Das, N., Yasmin, R., Kamruzzaman, M., Davis, P., Behrman, J., Roy, S. and Quisumbing, A. (2013) *How do Intra Household Dynamics Change When Assets are Transferred to Women?* Discussion Paper No. 1317. International Food Policy Research Institute, Washington, DC.
- Deshpande, A. (2002) Assets versus autonomy? The changing face of the gender-caste overlap in India. *Feminist Economics*, **8**(2): 19-35.
- Duflo, E. (2003) Grandmothers and granddaughters: Old age pension and intra-household allocation in South Africa. *World Bank Economic Review*, **17**(1): 1-25.
- FAO-WHO (2004) *Human Energy Requirements*. Report of a Joint FAO/WHO/UNU Expert Consultation, Food and Nutrition Technical Report Series, FAO, Rome.
- Galab, S. and Rao, C. (2003) Women self-help groups: Poverty alleviation and empowerment. *Economic and Political Weekly*, **38**(12/13): 1274-1283.
- Garrett, J.L. and Ruel, M.T. (1999) Are determinants of rural and urban food security and nutritional status different? Some insights from Mozambique. *World Development*, **27**(11): 1955-1975.
- Hitchings, J.A. (1982) Agricultural determinants of nutritional status among Kenyan children. *PhD Dissertation*. Stanford University.
- Hoddinott, J., Headey, D. and Dereje, M. (2014) *Cows, Missing Milk Markets and Nutrition in Rural Ethiopia*. ESSP II Working Paper No. 63. International Food Policy Research Institute, Washington, DC.
- Jin, M. and Iannotti, L.L. (2014) Livestock production, animal source food intake, and young child growth: The role of gender for ensuring nutrition impacts. *Social Science & Medicine*, **105**: 16-21.
- Kabunga, N. (2014) Adoption and impact of improved cow breeds on household welfare and child nutrition outcomes: Empirical evidence from Uganda. Development Strategy and Governance Division of International Food Policy Research Institute, Kampala Office, Uganda. Contributed paper presented at the *88<sup>th</sup> Annual Conference of the Agricultural Economics Society*. AgroParisTech, Paris, France, 9-11 April.
- Kennedy, E. (1994) Health and nutrition effects of commercialization of agriculture. In: *Agricultural Commercialization, Economic Development and Nutrition*, Eds: J. Von Braun and E. Kennedy. The Johns Hopkins University Press, Baltimore.
- Kristjanson, P., Waters-Bayer, A., Johnson, N., Tipilda, A., Njuki, J., Baltenweck, I., Grace, D. and MacMillan S. (2010) *Livestock and Women's Livelihoods: A Review of the Recent Evidence*. ILRI Discussion Paper No. 20. International Livestock Research Institute, Nairobi.
- Leegwater, P., Ngolo, J. and Hoorweg, J. (1991) *Dairy Development and Nutrition in Kilifi District, Kenya*. Food and Nutrition Studies Programme, Report No. 35. Food and Nutrition Planning Unit, Ministry of Planning and National Development, Nairobi, Kenya and African Studies Center, Leiden, Netherlands.
- Malapit, H., Kadiyala, S., Quisumbing, A., Cunningham, K. and Tyagi, P. (2013) *Women's Empowerment in Agriculture, Production Diversity and Nutrition*. Discussion Paper No. 01313. International Food Policy Research Institute. Washington, DC.
- McPeak, J. and Doss, C. (2006) Are household production decisions cooperative? Evidence on pastoral migration and milk sales from northern Kenya. *American Journal of Agricultural Economics*, **88**(3): 525-541.
- Mistri, A. and Das, B. (2014) Assets disparities among social groups: A cross sectional analysis of Census 2011. *Social Change*, **44**: 1-20.

- Murphy, S.P. and Allen, L.H. (2003) Nutritional importance of animal source foods. *Journal of Nutrition*, **133**(11S-II): 3932S-3935S.
- NDDDB (National Dairy Development Board) (2014) *Annual Report, 2013-14*.
- Neumann, C., Harrison, D.M. and Rogers, L.M. (2002) Contribution of animal source foods in improving diet quality and function in children in the developing world. *Nutrition Research*, **22**:193-220.
- Nicholson, C.F., Mwangi, L., Staal, S.J. and Thornton, P.K. (2003) *Dairy Cow Ownership and Child Nutrition Status in Kenya*. AAEA Meetings Selected Paper.
- Okike, I., Jabbar, M.A., Abate, G. and Ketema, L. (2005) Household and environmental factors influencing anthropometric outcomes in preschool children in a rural Ethiopian community. *Ecology of Food and Nutrition*, **44**: 167-187.
- Pica-Ciamarra, U. (2005) *Livestock Policies for Poverty Alleviation: Theory and Practical Evidence from Africa, Asia and Latin America*. PPLPI Working Paper No. 27. Animal Production and Health Division, Food and Agriculture Organization, Rome, Italy.
- Quisumbing, A. and Maluccio, J. (2003) Resources at marriage and intra household allocation: Evidence from Bangladesh, Ethiopia, Indonesia, and South Africa. *Oxford Bulletin of Economics and Statistics*, **3**(0305-9049): 283-327.
- Rogers, B. (1996) The implications of female household headship for food consumption and nutritional status in the Dominican Republic. *World Development*, **24**(1): 113-128.
- Scrimshaw, N. (1994) The consequences of hidden hunger for individuals and societies. *Food and Nutrition*, **15**: 3-23.
- Senauer, B. (1990) Household behaviour and nutrition in developing countries. *Food Policy*, **15**(5): 408-417.
- Shicai, S. and Jie, Q. (2009) Livestock projects in southwest China: Women participate, everybody benefits. *Leisa Magazine*, **25** (3 September).
- Sinn, R., Ketzis, J. and Chen, T. (1999) The role of women in the sheep and goat sector. *Small Ruminant Research*, **34**(3): 259-269.
- Smith, L., Ramakrishnan, U., Ndiaye, A., Haddad, L.J. and Martorell, R. (2003) *The Importance of Women's Status for Child Nutrition in Developing Countries*. Research Report 131. International Food Policy Research Institute, Washington, DC.
- Tangka, F.K., Jabbar, M.A. and Shapiro, B.I. (2000) *Gender Roles and Child Nutrition in Livestock Production Systems in Developing Countries: A Critical Review*. Socio-economics and Policy Research Working Paper 27. International Livestock Research Institute, Nairobi, Kenya.
- Thomas, D. (1997) Incomes, expenditures, and health outcomes: Evidence on intra-household resource allocation. In: *Intra-household Resource Allocation in Developing Countries: Models, Methods, and Policy*, Eds: L. Haddad, J. Hoddinott and H. Alderman. The Johns Hopkins University Press, Baltimore.
- Thornton, P.K., Kruska, R.L., Henninger, N., Kristjanson, P.M., Reid, R.S. and Robinson, T.P. (2003) Locating poor livestock keepers at the global level for research and development targeting. *Land Use Policy*, **20**(4): 311-322.
- Villa, K.M., Barrett, C.B. and Just, D.R. (2010) Differential nutritional responses across various income sources among East African pastoralists: Intrahousehold effects, missing markets and mental accounting. *Journal of African Economies*, **20**(2): 341-375.
- Wilson, T., Pearson, A., Bradbear, N., Jayasuriya, A. Laswai, H., Mtenga, L., Richards, S. and Smith, R. (2005) Livestock products—Valuable and more valuable. In: *Livestock and Wealth Creation: Improving the Husbandry of Animals Kept by Resource-poor People in Developing Countries*, Eds: E. A. Owen, A. Kitalyi, N. Jayasuriya and T. Smith. Nottingham University Press, Nottingham, UK. pp. 109-126.
- World Bank (2010) *Demand Led Transformation of the Livestock Sector in India: Achievements, Opportunities, and Challenges*. Report No. 48412-IN. Washington, DC.
- WHO (World Health Organization) (2006) WHO child growth standards and the identification of severe acute malnutrition in infants and children: A joint statement by the World Health Organization and the United Nations Children's Fund.

**Appendix Table 1(a). Probit regression estimates on severe stunting, severe underweight and severe wasting**

Variables	Severe stunting		Severe underweight		Severe wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
Female child	-0.0000 (0.015)	0.0121 (0.010)	-0.0139 (0.012)	-0.0069 (0.008)	0.0014 (0.014)	-0.0059 (0.005)
Age of child (in years)	-	-0.0652*** (0.011)	-	-0.0241*** (0.007)	-	-0.0120** (0.005)
Presence of cash in hand	-0.0074 (0.019)	-0.0277** (0.014)	-0.0046 (0.014)	0.0138 (0.010)	0.0093 (0.016)	0.0117* (0.007)
Age of child squared (in years)	-0.0690*** (0.004)	0.0195*** (0.005)	-0.0565*** (0.005)	0.0088** (0.004)	0.0063* (0.004)	0.0030 (0.002)
<i>Household has</i>						
Traditional pit latrine	-0.0287 (0.033)	-0.0271 (0.021)	-0.0191 (0.022)	-0.0250 (0.016)	-0.0331 (0.029)	0.0237** (0.010)
Ventilated improved pit latrine	-0.0613 (0.050)	0.0012 (0.030)	-0.0955** (0.041)	0.0066 (0.033)	-0.0709 (0.048)	0.0200 (0.025)
Flush toilet	-0.0579* (0.031)	-0.0093 (0.023)	-0.0422* (0.023)	-0.0598*** (0.018)	-0.0059 (0.027)	0.0080 (0.010)
Household has piped water source	-0.0363* (0.022)	-0.0319** (0.014)	-0.0177 (0.014)	-0.0100 (0.011)	-0.0058 (0.017)	0.0020 (0.006)
<i>Household has</i>						
Tile/slate/plastic roof	-0.0054 (0.021)	-0.0438*** (0.014)	-0.0213 (0.015)	-0.0317*** (0.011)	-0.0062 (0.017)	-0.0011 (0.007)
Gi metal/asbestos roof	-0.0840** (0.037)	-0.0814*** (0.024)	-0.0241 (0.024)	-0.0595*** (0.019)	-0.0377 (0.027)	-0.0076 (0.012)
Cement roof	-0.0467* (0.028)	-0.0349* (0.020)	-0.0206 (0.020)	-0.0229 (0.016)	-0.0506* (0.027)	-0.0100 (0.010)
Brick/stone roof	0.0255 (0.025)	-0.0287 (0.018)	0.0209 (0.017)	-0.0545*** (0.014)	-0.0126 (0.023)	-0.0214** (0.009)
Age of mother	0.0032** (0.001)	0.0001 (0.001)	0.0018* (0.001)	-0.0011 (0.001)	-0.0024* (0.001)	-0.0004 (0.000)
Number of females in-between 15-60 years	0.0029 (0.009)	0.0030 (0.006)	0.0023 (0.006)	0.0045 (0.005)	0.0005 (0.008)	0.0002 (0.003)
Number of large ruminants	-0.0050 (0.006)	-0.0003 (0.004)	0.0039 (0.005)	-0.0030 (0.003)	0.0009 (0.004)	-0.0022 (0.002)
Number of small ruminants	0.0019 (0.001)	-0.0008 (0.001)	0.0012 (0.001)	0.0008 (0.001)	0.0000 (0.002)	0.0006** (0.000)
Number of poultry birds	-0.0015 (0.002)	-0.0034 (0.003)	-0.0028 (0.003)	-0.0001 (0.002)	-0.0000 (0.001)	0.0024*** (0.001)
Mother's education (max. years)	-0.0050** (0.002)	-0.0117*** (0.002)	-0.0051*** (0.002)	-0.0059*** (0.001)	0.0015 (0.002)	0.0006 (0.001)
Child illness during past 30 days	-0.0074 (0.017)	0.0240* (0.012)	0.0024 (0.012)	0.0121 (0.009)	0.0064 (0.014)	-0.0085 (0.006)

Contd...

**Appendix Table 1(a).... contd.**

Variables	Severe stunting		Severe underweight		Severe wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
Dependency ratio	-0.0001 (0.000)	0.0001 (0.000)	0.0001 (0.000)	0.0000 (0.000)	0.0001 (0.000)	-0.0001 (0.000)
Livestock care by females	-0.0380** (0.017)	-0.0061 (0.012)	-0.0273** (0.013)	-0.0051 (0.009)	-0.0163 (0.014)	-0.0023 (0.006)
MPCE	-0.0000 (0.000)	-0.0000 (0.000)	-0.0000 (0.000)	-0.0001*** (0.000)	0.0000 (0.000)	-0.0000* (0.000)
Number of observations	2,572	8,193	2,854	9,084	1,700	8,232
Number of clusters	1347	1347	1059	1385	833	1347
$\chi^2$	252.72	214.22	179.91	179.50	23.50	54.05
Probability	0.0000	0.0000	0.0000	0.0000	0.3177	0.0002
Pseudo R <sup>2</sup>	0.1146	0.0236	0.1273	0.0264	0.0174	0.0180

Notes: Standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Appendix Table 1(b). Instrumental variables (IV) Probit regression estimates on severe stunting, severe underweight and severe wasting**

Variables	Severe stunting		Severe underweight		Severe wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
MPCE	-0.0001* (0.000)	-0.0001*** (0.000)	-0.0001*** (0.000)	-0.0002*** (0.000)	-0.0001** (0.000)	-0.0000 (0.000)
Female child	-0.0001 (0.015)	0.0105 (0.010)	-0.0152 (0.012)	-0.0087 (0.008)	-0.0002 (0.016)	-0.0059 (0.005)
Age of child (in years)	-	-0.0646*** (0.010)	-	-0.0252*** (0.008)	-	-0.0121** (0.005)
Age of child squared (in years)	-0.0685*** (0.004)	0.0195*** (0.005)	-0.0576*** (0.005)	0.0095** (0.004)	0.0069* (0.004)	0.0030 (0.002)
Presence of cash in hand	-0.0030 (0.019)	-0.0243* (0.014)	-0.0011 (0.015)	0.0186* (0.011)	0.0189 (0.019)	0.0118* (0.007)
<i>Household has</i>						
Traditional pit latrine	-0.0048 (0.037)	-0.0085 (0.021)	0.0096 (0.025)	-0.0027 (0.017)	-0.0043 (0.037)	0.0242** (0.010)
Ventilated improved pit latrine	-0.0384 (0.054)	0.0225 (0.030)	-0.0648 (0.044)	0.0312 (0.033)	-0.0549 (0.054)	0.0205 (0.026)
Flush toilet	-0.0410 (0.032)	0.0130 (0.024)	-0.0198 (0.025)	-0.0321 (0.020)	0.0247 (0.032)	0.0085 (0.011)
Household has piped water source	-0.0322 (0.022)	-0.0247* (0.014)	-0.0149 (0.014)	-0.0015 (0.011)	-0.0040 (0.019)	0.0022 (0.006)
<i>Household has</i>						
Tile/slate/plastic roof	-0.0067 (0.021)	-0.0469*** (0.014)	-0.0229 (0.015)	-0.0366*** (0.011)	-0.0087 (0.019)	-0.0012 (0.007)
Gi metal/asbestos roof	-0.0863** (0.038)	-0.0831*** (0.024)	-0.0259 (0.025)	-0.0640*** (0.019)	-0.0514* (0.030)	-0.0077 (0.012)

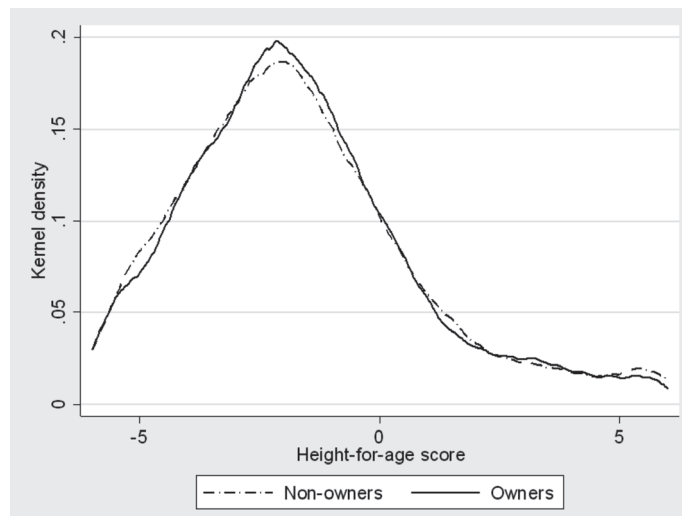
Contd...

**Appendix Table 1(b) contd.**

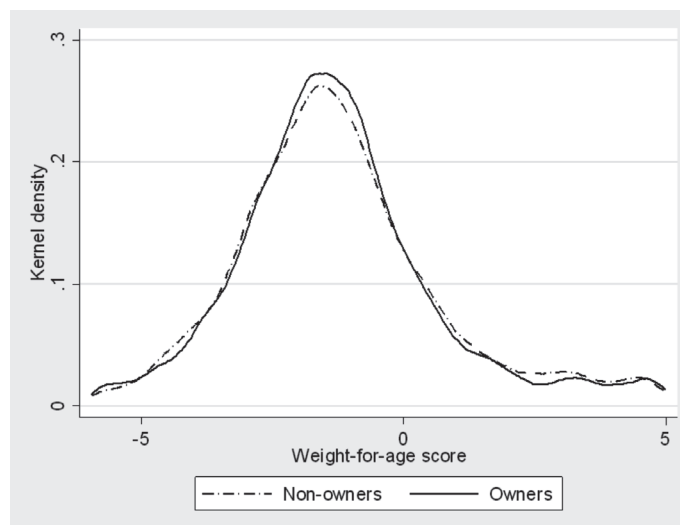
Variables	Severe stunting		Severe underweight		Severe wasting	
	0-2 years	2-5 years	0-2 years	2-5 years	0-2 years	2-5 years
Cement roof	-0.0356 (0.029)	-0.0172 (0.020)	-0.0052 (0.022)	-0.0044 (0.016)	-0.0293 (0.032)	-0.0096 (0.010)
Brick/stone roof	0.0387 (0.026)	-0.0161 (0.018)	0.0366* (0.020)	-0.0418*** (0.015)	0.0063 (0.028)	-0.0211** (0.009)
Age of mother	0.0032** (0.001)	0.0002 (0.001)	0.0019* (0.001)	-0.0009 (0.001)	-0.0026* (0.001)	-0.0004 (0.000)
Number of females in-between 15-60 years	-0.0019 (0.009)	-0.0012 (0.006)	-0.0041 (0.007)	-0.0005 (0.005)	-0.0059 (0.009)	0.0001 (0.003)
Number of large ruminants	-0.0017 (0.007)	0.0021 (0.004)	0.0084* (0.005)	-0.0003 (0.003)	0.0035 (0.005)	-0.0022 (0.002)
Number of small ruminants	0.0019 (0.001)	-0.0008 (0.001)	0.0012 (0.001)	0.0009 (0.001)	0.0001 (0.002)	0.0006** (0.000)
Number of poultry birds	-0.0018 (0.002)	-0.0033 (0.003)	-0.0038 (0.003)	-0.0002 (0.002)	-0.0002 (0.001)	0.0024*** (0.001)
Mother's education (max. years)	-0.0026 (0.003)	-0.0093*** (0.002)	-0.0020 (0.002)	-0.0032** (0.001)	0.0053* (0.003)	0.0007 (0.001)
Child illness during past 30 days	-0.0052 (0.017)	0.0267** (0.012)	0.0038 (0.013)	0.0152 (0.009)	0.0126 (0.016)	-0.0084 (0.006)
Dependency ratio	-0.0002 (0.000)	0.0000 (0.000)	0.0000 (0.000)	-0.0001 (0.000)	-0.0001 (0.000)	-0.0001 (0.000)
Livestock care by females	-0.0367** (0.017)	-0.0014 (0.012)	-0.0254* (0.013)	0.0024 (0.009)	-0.0170 (0.016)	-0.0022 (0.006)
Number of observations	2,572	8,193	2,854	9,084	1,700	8,232
Number of clusters	1015	1347	1059	1385	833	1347
$\chi^2$	257.96	220.15	213.36	217.32	40.68	51.25
Probability	0.0000	0.0000	0.0000	0.0000	0.0061	0.0004
$\chi^2$ for exogeneity	2.81	9.24	8.95	25.23	6.13	0.03
Probability for exogeneity	0.0939	0.0024	0.0028	0.0000	0.0133	0.8679

Notes: Standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

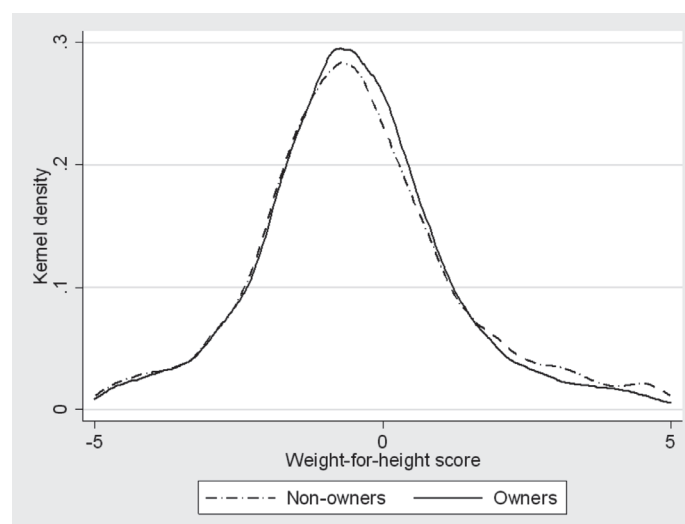




**Appendix Figure 1. Height-for-age z-score (Stunting)**



**Appendix Figure 2. Weight-for-age z-score (Underweight)**



**Appendix Figure 3. Weight-for-height z-score (Wasting)**