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## Smallholder milk market participation, dietary diversity and nutritional status among young children in Ethiopia

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### Abstract

This study examines the effects of smallholder milk market participation on household and intra-household dietary diversity and on nutritional status of young children in Ethiopia. Using the FAO dietary diversity questionnaire, 164 households were followed for two consecutive days and all food items consumed by five household members were recorded. T-test and propensity score matching were used to analyze the data. Milk market participant households have significantly higher levels of milk production, household income, dietary diversity and nutritional status of young children. Despite significant differences in milk production between market participant and non-participant households, no significant differences were found with regard to animal source food consumption in general and milk consumption in particular. However, dietary diversity and nutritional status of children under five is better in participant households, thus indicating that smallholder market participation is positively associated with food security and nutritional status of farm households in rural Ethiopia.

**Keywords:** Child-anthropometry, dietary diversity, Ethiopia, milk-market, nutrition

### Introduction

The World Food Summit in 1996 agreed that the most widely used definition of food security is that food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Summit & FAO, 1996). From this definition one can recognize that dietary diversity and the nutrient contents of the food are an important aspect of food security. In developing countries where the majority of the population lives in rural areas and derive their livelihood from agriculture, increasing agricultural productivity is seen as a critical step in ensuring sustainable food security (Headey, 2011, Kirimi, *et al.*, 2013). Growing evidence indicates that the success of agricultural productivity depends on the expansion of market opportunities (Gabre-Madhin & Haggblade, 2004; Njuki, *et al.*, 2011). Linking smallholder farmers to the market is therefore emphasized in many African countries.

However, there is no consensus in the literature about the impact of smallholder commercialization on nutritional status and food security of household members. Some studies point to the existence of potential synergies. They argue that sustainable

household food security and welfare requires a commercial transformation of subsistence agriculture, because this leads to higher productivity and increased household income and thus to improved welfare gains for the smallholder farmer (Pingali, 1997, World Bank, 2008). A rise in income accompanying commercial production does not, however, automatically lead to improved nutrition, at least not for all household members. A shift towards commercial agriculture may as well lead to a decline in nutritional status of household members (Dewey, 1981). It can lead to a diversion of resources from food to cash crop production and lower food availability from own production (Immink and Alarcon, 1993, Hoorweg *et al.*, 2000). Commercial transformation may also have adverse consequences because it exposes households to volatile market prices in situations where the rural markets are not well integrated (Jaleta *et al.*, 2009). Hence, while commercial transformation may potentially affect the food security and nutritional status of farm households, no definitive evidence is available about the size and direction of the effects.

In this paper, we study the relationships between Ethiopian smallholder milk market participation, dietary diversity, and child nutritional status by performing a household survey and an observational study. We examine the pattern of milk consumption, household and intra-household dietary diversity and nutritional status of young children in milk market participant and non-participant households.

### **Background**

The Ethiopian economy is based on subsistence agriculture, whereby 85% of the population produces its own food (CSA, 2008). In a recent development plan the country aims at transforming the agricultural sector from a subsistence to a market oriented production system. This transformation plan entails the participation of smallholders in both input and output markets. The policy targets dairy farmers in peri-urban areas. This is because Ethiopia, despite having the largest livestock population in Africa, has one of the lowest dairy production and consumption on the continent. The country has an average production of four billion liters of milk per annum and a consumption of 25.6kg/year per person (Ayenew, 2008). Food consumption in Ethiopia largely depends on cereals. In the central highland areas, *Enjera-be wet*, traditional bread with spiced sauce is the most common food item. The fasting season among the Orthodox Church followers restricts animal source food consumption for about five to seven months per year for adults. Hence, consumption is mostly based on cereals. However, cereal based diets are recognized as monotonous, lacking essential micronutrients and contributing to malnutrition and micronutrient deficiencies, especially in children, who need energy and nutrient-dense food to grow and develop both physically and mentally (Vakili *et al.*, 2013; Arimond & Ruel, 2004 and (Bukania *et al.*, 2014)

Food consumption in Ethiopia is tidily associated with cultural taboos and religious practices (Seleshe *et al.*, 2014). Many tales and jokes in the country characterize eating as wasting resources and those who consume less are admired and considered as good boys and girls in the family. Preferential and sequential feeding is also common in rural households whereby the males eat first and the women eat the leftovers. Girls are advised to eat less to keep their body shape, and to tie their stomach with *Mekenet*, a strong traditional belt. As a result of this culture and the pervasive food insecurity, Ethiopia has a high rate of stunting and great lack of dietary diversity (Hoddinott *et al.*, 2014). Despite

this fact, recently the government started to award farmers for saving more money in the bank or investing it in physical assets. This policy can divert attention from consumption and may worsen the already high level of food insecurity and micronutrient deficiencies in the country.

According to Kennedy, *et al.*, (2008) and Swindale & Bilinsky (2006) a more diversified diet is associated with improved birth weight, child anthropometric status, and hemoglobin level. Hence, improving dietary diversity and animal source foods intake can potentially contribute to alleviating micronutrient deficiencies in Ethiopia. This is also confirmed in empirical research that documented a positive relationship between dairy intensification and child nutritional status in the central highlands of Ethiopia (Ahmed *et al.*, 2000, Tangka *et al.* 2002 and Ahmed *et al.*, 2003). A recent study by Hodidinott *et al.*, (2014) also indicated that cow ownership raises children`s milk consumption, increase linear growth and reduces stunting. However, this positive impact might be the result of direct milk (product) consumption at the household level, which potentially might be affected by the level of households` milk market integration. When the households are active in the milk market, milk consumption at the household level may happen only if the household can afford to forgo the cash income generated from its sale. Hence, in this paper we investigate whether and how smallholder milk market participation affects milk (product) consumption, dietary diversity and nutritional status of household members.

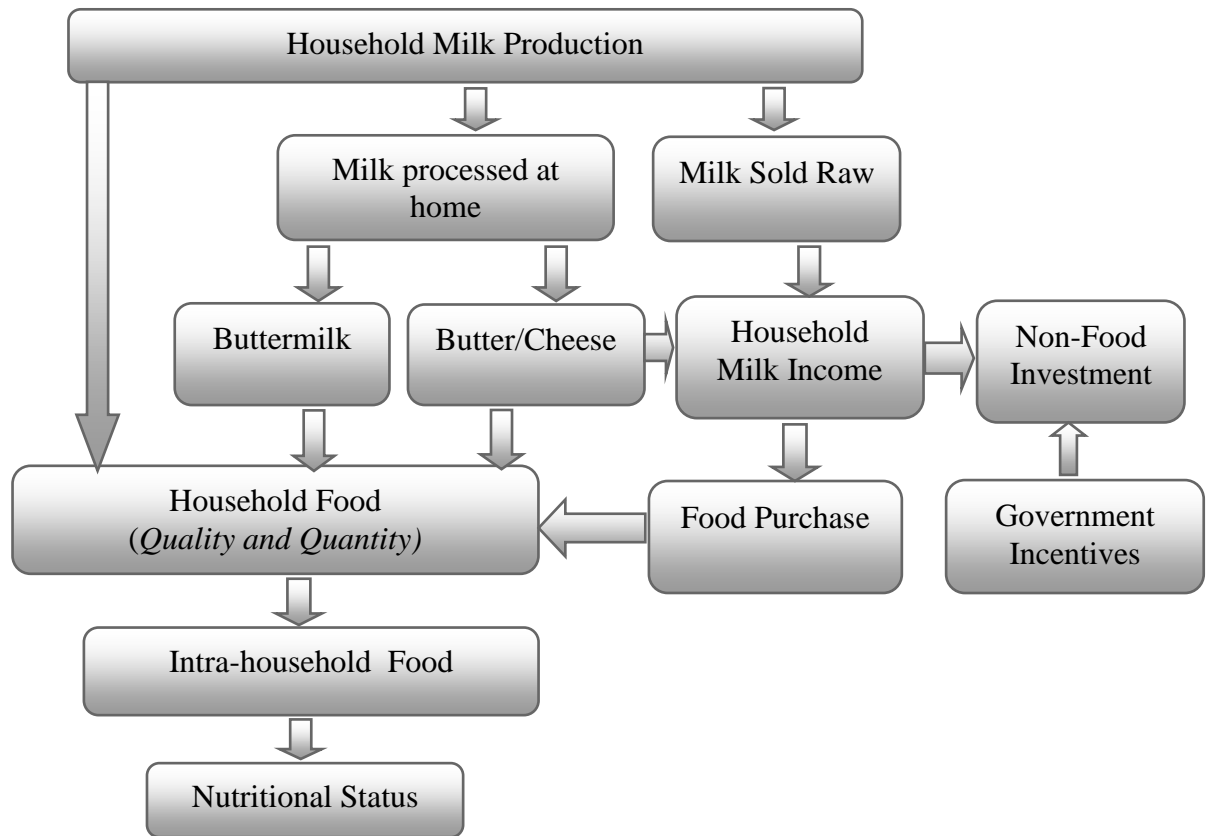
### **Conceptual framework**

According to Njuki & Sangina (2013 p 95-96) livestock plays an important role in contributing to food security through (i) enabling direct access to animal source foods (ASF) at household level (ii) providing cash income from sale of livestock and livestock products (dairy) that can in turn be used to purchase food (especially during time of food deficit) (iii) contributing to increased aggregate cereal supply as a result of improved productivity from use of manure and traction and (iv) lowering the price of livestock products and therefore increasing access to such products by the poor. Ethiopia is making an effort to meet the increasing demand for livestock products by transforming the livestock and dairy sector from subsistence to market-oriented production system. This transformation can potentially affect food consumption, dietary diversity and nutritional status, at least via two pathways. First, it increases the availability of dairy products for consumption at household level. Second, the households can generate income from milk (products), which can be used to improve dietary quality at household and individual level.

Figure 1 captures household market participation and its food consumption and nutrition effects. Dairy farm households make a critical decision in allocating their daily milk production between consuming at home, processing into butter/cheese or selling raw to generate cash income. When households directly consume their milk production, it will lead to better diet quality and nutritional status. When they process milk into butter and cheese, they can generate income by selling the products in the local market (controlled by women). Moreover, buttermilk will be consumed in the household contributing to dietary quality. When the household supplies the entire milk to the milk market, milk (product) consumption might be negatively affected. However, the households can use

the additional income to purchase diverse and quality food to boost their nutritional status.

By effecting these intra-household milk allocation decisions, between direct consumption, processing into butter/cheese or selling raw milk, milk market participation can affect animal source food consumption, dietary diversity and nutritional status at household and intra-household level. This study mainly aims to investigate this intra-household allocation decisions and its effect on food security in the Ethiopian context (Figure 1).



**Figure 1: Dairy production, marketing consumption-A conceptual framework**

## Materials and methods

### *Data and measurement*

This study was conducted in Selale situated in Oromia national regional state of Ethiopia. Selale was selected for this study because of its potential for and tradition of dairy production and marketing. Most of the populations in Selale are followers of the Orthodox Church. This is relevant as the Orthodox Church followers have two fasting days every week and other additional major fasting seasons that makes up to five to seven months per years in which animal source food consumption is prohibited. The farming system and milk market coverage is similar across Selale. The Selale Dairy Cooperative

Union (SDCU) is the only formal milk buyer in the area and is used as an entry point for this study. Four primary dairy cooperatives were randomly selected from a list of 22 primary dairy cooperatives that are active members of SDCU. These dairy cooperatives were located in four different *kebeles*, which were taken as the sample *kebeles* for the study. By employing a stratified sampling technique, 300 farm households (150 members of dairy cooperatives and 150 non-members) were selected proportional to the size of the population in the *kebeles*.

A structured questionnaire on the socioeconomic and demographic background of the dairy farm households and on household food consumption patterns was administered to the male head of the household or his spouse. After further stratifying the households into milk market participant and non-participant households based on the survey result, 168 farm households with five household members, four adult members and a young child under age of five were selected for the dietary diversity observational study.

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods as well as nutrient adequacy of the diet of individuals (Arimond & Ruel, 2004;). Dietary diversity is relevant for and contributes to food security (Hoddinott & Yohannes, 1999; Kennedy, 2009; Uraguchi, 2011). A dietary diversity observation checklist was prepared on the basis of FAO dietary diversity questionnaire (FAO, 2008). The checklist covers almost all food items used in the community. It includes questions on cereals, milk and milk products, meat, egg, potatoes and roots, vegetables, fruits, legumes, oil and fat, sweets, fish, and other food categories. The food items were categorized into 12 food groups to create the household dietary diversity score (HDDS) (Table 1) and into nine food groups to compute an intra-household individual dietary diversity score (IDDS) (Table 2). Any ingredient that was used in the meals independent of its quantity was recorded.

**Table 1: Household level food categories and examples**

S. N	Food Groups	Examples in the group	1=Yes, 0=No
1	Cereals	Any food made of cereals/grains (Injera, bread, rice, pasta, porage, pancake etc)	
2	Milk products	Milk, buttermilk, cheese, butter, yogurt	
3	Meat	Any meat	
4	Egg	Egg	
5	Potatoes/roots	Potatoes and other root foods	
6	Vegetables	Tomato, onion, cabbage	
7	Fruits	Banana, orange	
8	Legumes	Beans, peas, lentils, nuts	
9	Oil and fat	Oil, fats, butter	
10	Sweets	Sugar, honey	
11	Fish	Fish foods	
12	Others	Kolo, alcohol, coffee, tea, spices	

The dietary diversity score used in this paper consists of a simple count of food groups

from which the household/individual has consumed in the two-day study period. Based on (Kennedy *et al.*, 2008), we assume this score at the household level to reflect the economic ability of the household to access a variety of food. At the individual level, it is assumed to reflect nutrient adequacy. Hoddinott & Yohannes (1999) and Kennedy *et al.*, (2008) noted that dietary diversity could be used to assess changes in diet before and after an intervention with potential impact or after a disaster such as crop failure or drought. The mean dietary diversity score can be used to compare sub-populations. Hence, we compared milk market participant and non-participant households in this regard.

**Table 2: Individual level food categories and examples**

S. N	Food Groups	Examples in the group	1=Yes, 0=No
1	Starchy staples	Any food made of cereals/grains (Injera, bread, rice, pasta, porage, pancake etc)	
2	Milk products	Milk, buttermilk, cheese, butter, yogurt	
3	Meat and fish	Flesh meat, fish and sea foods	
4	Organ meats	Organ meats	
5	Eggs	Eggs	
6	Vitamin A rich fruits & vegetables	Vegetables, fruits	
7	Green leafy vegetables	Cabbage	
8	Other fruits and vegetables		
9	Legumes	Beans, peas, lentils, nuts	

Animal source food (ASF) consumption based on the sum of the score for animal origin foods was also measured. Animal source food score contains three food groups: meat foods, egg foods and milk and milk product foods and the score ranges between zero and three (Kennedy *et al.*, 2008).

Child anthropometry is considered as the best general proxy measure of human welfare of the poor, reflecting dietary inadequacies and other environmental health risks (UN-ACC/SCN, 1992). It is also a strong and feasible predictor, at the individual and community level, and an appropriate indicator of the success or failure of interventions directed towards economic and environmental factors underlying nutrition deprivation. In this study the height, weight and age of children under five were measured and calculated the standard height-for-age, weight-for-age and weight-for-height z-scores by using WHO AnthroPlus for personal computer version 3.2.2, 2011 Software (for children aged 0-59 months). Based on these indicators, the proportion of stunted, wasted and underweight children in milk market participant and non-participant households were determined.

According to WHO (2010) stunting is below minus two standard deviations from median height-for-age of reference population. Child growth is an internationally recognized

indicator of nutritional status and health in populations; hence the proportion of children with a low height-for-age (stunting) reflects the cumulative effects of under-nutrition and infections since and even before birth. Similarly, the cut-off point for wasting is below minus two standard deviations from median weight-for-height of the reference population and is a symptom of acute under-nutrition, usually as a consequence of insufficient food intake or a high incidence of infectious diseases while underweight is below minus two standard deviations from median weight-for-age of reference population reflecting 'wasting', 'stunting', or both (WHO, 2010).

Twelve extension worker comprising; eight agricultural and four health extension workers were trained to do the observation study. The checklist was pretested in 12 households. The extension workers stayed within the household and recorded food consumed by four-five household members for two consecutive non-fasting days. Completed observation checklists were returned from 164 households. For four households the checklists were incomplete. These households were discarded from the analysis to maintain consistency in the data.

### ***Analyses***

#### *T-Test statistics*

A T-test was used to compare milk market participant and non-participant households on selected socioeconomic and demographic backgrounds, anthropometric indices for children under five, daily milk production, and its intra-household allocation and dietary diversity score at household and intra-household level.

#### *Propensity score matching*

To determine the effect of smallholder milk market participation on household milk consumption and dietary diversity and on the animal source food score, it was necessary to compare observed outcomes for these variables with the outcomes that would have been obtained for those same households in the same time-period if they did not participate in the milk market. The fundamental challenge here is that we do not have the counterfactual, the outcome of participant households if they would not have entered the milk market. The key to this challenge is to construct these counterfactual outcomes using information from non-participant households. However, a simple comparison of the average outcomes for the two households would misrepresent the effect, conflating differences caused by household market participation with differences that already existed (selection bias). Constructing a valid counterfactual is thus critical. This requires controlling for the effects of confounding factors that make participants systematically different from non-participants. By using effect estimates adjusted for these confounders the likelihood of selection bias will be reduced.

For this adjustment, we rely on propensity score matching (PSM). PSM uses information from a pool of units that do not participate in the intervention, to identify what would have happened to the participating units in the absence of the intervention (Austin, 2011; Heinrich *et al.*, 2010; Rosenbaum & Rubin, 1983). It has two major assumptions; *the conditional independence assumption* and *the common support assumption* (Rosenbaum, & Rubin, 1983). 'Conditional independence' means that there is a set of X covariates and



that controlling for these covariates makes the potential outcomes independent of the treatment status. ‘Common support’ implies that for each value of X, there is a positive probability of being both treated and untreated (to be on common support). Three main variables are required to do the matching. These are (1) a dummy variable that groups households into participants and non-participant, (2) predicted probability scores, indicating the probability that a unit in the combined sample of treated and untreated units receives the treatment given their observed characteristics and (3) the outcome variable(s) on which the average treatment effect on the treated will be evaluated. The average treatment effect on the treated (ATT) is given as follows (Austin, 2011; Heinrich et al., 2010; Rosenbaum & Rubin, 1983).

$$\begin{aligned} \mathcal{J}ATT &= E(\mathcal{J}|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \\ \mathcal{J}ATT &= E(\mathcal{J}|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \end{aligned}$$

Where  $Y_0$  = the outcome in control group and  $Y_1$  = the outcome in treatment group

To assess the effect of smallholder milk market participation on dietary diversity and nutritional status of young children, we matched the households based on their baseline characteristics which includes household distance from milk collection center (MCC), household size, household total number of cows, lactating cows and crossbreed cows, household land size, age of parents, education of parents, membership in dairy cooperatives and dairy experience. The result of the logit regression is presented in Table 3.

**Table 3: Logit model - probability of milk market participation**

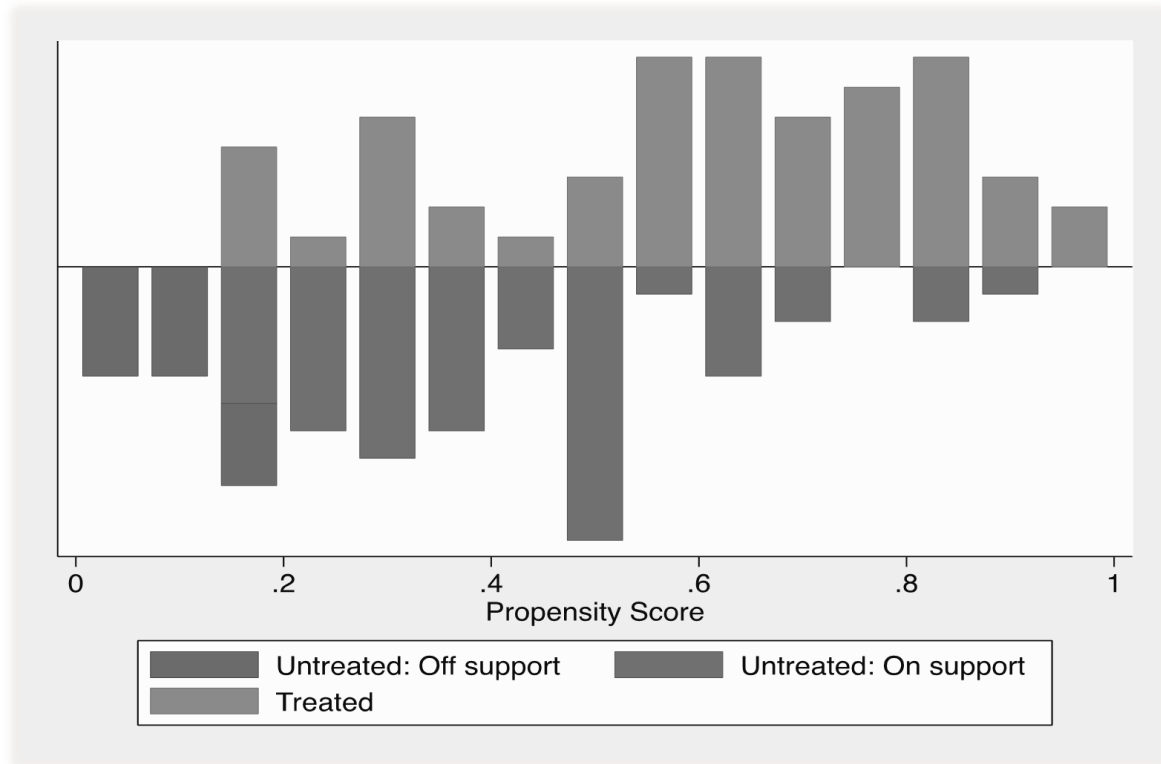
<i>Variables</i>	<i>Coff</i>	<i>Stt.Er</i>	<i>T-Stata</i>
Household distance from MCC	-.431	.1288	-3.35***
Household size	.589	.236	2.12**
Household female size	-.187	.298	-0.63
Household child under Five	.1020	.959	0.11
Husband age	.048	.026	1.98**
Wife age	-.025	.0219	-1.17
Household land size	-.306	.160	-1.91
Household head education	.544	.353	2.23**
Household total cow size	-.133	.196	-0.68
Household lactating cow size	.372	.299	1.24
Household crossbred cow size	0.67	.134	2.34**
Household dairy experiences	.722	.033	1.99**
Membership in dairy cooperatives	-.125	.482	-0.26
_cons	1.292	2.21	-0.59

*Number of obs = 123, LR chi2(12) = 31.11, Prob > chi2 = 0.0019, Log likelihood = -61.270373, Pseudo R2 = 0.2025, Region of common support [.16133051, .94757662]*

Household distance from milk collection center (MCC) is significantly and negatively related to household milk market participation. On the other hand, household size, age of

head of the household head, education level of the household head, household crossbred cow size and household diary experience are significantly and positively related to household milk market participation.

The result shows that there are households from the participant as well as the non-participant group on the common support region. The distribution of the estimated propensity scores is presented in Figure 2.



**Figure 2: Distribution of propensity scores**

To estimate ATT, the mean difference in outcomes for market participant and non-participant households after matching, two matching algorithm; nearest neighbor (NN) matching and kernel matching was used. We have imposed the common support condition to minimize drawback and to improve the robustness of the results. The standard errors have been computed using 100 bootstrap replications. According to De Hoop (2012), using both nearest neighbor matching with replacement and kernel matching provides a natural robustness check to guard against the disadvantages of the two matching algorithm.

## Empirical results

### *Characteristics of the study participants*

About 51 percent of the households are milk market participants. They sell milk to cooperatives, middlemen, processing companies, hotels and cafeterias.

**Table 4: Socioeconomic comparison in market participant and non-participant households**

Covariates	Market Participant		Non-Participant		T-Stat
	Mean	Std Error	Mean	Std Error	
Household distance from MCC	3,1	0,208	5,2	0,297	-5,2***
Household size	7,7	0,219	6,7	0,230	2,99***
Household land	4,7	0,260	3,9	0,195	2,22**
Household total cow	4,7	0,187	4,1	0,140	2,50***
Household lactating cow	2,8	0,127	2,2	0,079	3,85***
Household crossbreed cow	2,1	0,189	1,2	0,138	3,58***
Household dairy experience	20,6	0,91	17,1	0,71	3,02***
Number of children <5	0,81	0,062	0,64	0,054	2,08**
Age of child <5 (in months)	25,1	1,28	36,2	1,73	-5,05***
Weight of child <5 (in kg)	12,1	0,477	12,3	0,361	0,211
Height of child <5 (in cm)	83,1	1,45	87,5	1,53	2,11**
Height4age z-score	-1,18	0,238	-1,94	0,240	2,22**
Weight4age z-score	0,17	0,220	-1,15	0,154	3,68***
BMI4age z-score	0,80	0,351	0,15	0,273	1,47

\*\*\* P<0.01, \*\* P<0.05, Number of obs = 164 (84 market participant and 80 non-participant)

The remaining 49% are non-participants. They do not sell raw milk, although they can process and sell butter and cheese in the local market. Market participants are located significantly closer to milk collection centers and have higher mean for household, land, total cow, lactating cows and crossbred cow size compared to non-participant households (Table 4). Milk market participants also have longer dairy experience compared to non-participant households. The number of children under five is also significantly higher in market participant compared to non-participant households. Children in market participant households are on average one year younger than children in non-participant households. They are also significantly shorter, but there are no significant weight differences between both groups of children. Children in non-participant households are significantly more stunted and underweight compared to children from participant households.

#### ***Food consumption patterns in market participant and non-participant households***

Table 5 summarizes household total daily milk production and its allocation across home consumption, processing and sales in milk market participant and non-participant households. Market participant households produce significantly more milk per day than non-participant households. The mean for milk production per day in market participant household is 12.3 liters while it is 6 liters in non-participant households. The milk that is produced can basically be used for three purposes; it can either be sold raw at the market, processed into butter and cheese at the household level, or be consumed at the household

level.

**Table 5: Comparison of daily milk production and allocation across home consumption, processing and sales**

	Market Participant		Non-Participant		T-Test
	Mean	Std Error	Mean	Std Error	t-Value
Total household milk production (per day)	12,2	1,39	5,97	,3034	4.34***
Milk sold raw	9.42	0,946	--	--	9.22
Own consumption	1,15	,14017	1,05	,1137	0.577
Per capita own consumption	0.15	,182	0.176	,210	0,864
Milk processed into butter per day	1,71	,1874	4,925	,274	11.44***

\*\*\* P<0.01, \*\* P<0.05, Number of obs = 164 (84 market participant and 80 non-participant)

Milk market participant households sell 9.4 liters (76.6 percent) of their daily milk production and consume 1.2 liters (9.4 percent) of their daily milk production. Non-participant households do not sell raw milk and they consume on average 1.1 liters (17.6percent) of their daily milk production. Participants process 1.7 liters (14 percent) of their daily milk production into butter and cheese, while non-participants process 4.9 liter (82.4%) of their daily milk production into butter and cheese.

**Table 6: Dietary diversity and animal source food consumption comparison**

Score	Market Participant		Non-Participant		T-Stat
	Mean	Std Error	Mean	Std Error	
Household dietary diversity	5,37	,153	4,08	,111	6,90***
Household animal source food	,818	,194	,845	,042	0,105
Husband`s dietary diversity	4,62	,046	4,69	,228	0,069
Husband`s animal source food	1,01	,088	1,14	,098	0,95
Wife`s dietary diversity	4,20	,218	3,25	,196	3,23***
Wife`s animal source food	,523	,0708	,575	,810	0,477
Boy`s dietary diversity	5,13	,213	3,55	,235	4,97***
Boy`s animal source food	1,19	,084	,801	,091	3,15***
Girl`s dietary diversity	3,71	,211	2,78	,212	3,08***
Girl`s animal source food	,55	,088	,790	,809	1,99**
Child dietary diversity	4,66	,273	3,96	,196	2,09**
Child Animal Source food	1,13	,094	1,08	,101	0,315

\*\*\* P<0.01, \*\* P<0.05, Number of obs = 164 (84 market participant and 80 non-participant)

Table 6 shows that market participant households have a mean dietary diversity score of 5.3 while non-participants have a score of 4.3. The dietary diversity score at the individual level is higher for the wives, boys and children under five in the participant households. For the husbands, this score does not differ between the groups. For husbands it is in both groups higher than for the wives. Compared to non-participant households, in participant households the animal source food score is higher for boys but lower for girls. A general observation is that males consume more animal source food than females.

### ***Effect of milk market participation on milk consumption and dietary diversity***

Table 7 presents the outcomes of the PSM analysis of the effect of household milk market participation on the daily milk production, consumption and marketing.

**Table 7: Effect of market participation on milk consumption at household level**

Variable	NN Matching			Kernel Matching		
	Mean Difference	S.E.	T-stat	Mean Difference	S.E.	T-stat
Total household milk Production (in liter per day)	3,9	1,83	2,15**	4,4	1,58	2,80***
Milk sold raw (in liter)	8,94	0,96	9,26***	8,94	0,95	9,39***
Own consumption (in liter)	-0,33	0,29	-1,16	-0,21	0,20	-1,06
Per capita own consumption	-0,05	0,04	-1,35	-0,045	0,03	-1,35
Milk processed (in liter) per day	-5,69	0,94	-6,04***	-5,32	0,74	7,23***

Total Number of Obs =164, Number of common support= 123, \*\*\* P<0.01, \*\* P<0.05

Market participant households produce, on average, 4 liter more milk per day compared to non-participant households. These households sell 9 liter more milk per day to the milk market (cooperatives, private middlemen, processors, hotels and cafeterias). On the other hand participant household's process 5 liters less milk into butter and cheese at the household level compared to non-participants. In spite of the significant production difference between the two household types, there is no significant difference in the amount of milk that is consumed daily at the household level.

Table 8 presents the effect of market participation on dietary diversity. Market participant households have a better average dietary diversity score compared to non-participant households (about four points more). There is no significant difference between the household types in animal source food consumption. At the individual level, wives, boys, girls and children under five have significantly higher dietary diversity in market participant compared to non-participant households. Boy's animal source food consumption is also significantly higher in market participant households. From this we can argue that household status in milk market has a positive effect on women's dietary diversity compared to men's dietary diversity because we observed that the average for women's dietary diversity score is significantly higher in market participant households compared to non-participant households. However, the average magnitude for men's

dietary diversity score is already higher in non-participant households. Similarly, boy's animal source food consumption is the only animal source food consumption score that has shown significant difference between members of market participant and non-participant households.

**Table 8: Effect of market participation on household and Intra-household dietary diversity**

Variable	NN Matching			Kernel Matching		
	Mean Difference	S.E.	T-stat	Mean Difference	S.E.	T-stat
<b>Household level</b>						
Household Dietary Diversity	4,40	1,75	2,52***	3,70	1,25	2,97***
Household Animal Source food	0,46	0,38	1,21	0,24	0,32	0,39
<b>Intra-housheold level (members)</b>						
Husband Dietary Diversity	0,42	0,61	0,68	0,021	0,44	0,45
Husband Animal Source food	0,08	0,18	0,46	-0,08	0,18	-0,47
Wife Dietary Diversity	1,05	0,61	1,90*	1,13	0,48	2,34***
Wife Animal Source food	0,01	0,20	0,06	0,07	0,17	0,43
Boy Dietary Diversity	2,01	0,68	2,97***	1,40	0,43	3,22***
Boy Animal Source food	0,51	0,20	2,54***	0,31	0,15	2,09**
Girl Dietary Diversity	1,23	0,49	2,48**	0,98	0,50	1,97**
Girl Animal Source food	-0,14	0,19	-0,76	-0,18	0,18	-0,99
Child Dietary Diversity	1,48	0,64	2,30**	2,15	0,44	4,87***
Child Animal Source food	0,65	0,51	1,77	0,29	0,46	0,62

Total Number of Obs =164, Number of common support= 123, \*\*\* P<0.01, \*\* P<0.05

### *Effect of milk market participation on child nutritional status*

Table 9 below shows the results of the PSM procedure for the effect of household milk

Outcome variable	NN Matching	Kernel Matching
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market participation on the nutritional status of young children.

**Table 9: Effect of milk market on Child nutritional status**

The average effect of household milk market participation on the proportion of children wasted, stunted and underweight is presented in the Table 9.

	Mean Difference	S.E.	T-stat	Mean Difference	S.E.	T-stat
Wasting	-0,113	0,095	-1,196	-0,098	0,078	-1,401
Stunting	-0,347	0,125	-4,389***	-0,531	0,131	-4,095***
Underweight	-0,198	0,127	-1,633	-0,210	0,113	-1,961**

Total Number of Obs =164, Number of common support= 123, \*\*\* P<0.01, \*\* P<0.05

The result shows that there is a significant difference between milk market participant and non-participant households in terms of the proportion of wasted, stunted and underweight children. Children from non-participant households have 11.3 percent more likelihood to be wasted compared to children from milk market participant households. However, this result is not statistically significant at 5 percent level. Similarly, we found a 34.7 percent difference in the probabilities of children being stunted in milk market participant and non-participant households, i.e. children from non-participant households have 35 percent more likelihood to be stunted compared to children from market participant households and this result is significant at 1 per cent level. There is also a difference in the proportion of underweight children in milk market participant and non-participant households. Children in non-participant households are 19.8 percent more likely to be underweight compared children from market participant households. This result is also statistically significant at 5 percent level.

## Discussion and policy implications

### *Discussion*

This paper examines the relationship between household milk market participation and food security as indicated by dietary quality and the nutritional status of young children. The analyses reveal a direct relationship between household milk market participation, household and intra-household dietary diversity and nutritional status of young children. Milk market participant households have better dietary diversity scores than non-participant households. Children in market participant households have better dietary diversity and nutritional status compared to children from non-participant households. These findings indicate that smallholder milk market participation has the potential to improve household and intra-household food security and nutritional status of young children in rural Ethiopia. This finding is consistent with previous studies in Ethiopia (Tankga *et al.*, 2002, Ahmed *et al.*, 2000 and Hoddinott *et al.*, 2014), which suggested that cow ownership and increased dairy production can lead to improved child nutrient intake.

The data shows that milk market participant households produce significantly more milk per day compared to non-participant households. This is consistent with previous studies that dairy market participation can increase milk production and income (Shapiro, *et al.*, 2000). It was also observed that the intra-household allocation of milk differed substantially between market participant and non-participant households. More milk goes to milk market (cooperatives, middlemen and process companies) in market participant

households, while more milk is processed into butter and cheese at the household level in non-participant households. Despite the significant production difference between the two household types, own consumption does not significantly differ between in market participant and non-participant households.

The results of propensity score-matching analysis confirms that market participant households produce more milk, and sell more milk raw compared to non-participant households. Hence, there is no significant difference in own milk consumption between the two household types. However, these households have a better dietary diversity, both at household and intra-household (individual) level. Participant households have about one third higher average dietary diversity score compared to non-participants. This is the result of the income effect of smallholder milk market participation and hence, the conclusion that the commercial transformation of the dairy production system has the potential to improve household dietary diversity and food security. The fact that there is no significant difference in animal source food consumption between market participant and non-participants households could be explained by the consumption culture and the fasting tradition in the study area.

Intra-household dietary diversity also varies significantly between the member of market participant and non-participant households. In participant households, dietary diversity is higher for the wives, boys, girls and children under five. Women have better dietary diversity scores in participant compared to non-participant households and also compared to men. Dietary diversity of men is high in both types of households and does not significantly differ between the households. This is probably due to the preferential and sequential feeding culture whereby the man eats first with all possible diversity, and the other household members eat the leftovers. Animal source food consumption of boys is higher in participant compared to non-participant households. The increase for boys is in line with the culture of rearing male children as the security for the future of the household and as old age insurance.

The result of the PSM procedure for child nutritional status shows that children in market participant households have less likelihood to be wasted, stunted and underweight compared to children from non-participant households. The difference in the proportion of children stunted (35 percent) and underweight (20 percent) is significantly higher in non-participant households compared to market participant households. This significant difference in undernutrition of children from market participant and non-participant households could be related to the better dietary diversity in market participant households as the result of their higher household income.

The general conclusion is that milk market participation is associated with higher milk production and household income. There was no significant difference in animal source food consumption in general and milk consumption in particular between the two household types. Therefore, the significant difference in dietary diversity and nutritional status of young children is the result of increased income at household level. Consistent with previous research (FANTA, 2006) which shows a positive relationship between dietary diversity and adequate micronutrient density of complementary foods for young children, the result of this study shows that children in milk market participating



households, where dietary diversity score is better both at household and individual level, have a better nutritional status as indicated by child anthropometric indices.

This study has several limitations. First, the behavior of the household members may have been influenced by the presence of the observers. Second, these observations were made on non-fasting days to reduce the difference between households based on religion. However, as many households in Selale are followers of the Orthodox Church that has a five-to-seven-month fasting period, the observations might provide only a partial perspective on the year-round dietary diversity and child nutritional status. Moreover, the fact that two consecutive days have been used rather than two random visits during a week may introduce some biases. Third, the study is based on observations within the household; therefore, our dietary diversity score might underestimate the true value since food consumed outside the household is not included. We recommend that future studies should take these potential limitations into consideration.

### ***Policy implications***

This study indicates that milk market participant households have better dietary diversity compared to non-participant households. Individual members of market participant households, including children under five, also have better dietary diversity compared to those in non-participant households

Therefore, we conclude that transforming the dairy sector from subsistence to a market oriented production system and integrating dairy farmers into the milk market has the potential to improve food security in rural Ethiopia. Although we observed that the increased milk production in market participant households did not translate into more milk consumption at the household level, as has been argued in previous research (Steglich, 1998; Tangka *et al.*, 2002), it seems that households use the additional income generated from selling milk at the market to boost their dietary quality and improve the nutritional status of their family members, especially children. This finding can encourage Ethiopian policy makers to further stimulate smallholder market integration and the transformation of their production. Given the high number of malnourished children in Ethiopia and the potential contribution of animal source food consumption in solving this problem, the study also calls for encouraging milk consumption at the household level as an important strategy for addressing micronutrient deficiencies in the country.

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