The Impacts of Dairy Cattle Ownership on the Nutritional Status of Pre-school Children in Coastal Kenya

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Background

In many parts of the developing world, the availability of sufficient food—food supplying sufficient daily energy and protein—remains a key challenge for many families, despite substantial increases in total food production in the past two decades. At present there is sufficient food produced to feed everyone in the world, but the available food is neither evenly distributed nor fully consumed. As a result, some 800 million people—200 million children—are food insecure, that is, they lack consistent access to the food required for a healthy and productive life (Pinstrup-Andersen, 1994). The roots of food insecurity and malnutrition are complex, but limited ability of households to produce and purchase food often is a fundamental cause. As a result, policy makers (governments) and development agencies are continually seeking to identify opportunities for people in rural areas to produce more food.

Increased food production increases the availability of food for rural populations, and often increases household incomes. Increased production and income are associated with improvements in household nutritional status (Low, 1991). In selected regions of the developing world, one option for increasing food production and incomes is dairy production and marketing. In much of East Africa, dairying by smallholder farm families is viewed by governments and development agencies as a means of increasing the production of needed nutrients, and as a source of cash income to purchase other foods (Staal *et al*., 1997). The potential contribution of

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dairying to improvement of nutritional outcomes has led to efforts to develop new technologies and production practices that can be used by resource-poor households in East Africa. These technologies include the introduction of crossbred animals[2] and complementary feeding and animal health practices (Nicholson *et al*., 1999). Promoting the use of these technologies by farmers is often the focus of efforts at what has been termed 'dairy development'. Because these practices can increase milk production and household incomes by substantial amounts, they have been widely adopted in the cooler highlands of East Africa (particularly in Kenya and Tanzania).

However, even in relatively prosperous developing countries such as Kenya, large differences in income and nutritional status exist between regions. As an example, the economic development of lowland Coast Province has lagged behind other areas of Kenya. The province suffers from 20% higher infant mortality than other parts of the country. Malnutrition of children is common—previous studies estimated that 39% of children were stunted to some degree—and the prevalence of rural poverty may be more than 40% of all households. Despite this, milk and milk products enjoy a strong demand. This, and farm-level prices higher than elsewhere in Kenya, have been taken as indicators of the potential for dairy development in the region (Staal and Mullins, 1996).

The promotion of dairy production by development agencies is often justified by the assumption that adopting households will consume more milk and generate more cash income. Milk is a significant source of both energy and protein, including many essential amino acids lacking in carbohydrate-based diets (Huss-Ashmore, 1993). Milk also contains many essential micro-nutrients, such as Vitamins A and D. Increased milk consumption is therefore assumed to

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improve nutritional outcomes for households. In addition, to the extent that dairy production increases incomes, households with dairy cattle can afford to purchase more food and a wider variety of foods. This 'income effect' is expected to contribute to improvement of nutritional status in households owning crossbred cattle and using complementary feeding strategies. Previous studies in coastal Kenya have associated dairy production with better nutritional status, but have not controlled for other household- and child-level characteristics such as wealth, location, or child's age (Leegwater *et al.*, 1991).

The objectives of this study are to examine the impact of the milk production and consumption on the nutritional status of pre-school children in coastal Kenya, controlling for other household and child-level characteristics. Specific sub-objectives include:

1) To document the continued prevalence of malnutrition in pre-school children in coastal Kenya, using comparative measures of weight-for-height (an indicator of acute malnutrition) and height-for-age (an indicator of chronic malnutrition);

2) To develop econometric models to examine the impact of milk production and consumption on the nutritional status of pre-school children. These models will control for other factors affecting nutritional status, isolating the effect of milk production and consumption;

3) To use the econometric models to examine how interactions among milk production, income from sales of milk, and consumption of milk influence the nutritional status of pre-school children.

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[2] Here, 'crossbred' refers to cattle that are a cross between 'european' breeds (like the black and white Holsteins

The key hypotheses to be explored are:

1) Malnutrition continues to affect substantial numbers of households in coastal Kenya, but chronic malnutrition is more common than acute malnutrition for all ages of pre-school children;

2) Increases in income from sales of milk improves the nutritional status of pre-school age children, but increases in milk consumption have a larger positive impact on child nutritional status than income from milk.

If confirmed, these hypotheses will provide evidence supporting the promotion of dairy 'technologies' such as crossbred cattle, feeding strategies, and animal health services to improve the nutritional well-being of resource-poor farmers in coastal Kenya and other similar regions.

Methodology

Data Collection Methods. Anthropometric measures for children 0 to 59 months of age often are used as indicators of nutritional status for households in societies with significant levels of protein-energy malnutrition (Low, 1991; Quinn, 1992). Children are measured because they are presumed to be the most vulnerable members of the household, and thus provide a sensitive indicator for the household as a whole. The interpretation of anthropometric measurements is also easier for children than for older members of the household because there are fewer genetic differences among children in different ethnic groups and reproductive status of females can be ignored. The measures typically used include 'weight-for-height' and 'height-for-age'. A low value of weight-for-height indicates that the child is very thin for his or her stature, and thus provides a measure of acute malnutrition (often referred to as 'wasting'). A low value of height-for-age indicates that the child is shorter than one would typically expect for a child of the same

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common in the US) and local cattle, which are typically of the smaller but more disease-resistant Zebu breed.

age because of the accumulated effect of periods of morbidity and inadequate food intake (often referred to as 'stunting'). The measures are typically converted to z-scores (the number of standard deviations from the mean of a reference population) using the U.S. National Center for Health Statistics (NCHS) growth percentiles as a reference (WHO, 1983). Because they are standardized measures, the z-scores can be compared for different age groups and for the two indicators of nutritional status (Quinn, 1992).

Anthropometric data for individual pre-school aged children (0 to 59 months) and household-level control variables were collected from 198 households in three districts of coastal Kenya during March to May 1998. Of these households, 75 owned dairy cattle and 123 owned no dairy cattle. Dairy cattle owners were randomly selected from a listing of dairy cattle owners in the region compiled by the Ministry of Agriculture, Livestock, and Marketing of Kenya that contained a total of about 750 names. To select non-owners, project enumerators identified the 20 nearest neighbors and sampled these lists randomly to obtain the appropriate number of names of non-adopters to interview. Households were selected and data were collected consistent with protocols established by the Central Bureau of Statistics of Kenya (who conduct annual regional nutritional surveys) and the Ministry of Health of Kenya, which operates field clinics in coastal Kenya. Staff from each of these government organizations participated in data collection. The anthropometric measurements for 112 pre-school children obtained in the field surveys of were used to calculate 'height-for-age' (HAZ) and 'weight-for height' (WHZ) z-scores for each child[3].

[3] Z-scores compare the individual child to a reference population of the same age and sex, where z indicates the number of standard deviations away from the mean of the reference population. Low z-scores for height-for-age indicate chronic malnutrition; low z-scores for weight-for-height indicate acute malnutrition.

Econometric Methods. Following Randolph (1992), we used random effects models to examine the impacts of milk production, income from milk sales, and milk consumption on the nutritional status of pre-school children in coastal Kenya. A random effects model is an econometric model of the form:

$$N_{ikt} = \sum \beta_{ir} X_{rk} + \gamma_{ikh} + \varepsilon_{ik}$$

where N_{ikt} is nutritional status as indicated by the *i*th indicator (weight-for-height and height-for-age), the β are parameters to be estimated associated the independent variables *X*, *k* indicates the individual child, *h* is the household, *r* indicates individual explanatory variables, γ are random effect specific to a particular indicator, child, and household, and ε is a random error term for each indicator and child. With the random effects model, the γ are considered to be generated by a random process with a specific variance structure. As a result, the model can be estimated with a generalized least squares (GLS) econometric estimator.

Most of the explanatory variables in the model are assumed to be 'exogenous' to the household. These variables include household wealth indicators such as landholdings, but also demographic characteristics (e.g., age of the mother) and locational characteristics (e.g., distance to the nearest local market). In addition, the models include two indicators of dairy cattle ownership: 1) a binary variable indicating whether the household is an owner or non-owner and 2) the number of crossbred dairy cows owned by the household. Mean monthly cash income during the previous year and milk consumption per consumer unit in the week prior to the survey are also included as explanatory variables. However, because these ownership, income, and consumption variables are household decisions, they are predicted in separate probit and tobit models. This allows the model to account for the simultaneity of nutritional outcomes, household technology-adoption decisions, household income, and household consumption. The variables included in the models are summarized in Table 1.

Results

Findings on the Prevalence of Malnutrition. Our study confirms the high levels of chronic malnutrition (more than two-thirds of children suffer some stunting) and acute malnutrition (nearly one-third of children suffer some wasting) found in previous studies at the Kenya coast (Table 2).

The percentages of children suffering from different degrees of wasting did not differ significantly for dairy cattle owners and non-owners (a χ^2 test for differences between the distributions for adopters and non-adopters was not significant at the p=0.10 level). Despite the potential benefits of dairy cattle ownership, more than two-thirds of children in adopting and non-adopting households showed some degree of stunting. Leegwater *et al.* (1991) also observed that stunting was much more common than wasting among households in coast Kenya. Moderate and severe stunting was more common for children in households without dairy cattle, but a χ^2 test for differences between the distributions for adopters and non-adopters was not significant at the p=0.10 level. However, these results are only indicative because they do not control for other factors influencing nutritional outcomes (household characteristics such as wealth and location, and child-specific characteristics such as birth order, sex, and maternal characteristics).

Table 1. Variables Used in Econometric Analyses

Variable Name	Variable Description	Mean	s.d.
ADOPPRED[1]	Predicted value of adoption variable	0.41	0.50
BIRTHORD	Child's place in birth order	4.03	2.54
CHILD6	Number of children < 6 years in HH	2.57	1.20
CHILDAGE	Age of child, months	32.79	14.02
CHSEX	Sex of child (1=Male)	0.50	0.50
DCPRED[1]	Predicted dairy product consumption (milk equivalents) per consumer unit, litres/week	0.84	0.55
DEPRATIO	Dependency ratio of HH	2.62	1.84
DISTDUM1	District dummy (1=Malindi and Kilifi)	0.47	0.50
DISTDUM2	District dummy (1=Malindi)	0.09	0.29
DISTMKT	Distance to market place, km	4.09	4.02
EDUCCG	Education of child's caregiver, years	4.12	4.14
EDUCSUM	Total education of HH's adults, years	23.86	21.21
FEMALE	Number of adult females in the HH	2.70	1.31
GXPRED[1]	Predicted number of G/C cows owned by HH	0.68	0.79
HHAGE	Age of HH head, years	52.63	12.61
HHAGE2	Age of HH head squared	2,926.90	1,355.92
HHEDUC	Education of HH head, years	3.71	4.11
HHMWAGE	Household's maximum predicted wage, KSh/day	109.36	49.63
HHRELG	Religion of HH (1=Christian or Muslim)	0.90	0.31
HHSEX	Sex of HH head (1=Male)	0.96	0.20
HHSTDUM1	HH stage dummy (0=Establishment)	0.93	0.25
HHSTDUM2	HH stage dummy (0=Establishment, Expansion)	0.84	0.37
HHSTDUM3	HH stage dummy (0=Establishment, Expansion, Consolidation)	0.18	0.39
HOUSE	Number of permanent or semi permanent houses	0.55	0.72
INCPRED[1]	Predicted amount of endogenous income, 000 KSh/mo	5.51	4.05
MALE	Number of adult males in HH	2.33	1.22
MIGIFT2	Exogenous income (gifts and remittances), 000 KSh/mo	0.13	0.43
MIGRANT	Ethnicity of HH head (1=Migrant)	0.13	0.34
MOTHERHT	Mother's height, cm	155.08	10.02
PARENT	Is HH head child's biological parent	0.67	0.47
PRMILK	Milk price perceived by HH, KSh/litre	26.96	7.81
PRODCAP	Number of plows, grain storage facilities, and wheeled carts owned by the HH	2.46	2.56
RELCGDUM	Religion of child's caregiver (1=Christian or Muslim)	0.93	0.25
TENURE	Land tenure status (1=Title deed)	0.76	0.43
TOTLAND	Total land used by HH, acres	12.04	13.66
WATER	Piped water (1=Yes)	0.04	0.20
HAZ	Height for age z-score	-2.02	1.25
WHZ	Weight for age z-score	-.49	1.23

[1] Indicates predicted value of an endogenous variable estimated from separate probit and tobit models. Results are not shown due to space limitations.

Table 2. Nutritional Status of Pre-school Children and Dairy Cattle Ownership

Nutritional Indicator	Adopters	Non-adopters	Test for equality of means or distributions
Weight-for-height (indicates wasting)			
Number of children	39	65	
Percentage of children:			(p=0.23)
Normal	71.8	72.3	
Mild wasting	20.5	21.5	
Moderate wasting	0.0	4.6	
Severe wasting	7.7	1.5	
Height-for-age (indicates stunting)			
Number of children	41	71	
Percentage of children:			(p=0.33)
Normal	31.7	21.1	
Mild stunting	34.1	28.2	
Moderate stunting	19.5	33.8	
Severe stunting	14.6	16.9	

[1] Pre-school children are those 0-59 months of age. Owners are households currently owning at least one crossbred diary animal. Non-owners currently own no crossbred dairy animals.

[2] Categories of wasting and stunting are based on z-scores, where z>-1.00 is normal, -1.00>z>-2.00 is mild malnutrition, -2.00>z>-3.00 is moderate malnutrition, and z<-3.00 is severe malnutrition (WHO/Brazzaville, n.d., as cited in Quinn (1992)).

Source: KARI-ILRI Nutrition and Health Survey, March-May 1998.

Findings on the Impact of Dairy Production and Consumption on Child Nutritional Status. The econometric analyses examine the impacts of four variables on the nutritional status of pre-school children in coastal Kenya. Two of these variables are indicators of the extent to which the household has adopted crossbred dairy cows—one part of the technological package promoted by dairy development efforts in coastal Kenya. Dairy consumption, measured in milk equivalents per consumer unit, is likely to have impacts on nutritional status for households with and without crossbred dairy cattle. Household income is commonly assumed to influence nutritional status, and therefore its impact is also assessed.

The results of the random effects models suggest that only dairy consumption is associated with improvements in nutritional status of pre-school children in coastal Kenya (Table 3)[4]. Further, increases in dairy consumption have a statistically significant impact only on the height-for-age z score; that is, the evidence suggests that increased dairy consumption reduces the prevalence of stunting but not wasting. This evidence of the greater impact of dairy consumption on chronic malnutrition is consistent with the observation that milk is not a major source of calories in the diets of children in coastal Kenya, even when some milk is consumed in the household. Thus acute malnutrition may be due to factors affecting the intra-household distribution of food, rather than the household factors examined in this study. Although dairy development appears to benefit households in other ways—higher income, for example—projects seeking to reduce the incidence of acute malnutrition in coastal Kenya may need to focus on interventions other than dairy development.

Ownership of crossbred dairy cattle *per se* has no statistically significant effect on either measure of nutritional status for pre-school children. Nor does ownership of larger numbers of crossbred dairy cattle have a statistically significant effect on WHZ or HAZ. Our analyses indicate that increases in household income—often assumed to be a proxy for household welfare—also have no statistically significant effect on measures of acute or chronic malnutrition among pre-school children in coastal Kenya. Thus, the relationship between dairy cattle ownership and improved nutritional outcomes undoubtedly involves some "leakages" as income generated from dairy production is used for purposes other than food consumption by children. However, because the number of observations in this study is small, and we did not examine in

[4] Due to space limitations, only the estimated values of the parameters associated with the variables above are presented in Table 3, along with summary measures of the overall regression.

detail the mechanisms by which dairy production influences dairy product consumption, further research would help dairy development efforts to better achieve desired outcomes.

Table 3. Estimated Impacts of Dairy Adoption, Dairy Consumption, and Household Income on Indicators of Nutritional Status for Pre-school Children in Coastal Kenya

Indicator of dairy adoption, income, or consumption	Nutritional Indicator	
	Height-for-age z score	Weight-for-height z score
Probability of crossbred cow ownership		
Value of β	0.33	-0.20
Significance of β	0.48	0.70
Observations	76	76
Adjusted R^2	0.30	0.14
Significance of F	0.02	0.17
Number of crossbred cattle owned		
Value of β	0.24	-0.49
Significance of β	0.53	0.23
Observations	76	76
Adjusted R^2	0.30	0.17
Significance of F	0.02	0.13
Dairy Consumption, milk equivalents		
Value of β	1.17	0.12
Significance of β	0.01	0.83
Observations	76	76
Adjusted R^2	0.39	0.14
Significance of F	0.003	0.17
Household income, 000 KSh / month		
Value of β	0.17	-0.23
Significance of β	0.47	0.40
Observations	71	71
Adjusted R^2	0.37	0.08
Significance of F	0.01	0.31

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