DISCRIMINANT FUNCTION ANALYSIS FOR TRACING SUCCESSFUL FACTORS ASSOCIATED WITH LIVESTOCK PROJECTS FOR NUTRITION IMPROVEMENT IN WESTERN KENYA.

Mary K Walingo.

Abstract

Background: Livestock development is one of the major important strategies adopted by the Government of Kenya to expand agricultural output and to improve the nutritional status in rural areas. Livestock development interventions have targeted women smallholder farmers, with the realization of the great role they play in agriculture and as gatekeepers of the health and nutritional status of their household members. The purpose of the present study was therefore, to trace successful factors associated with Livestock Projects in Kenya in improving food and nutrition of populations.
Methods: Discriminant functions for tracing successful factors for improved food security with livestock development projects were constructed for socio-demographic and agro-economic variables, patterns of food and nutrient intake by households, women and preschool children. The power of efficiency of various combinations was compared between beneficiary and non-beneficiary households, women and preschool children of the Livestock Development Projects (LDPs.)
Results: The order and best set of socio-demographic and agro-economic variables that differentiated between beneficiary and non-beneficiary households were milk price, time and income expenditure in the dairy enterprise expenditure on veterinary services, knowledge of dairy management, occupation of women heads of households, employment status of households member and milk yield. The order and best set of foods that were different between beneficiary and non-beneficiary households, women and preschool children were consumption of milk and milk products and green leafy vegetables. Further the order and the best set of nutrients that differentiated between beneficiary and non-beneficiary households, women and preschool children were intake of protein, vitamin A and energy.
Conclusion: Livestock Development Projects, improved intake of milk and milk products green leafy vegetables, protein, vitamin A and energy among beneficiaries. These projects have great potential to improve food and nutrient security of households.

Key Words: Food, nutrient, women, preschool children, households

Introduction

The past failure to explicitly include nutritional goals or to anticipate nutritional impacts of agricultural projects may have led to the deterioration of nutritional status of rural populations in many parts of the world. Now many agricultural projects seek to enhance household food security for improved health and nutrition status, and to empower women in decision-making. These projects include Livestock development Projects that are seen as a means to bridge the food gap especially in sub-Saharan Africa. Livestock play diverse economic and social roles in the national economies of Sub-Saharan Africa, such as production of milk and beef for subsistence, supply of draught power and manure for cropping, and as direct cash to farmers. The National Livestock Policy seeks to increase self-sufficiency in beef and milk production, promote exports, stabilize and control inflation, create employment opportunities, generate government revenue and improve nutrition.

Livestock development is one of the major important strategies adopted by the Government of Kenya to expand agricultural output and to improve the nutritional status in rural areas. Livestock development interventions have targeted women smallholder farmers, with the realization of the great role they play in agricultural production, food production and distribution, and, as gatekeepers of the health and nutritional status of their household members.

Correspondence: ***Mary Khakoni Walingo.*****, Maseno University, P O Box 333, Maseno, Kenya.**

E-mail: Khakoni@yahoo.com School of Public Health and Community Development *(ESPUDEC)*

There is increasing realization of the need to maximize resources of rural women who are major actors in agricultural production, and to provide an enabling policy and institutional framework for them. Intensification of dairy programmes is expected to meet increasing demand for dairy products and to reduce imports.

The Livestock Development Programme (LDP) was incorporated in western Kenya a region found to manifest negative development characteristics this region lacks income-generating activities resulting in adverse poverty. The region is also characterized by high population density with small landholdings such that small-scale livestock farming can become an amiable income generating activity. Cattle herds in the programme were dominated by low genetic potential zebu cattle, known for their low milk output through they are environmentally adapted.

Livestock Projects target women farmers who are perceived to be doing the bulk of the farm and domestic work, but are left out in decision making regarding income expenditure and controlling of income generating activities. The programme had to create conditions for motivating women to participate more productively in the ownership and care taking of dairy animals through training and providing them with workload easing facilities on a cost sharing basis. Grade bulls are given to male farmers who are strategically located in the area. The preparatory conditions for receiving a grade bull are establishment of a nappier grass plot (*Pennisetum purpureum*) and other fodder trees, which helps to ensure satisfactory nutritional status for the animals. The projects sought to enhance milk marketing through the provision of milk collection and marketing facilities to cooperative societies in the form of buildings, coolers, and milk cans, quality testing equipment and transport. Indirect support to this sector was through

training of members of societies in order to sensitize small scale farmers to modern methods of dairy farming, training was undertaken for women group leaders and individual women and men beneficiaries of the cow and bull schemes apparently.

In the past, development projects have sought to enhance socio-economic development of communities by targeting efforts on children and pregnant and lactating women. It was believed that improving the socio-economic and nutritional status of vulnerable groups would result in general development and enhancement of quality of life. These programs have failed to improve the nutritional status of vulnerable groups and also improve the household food security situation. In the view of the failure of past projects to achieve their objectives, there is a realization that concerns for the welfare of women is addressed, if these development programs are to attain any success. Though livestock interventions have targeted women smallholder farmers in Kenya, there are very few studies, if any on the impact of livestock programmes on the beneficiary households. Development programmes may also contribute to general social and economic improvement in households, which may not necessarily have been part of the project objectives. The purpose of the present study was therefore to trace successful factors associated with Livestock projects

Materials and Methods

Study Design and Sampling:

The study was carried out in Western Kenya. Livestock interventions have been initiated in this area in view of the manifestation of negative developmental characteristics, including high levels of poverty. The study was carried out using a cross-sectional design with a case-control model. Women beneficiary in the livestock programme were cases matched for locality, age and economic status with women non-beneficiary in the dairy programme as the controls. Three Divisions in the district were randomly selected for the purpose of the study. In each Division, a total of 50 households were randomly selected from a list of beneficiary in a livestock programme, and were matched with 50 households non beneficiary in any dairy programme. Overall, 300 households were selected to form the sample households: 150 beneficiary and 150 non-beneficiary households.

Data Collection and Statistics:

Pre-tested interview schedules were used to collect data on socio-demographic and agro-economic characteristics of index households. Women heads of households were the respondents who provided information on selected variables of the study. Anthropometric measurements of women and preschool children were taken using standardized techniques. Anthropometric measurements of preschool children were expressed as Z-scores of weight-for-age, height-for-age and weight-for-height. Preschool children falling below – 2SD were considered to be malnourished. Body mass index (BMI) was used as an indicator of nutritional status of women. Women falling below 18.5 were considered malnourished, while those below 16 were classified as severely malnourished.

Data analysis:

The socio-demographic and agro-economic data were analyzed using chi-square, Z-test and ANOVA. Correlation of these variables with indices of nutritional status was carried out to find the associated variables. The discriminant function analysis was used to select the best set of variables, which has the highest power of discrimination between groups. This method was one of selecting a linear function, which would best discriminate between beneficiary and non-beneficiary households of a livestock development projects on the basis of certain selected variables. The discriminant function classifies and estimates differences between two or more groups. Discriminant functions were fitted for socio-demographic and agro–economic variables, patterns of food intake in households by women and preschool children, and patterns of nutrient intake by households' women and preschool children. The significance of each discriminant functions fitted was assessed by Mahalanobis D^2 and Fishers 'F' test of significance. The relative importance of all the discrimination functions was assessed by comparison of the absolute values of 'F' ratio showing the significance of each linear discriminating function and by testing the significance in relation to each other.

Results

Socio-Demographic Characteristics of Households

Population composition*:*

The total population under 15 years was 38% and 39% males in beneficiary and non- beneficiary households respectively, and 36.6% females in beneficiary and 43% females in the non- beneficiary households. There were more females in the non-beneficiary households than males, unlike the participant households. The high population below 15 years implies high dependency ratio.

Mean Age:

The mean age was 24.01 ($\pm$18.02) years and 22.87 ($\pm$17.22) years in the beneficiary and non- beneficiary households respectively among males. The mean age among females was 23.01 years and 20.35 years in the beneficiary and non-beneficiary beneficiary households respectively. While there was no significant difference in the mean age of males between beneficiary and non- beneficiary households, a significant different ($P<0.01$) between the two groups with respect to mean age of females was found. Females from participant households tended to be older than those from non-beneficiary households.

Family Size:

About 14.7% beneficiary and 18.5% non-beneficiary households had small families (less than 5 members). While 27.3% beneficiary households had medium family (5-6 members), about 35.8% non-beneficiary households had medium families. Large families (over 6 members) were observed in 58% beneficiary and 45.7% non-beneficiary households. The mean family size was 7.04 in beneficiary and 6.54 in non-beneficiary households. Dependency ratio was 1.1.68 in the beneficiary households and 1:1.37 in the non- beneficiary households.

Education of Male and Female Heads of Households*:*

Only 37.7% male heads of households in the beneficiary group had up to primary level education compared to 58.8% male heads of households from the non-beneficiary group. Thus more than half of the male heads of households in the non-beneficiary group had low level of education. Among the female heads of households 57.4% and 76.8% women from the beneficiary and non- beneficiary households respectively had low education. This level is high compared to that of their male counterparts. However, there was no significant difference in the education level among the male and female heads of households from both groups.

Agro-economic characteristics of households

Employment and Occupation Structure of Female Heads of Households: More females from the beneficiary households (57.3%) were employed compared to only 38.4% women from the non- beneficiary households. Statistically significant differences were observed between the two groups regarding employment structure ($P<0.01$) and occupation structure: primary teaching ($P<0.001$) and high school teaching ($P<0.05$). More females from beneficiary households were employed in the teaching profession compared with those from non-participant households. While 8% beneficiary households owned less than 0.5 Ha, 29% non-beneficiary households owned 0.5 Ha of land. Landholding size was significantly higher ($P<0.001$) in the beneficiary households.

Monthly income:

A statistically significant difference was found in the monthly household income ($P<0.05$) and mean household income ($P<0.001$). While 30.7% participant households earned over 5000 Kenya shillings (KShs.), 51.4% non-beneficiary households earned less than KShs. 5000 a month. Only 25.6% participant households had per capita income of KShs 600.00 compared to 35% non-beneficiary households. Though mean per capita income was higher in the beneficiary households than in the non-beneficiary group, the difference was not significant.

Sell and Purchase of Staple:

More beneficiary households (24.7%) sold crops harvested compared to non-beneficiary households (18.5%). On the other hand 80.4% and 88.2% beneficiary and non-beneficiary households respectively were purchasing staple to meet nutritional requirements of their family members. A significant difference was found regarding the ability of households to purchase staple ($P<0.001$). More households in the beneficiary group were able to purchase staple than those from the non-beneficiary households. Profit derived from the dairy enterprise was spent on non-food purposes. Similar findings were reported in South Western Kenya by Kennedy (1988).

Nutritional Status

Nutritional Status of preschool children:

Level of underweight was 1.25% and 2.9% amongst preschool from beneficiary and non-beneficiary households respectively. Level of stunting as measured by height-for-age was 1.25% in beneficiary and 1-% non- beneficiary households. However, the prevalence of stunting, on the whole, was significantly higher ($P<0.05$) in the non-participant group. Wasting was not a problem in this community. Factors which showed correlation with nutritional status were BMI of the mother, number of preschool children in a household, time input by women in the dairy enterprise, and amount of milk consumed by preschool children. The prevalence of underweight, stunting and wasting compare favourably with the national average of 22% underweight, 33% stunting and 6% wasting for Kenya (UNICEF, 1996).

Nutritional Status of Women:

Only 6.7% and 7.3% women from participant and non-participant households had BMI less than 18.5 cut-off point. However only 0.7% women from participant and 1.3% women from non-participant households fell below 16 cut-off point for severe malnutrition. Prevalence of obesity was higher (6%) among women from participant households compared to 4.5% women from non-participant households. BMI was associated with sell of crops harvested, ability of households to purchase staple, and the person managing the dairy enterprise. The mean BMI of 23.4 and 22.9 of women from participant and non-participant households respectively, is higher than the national average of 21 for Kenya. Mean height of 1.61m in both participant and non-participant households was higher than the national average of 1.59 m and mean weight of 60.9 kgs and 59.2 kgs in participant and non-participant households respectively are

higher than the national average height (1.59m) and weight (56 kg) (KDHS, 1992).

Socio-demographic, Agro-economic, Food and Nutrient Intake and Nutritional Scores of Households

The mean scores for all variables were significantly higher ($P < 0.001$) in the beneficiary group (Table 1). The LDPs had an impact in improving the overall socio-demographic agro-economic food and nutrient intake and nutritional status of women and preschool children from beneficiary households. LDPs increased significantly production, consumption and marketed surplus milk ($P < 0.00001$), food and nutrient intake ($P < 0.001$). There was no significant difference in nutrition status of women and preschool children, and, awareness of nutrition value of milk between the two groups.

Discriminant Function Model for Socio-Demographic and Agro-Economic

The discriminant functions for socio-demographic and agro-economic variable is presented in Table 2. The important variables with power to differentiate between participant and non-participant households were: milk price, time expenditure in dairy enterprise, income expenditure on animal supplements, change in diary size, mean age of household members, income expenditure on Government veterinary service, ability to purchase staple, knowledge of dairy management, occupation of women heads of households, employment status of household members milk yield, and income expenditure on green fodder. These variables except income expenditure on Government veterinary services were significantly improved in the participant households.

Discriminant Function Models for Patterns of Food Intake

Food intake model was fatted per fleshy foods, cereals pulses, green leafy vegetables, roots and tubes, milk and milk products, fats and oils and sugar. The discrimination function model is presented in table 3 for variables that have disseminating power. The best set of food that differentiated between participant and non-participant and participant households was milk and milk products. The consumption of milk and milk product was higher the participant group. Intake of milk and milk products, and green leafy vegetables formed the best set of foods with discriminatory power between women in participant and non-participant households. Mean intake of these foods was higher in the participant group. The best set of foods that discriminated preschool children in participant and non-participant households were: milk and milk products and green leafy vegetables.

Discriminant Function Models for Patterns of Nutrient Intake

Nutrient intake model was fitted for energy, protein, calcium, iron, vitamin A, thiamin, riboflavin, niacin and ascorbic acid. The discriminant for this model is presented in Table 3. The best sets of nutrients that differentiated between participant and non-participant households were protein, vitamin A and energy. Nutrient intake was higher in the participating households. Intake of protein, vitamin A and energy in that order were the best sets of nutrients that differentiated between women in participant and non-participant households. Protein and energy in that order were the best set of nutrients with discriminatory power between preschool children in participant and non-participant households.

Table I: Scores of Socio-demographic, agro-economic, food and nutrient intake and traditional status (mean ± SD) of beneficiary and non-beneficiaries of LDPs.

Variable	Ideal Score	Beneficiary Household	Non-beneficiary Household	Z-Value	Significant level
Demographic factors	**20**	**3.49 ± 0.98**	**2.78 ± 1.45**	**4.97**	**<0.001**
Economic factors	**75**	**4.19 ± 3.81**	**3.04 ± 3.01**	**2.90**	**<0.01**
Dairy cooperative factors	**45**	**0.74 ± 0.67**	**0.40 ± 0.40**	**5.24**	**>0.001**
Production, consumption and marketed surplus milk	**75**	**6.23 ± 1.37**	**2.10 ± 1.45**	**25.35**	**<0.00001**
Nutritional awareness of women	**90**	**5.04 ± 7.78**	**4.97 ± 7.71**	**0.77**	**NS**
Food and nutrient intake	**270**	**33.54±10.20**	**28.45 ± 9.43**	**4.50**	**<0.001**
Nutritional status of women and preschool children	**25**	**4.28 ± 0.51**	**4.20 ± 0.44**	**1.60**	**NS**

Ns – Not significant

Table 2. Order and best set of socio-demographic and agro-economic variables that are different between participant and non-participant groups

S. No.	Order and Best Set of Variables	D^2	D.F.	F-Ration	Percent Miscalculation
1.	**ORDER OF VARIABLES**				
	Milk price	7.81	18, 28	30.59	9.7
	Time expenditure in dairy:				
	Enterprise				
	Income expenditure on animal supplements				
	Change in dairy size				
	Mean age of household members				
	Income expenditure on government				
	Veterinary Service				
	Ability to purchase staple				
	Knowledge of diary management				
	Occupation of women heads of households				
	Employment of household members				
	Milk yield				
	Income expenditure on green fodder				
	Person managing dairy enterprise				
	Milk consumption by preschool children				
	Income expenditure on staple				
	Income from subsidiary sources				
	Income expenditure on veterinary medicines				
	Knowledge of diary cooperatives.				

2.	**BEST SET OF VARIABLES**				
	Milk Price		7.28	12, 28	
	43.69				
	Time expenditure in dairy enterprise				
	Income expenditure on animal supplements				
	Change in dairy size				
	Mean age of household members				
	Income expenditure on government				
	Veterinary service				
	Knowledge of dairy management				
	Occupation of women heads of households				
	Employment of household members				
	Milk Yield				
	Income expenditure on green fodder				

Table III Order and best set of foods that are different between participant and non-participant groups. (household, women and preschool children)

Sn.	Order and Best Set of Variables	Ratio	Percent Miscalculation	D^2	D.f.	F-
1.	**HOUSEHOLD**					
	All variables			4.53		6.53
	10.36	15.0				
	Milk and milk products					
	Green leafy vegetables					
	Roots and tubes					
	Other vegetables					
	Sugar					
	Fats and oils.					
	BEST SET OF VARIABLES					
	Milk and milk products		3.10	1.58		46.45
2.	**WOMEN**					
	All variables	4.92	6.53	11.25		11.7
	Milk and Milk products					
	Green leafy vegetables					
	Other vegetables					
	Fats and oils					
	Sugar					
	BEST SET OF VARIABLES		3.71	2.57		27.36
	Milk and milk products					
	Green leafy vegetables					
3.	**PRESCHOOL CHILDREN**					
	All variables	5.57	7.30	6.23		10.5
	Green leafy vegetables					
	Other vegetables					
	Roots and tubes					
	Pulses					
BEST OF VARIABLES						
	Milk and milk products					
	Green leafy vegetables		3.17	2.35		14.46

Table IV: Order and best set of nutrients that are different between the participant and non-participant groups (H, Women and Preschool Children)

Sn.	Order and Best Set of Variables	Ratio	Percent	D^2	D.f.	F-
1.	**HOUSEHOLD**					
	All variables					
	3.19	4.55	11.35	21.7		
	Protein					
	Vitamin A					
	Energy					
	Calcium					
	BEST SET OF VARIABLES					
	Protein					2.99
	3.56	14.43				
	Vitamin A					
	Energy					
2.	**WOMEN**					
	All variables					
	Protein				3.95	4.55
	14.05	13.3				
	Vitamin A					
	Energy					
	Calcium					
	BEST OF VARIABLES					
	Protein					3.75
	3.56	18.09				
	Vitamin A					
	Energy					
3.	**PRESCHOOL CHILDREN**					
	All variables					
	Protein					3.14
	4.33	6.77	26.3			
	Energy					
	Calcium					
	Vitamin A					
	BEST SET OF VARIABLES					
	Protein, Energy					2.6
	4.35	12.06				

Discussion

There is a high dependency ratio in this population. Providing for the welfare of this population presents an enormous challenge to the country. Culture plays a vital role in family size, and to induce a decline in population growth rates, concept of small families must gain cultural acceptance. Kenya has been known to depict one of the highest population growth rates in the world.

Education level of male and female heads of households is high in the beneficiary households. Education is not only crucial for improving quality of life but it is a major factor in bringing about changes, which affect nutrition. For the Livestock Development Project programme, education is vital in livestock veterinary services, interpretation of extension material and maintenance of farm records, and for both understanding and interpretation of programme objectives. There is a direct link between education and employment, evidenced through

higher employment rate in the beneficiary over the non-beneficiary households. Both factors have a resultant and determining effect on the occupation, and finally on the income earned in a household. This is seen in the more number of households with the ability to purchase staple from the beneficiary group, coupled with the positive impact of the dairy programme in enhancing purchasing power.

The immediate pressing demands more often dictate the pattern of profit utilization. The most common use of profit from the dairy enterprise was education, loan repayment and health care. Very few families use the profits to improve the dairy herd and the dairy enterprise. Thus dairy projects may be seen as important sources of income in households. It is not easy to pinpoint this decreasing trend to the dairy programme effects singly given that many rural development programmes are initiated in this area. However LDP interventions have created a healthy competition amongst households with a resultant effect on the general improvements in the overall family welfare. Preschool children from households where mothers were well nourished tended to be well nourished. There is a direct link between the preschool child nutritional status and the mothers' body mass index. However, there are some special cases where mothers body mass index is normal while the child's nutritional status is low and vice versa. Such cases are common in households where children have experienced prolonged illnesses, or children are left under the care of housemaids.

Amount of milk consumed by preschool children is an important factor associated with their nutritional status. Milk is considered to be vital in preschool children's diets. There is a tendency for mothers to serve milk in the form of tea to their preschool children and milk does not offer any nutritional value in the diets of preschool children in this form. There is need to have an in-built nutrition education component in the LDPs and other agricultural projects intervention strategies. Otherwise LDPs projects are not significant sources of improved nutritional status in the index population, as evidenced in the lack of significant difference in the two groups. Household income had no effect on the nutritional status of preschool children. Kennedy and Rodgers (1992), Kennedy and Oniang'o (1990), Rubin (1988, 1990) have also found no association between nutritional status of preschool children and income. The extra income earned is hardly spent on food but goes for non-food purposes.

Other studies that compared beneficiaries and non-beneficiaries of Kenya Sugarcane Outgrowers programme found no significant difference in the nutritional status of preschool children from both groups (Von Braun and Kennedy, 1986; Cogill, 1987; Kennedy & Cogill, 1987; Rubin, 1988; Kennedy and Oninag'o, 1990). Nutritional status of preschool children from beneficiary households tended to be poorer than that of preschool children from non-beneficiary households (Rubin, 1990). Women from beneficiary households spent less time with their children. Preschool children whose mothers were housewives had better nutritional status than those from households where mothers were employed (Walingo, 1991). Kennedy (1988) postulated that changes in time-use across and within agricultural households indicated that important shifts in production and consumption were occurring in areas other than nutrition that may have favourable effects on the welfare of some project population.

General information concerning nutritional status of non-pregnant and non-lactating women based on careful scientific research for developing communities is limited. However, programmes need to collect baseline data on socio-demographic and agro-economic characteristics and nutritional status of beneficiaries, for further evaluation of project impact. Women's body mass index was associated with the sell of crops harvested by households. The crops sold are, in most cases, surplus and thus add extra income to the households. However, households may sell most of the crops harvested to meet immediate pressing demands (e.g. payment of school fees to offset bills etc.). Where this is the case, ready cash may not be available to purchase staple in time of need, creating food deficits in households. Ability of households to purchase staple was associated with BMI of women. More participant households exhibited increased ability to purchase staple than those from non-participant households. This is a direct effect of the dairy programme, which has enhanced household's purchasing power.

Conclusion and Recommendations

Nutrition status of preschool children as measured by stunting was significantly higher among children from the non-participant group. Factors which showed correlation with nutritional status were BMI of the mother, number of preschool children in a household, time input by women in the dairy enterprise, and amount of milk consumed by preschool children. Intake of milk and milk products, and green leafy vegetables formed the best set of foods with discriminatory power between women in participant and non-participant households. Mean intake of these foods was higher in the participant group. Nutrient intake was higher in the participant households. Intake of protein, vitamin A and energy in that order were the best sets of nutrients that differentiated between women in participant and non-participant households. Protein and energy in that order were the best set of nutrients with discriminatory power between preschool children in participant and non-participant households.

There is a direct link between the preschool child nutritional status and the mothers' body mass index. However, there are some special cases where mothers body mass index is normal while the child's nutritional status is low and vice versa. Such cases are common in households where children have experienced prolonged illnesses, or children are left under the care of housemaids. Amount of milk consumed by preschool children is an important factor associated with their nutritional status. Milk is considered to be vital in preschool children's diets. There is need to have an in-built nutrition education component in the LDPs and other agricultural projects intervention strategies to enhance

the goal of projects to improved nutrition in households. Though Livestock Projects have not been found to be significant sources of improved nutritional status in the index population, there is enhanced nutrition status and household income in participating households. Building food and nutrition goals in agricultural projects for improved food and nutrition status require careful planning and implementation at all stages of the project.

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