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Socio-economic Factors Influencing Adoption of Feed Based Dairy Technologies among Smallholder Farmers in Ekerenyo Sub-County, Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Author MLA designed the study and performed the statistical analysis. Author DOO edited the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: The study examines socio-economic factors influencing adoption of feed based dairy technologies among smallholder farmers in Ekerenyo Sub County of Nyamira County. This is occasioned by lack of proper understanding of factors influencing adoption of feed based dairy technologies which has resulted in lack of competitiveness in the dairy industry despite efforts by public, private and non-governmental players to generate and disseminate technologies.
Study Design: The study employed a descriptive survey research design involving quantitative data.
Methodology: The target population was small scale dairy farmers estimated at 600 in Ekerenyo Sub-County. The sample size consisted of 199 drawn from individual farmers, farmers groups and key informants identified using stratified sampling procedure. Data was analyzed using descriptive and inferential statistical techniques like chi-square, frequency distribution and measures of central

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tendency using Statistical Package for Social Sciences (SPSS) version 22 and Microsoft Excel 2010. The yes or no dichotomous was used to measure adoption.
Results: Technologies with low adoption included fodder conservation (hay and silage making), Total Mixed Rationing and home-made ration formulation. On the other hand, technologies with medium adoption include mineral and concentrate supplementation, Tumbukiza establishment and legume establishment. Technologies with highest adoption rates were protein supplementation and use of feed structures/equipment. The results revealed that the level of adoption of feed based technologies by smallholder farmers is still unsatisfactory. It is highly dependent on family and land size, level of education, monthly income, labour availability, social exposure and participation, herd size and experience. Technology adoption rates decreased significantly with involvement in non-farm activities. There was no statistically significant difference in adoption with gender of household head.
Conclusion: There is need to enhance smallholders access to education, land ownership, labour availability and social participation. Further research is needed to find out innovative approaches that can uplift smallholder farmers' adoption of feed based technologies.

Keywords: Adoption; feed based dairy technologies; smallholder dairy farmer.

1. INTRODUCTION

Global food security is high on the development and research agenda now than any other time in history because of the continuing demand to feed an exponentially increasing population. Livestock contributes to food security by converting low-value materials into milk, meat and eggs [1]. In order to ensure that world's poorest people are food and nutritionally secure, greater emphasis has been put on feed based dairy technologies among smallholder farmers as they represent 35% of people living in the world today especially in Sub-Saharan Africa [2]. Therefore, a critical analysis of factors influencing adoption of these technologies may provide impetus for increasing their productivity and incomes hence reducing extreme hunger and poverty. Adoption of technologies is described as exogenous and endogenous process in response to various technical, social and economic forces affecting small scale farmers who have limited resource base [3]. The present study is anchored on innovation-decision model as described by [4]. According to Rogers' innovation decision theory, potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation, second, they must be persuaded of the value of the innovation for them to decide to adopt it. The innovation must then be implemented, and, finally, the decision must be reaffirmed or rejected. These stages are similar to ones developed by [5]. [6] on his study on *"Influence of study circle extension strategy on technology dissemination in Kenya"* used the same model. However, various limitations to the innovation diffusion theory were described by [7,8,9].

Smallholder farmers are heterogeneous and face different circumstances in decision making [10]. Farmers' socio-economic characteristics such as demographic (age, gender, level of education, experience in dairy farming, family size etc.); social participation (membership of farmer based associations/groups), cosmopolitanism and economic (land ownership, monthly income, herd size etc) have been found to influence their decision to adopt as they play a role in enhancing demand, adoption and use of technology [11,12].

Demographic characteristics are considered as precursor factors and have significant effects on the decision-making process [13] Farmers' resource endowment determines availability of key factors of production such as land, labour, access to information, materials and equipment. According to [14], farmers' participation in social functions enable them learn from each other and knowledge is carried from one community to another, providing access to information, inputs, infrastructure, and institutions, links individuals to the larger society and exposes them to a variety of ideas. Individuals also learn about an existing innovations, their characteristics and take advantage of others' experiences to lower uncertainties related to adoption. Contact with the world outside the village (Cosmo-politeness) especially urban centers, links the farmer with the larger society hence a positive influence on level of consciousness and outlook exposing them to a wide variety of ideas. Information

obtained through this outside contact makes the farmer progressive in outlook and "cosmopolite" in orientation as explained by [15].

The purpose of the study was to examine socio-economic factors influencing adoption of feed based dairy technologies among smallholder farmers in Ekerenyo Sub County of Nyamira County, Kenya. Specific objectives were threefold: to establish how demographic characteristics of farmers determine adoption of feed based dairy technologies; to investigate how economic characteristics of farmers influence adoption of dairy technologies and to establish the extent to which social participation of small scale farmers influences adoption of feed based dairy technologies in the study area.

2. METHODOLOGY

The study employed a descriptive survey research design involving quantitative data as recommended by [16]. The target population was smallholder dairy farmers in Ekerenyo division of Nyamira County, Kenya. The sample size was determined using Morgan table from a population of 600 dairy farmers. Stratified sampling procedure was used to arrive at a sample of 199 drawn from farmers and groups undertaking dairy production activities. The study employed questionnaires, key informant interview and focus group discussion to elicit information from respondents. The data collection instruments were pre-tested, validated by experts and reliability tested using Split half reliability method. Spearman's product moment of correlation (r) a coefficient value of 0.70 was obtained. Data was analyzed using descriptive and inferential statistical techniques, Statistical Package for Social Sciences (SPSS) version 22 and Microsoft Excel 2010 was used in data analysis.

Feed based dairy technologies (Fodder conservation technologies, Legumes establishments, Mineral supplementation, Protein feeding, Concentrate Supplementation, Total Mixed Ration, On-Farm Feed Formulation and Use of feed structures/equipment) were listed and their adoption level in percentage of farmers was measured. Further, adoption score for each technology was measured by scoring the level of technology used. Adoption index for each farmer was computed by score obtained for individual divided by total obtainable score and expressed as percentage. The dairy farmers were categorized into two categories (non-adopters and adopters) on the basis of their level of adoption measured in terms of adoption index.

3. RESULTS AND DISCUSSION

3.1 Farmers' Socio-economic Characteristics

Table 1 presents Socio-economic characteristics of farmers. The average age of dairy farmers in the study area is 45.6±11.3 years. The youth farmers (<36 years) comprise of 21.6% though the respondents ages ranged between 25-80 years of age. This is the same as reported by [17,18] slightly lower than one reported by [19]. This means there is relatively older farming population in Kenya. The highest percentage of respondents (79.9%) interviewed were in their productive age of up to 55 years.

Out of 199 respondents interviewed, more than a third (71.9%) of respondents were male. This is higher than reported by [20] in Ethiopia at 58% males and 42% females in Ethiopia but lower than previously reported in Kenya [19]. There are more married respondents (84.4%) than any other marital status. Marital status did not seem to have an influence on the adoption of improved feed based dairy technologies. The proportion of households heads who were married tended to be higher (but not significant) among farmers who adopted improved dairy technologies.

The mean age of respondents was 45.6 years but majority of respondents (33.5%) are in 36-45 years. Gender distribution showed that there were more male respondents (71.9%) than female respondents (28.1%). Majority of respondents (48.7%) had secondary education. This is higher than reported by [20] in Ethiopia but slightly varies with one reported by [19]. Most farmers (32.7%) have kept dairy animals in their farms for 6 – 10 years. This is lower than one reported by [23] in a study carried out in Bangladesh.

Family size was considered important because in addition to being a source of labour, the size of the family may also influence the need for increased milk production for home consumption as well as for the market. The average family size is 6 persons; the highest family has 11 persons while the lowest family size is 1 person. Many 146 households (73.4%) have less than 6 persons with average family size. Large families constitute 26.7% with average size of 8.1 persons.

Table 1. Distribution of respondents based on their socio-economic characteristics (n=199)

Characteristic	Category	f	%	Mean	Std. Dev.
Age	< 36 years	43	21.6	45.6	11.3
	36-45 years	66	33.2		
	46-55 years	50	25.1		
	56-65 years	31	15.6		
	> 65 years	9	4.5		
Gender	Male	143	71.9		
	Female	56	28.1		
Education level	Lower Primary	1	0.5		
	Upper Primary	61	30.7		
	Secondary	97	48.7		
	College/University	40	20.1		
	Never Attended school	0	0.0		
Monthly income	USD.10-50	42	21.1		
	USD. 60-100	36	18.1		
	USD.110-150	52	26.1		
	USD. 160-200	37	18.6		
	USD. 210-250	13	6.5		
	> USD.260	19	9.5		
Experience in dairy farming (years.)	1- 5 years	44	22.1		
	6-10 years	65	32.7		
	11-15 years	29	14.6		
	16-20 years	30	15.1		
	21-25 years	14	7.0		
	26 years and above	17	8.5		
Land size (ha)				3.0	2.8
Family size (No)				5.6	1.9
Herd size (No)				2.25	1.3
Availability of labour	Enough labour	71	35.7		
	Not enough labour	128	64.3		
Cosmopolitans	Lived outside Gusii area	80	40.2		
	Never lived outside Gusii area	119	59.8		
Membership of associations/groups	Members	115	57.8		
	Non-members	84	42.2		

Note: 1USD = 100KES (Kenya Shilling)

Land ownership can be used to classify farmers in terms smallholder, medium scale and large scale. Most of respondents (90%) owned less than 5 acres of land (considered small scale); the rest are medium scale owners with average 9.4 acres of land. Average land ownership by dairy farmers was 3.0 acres. This is consistent with [19] who asserted that the average land holding is 4.4 acres in Kenya. The smallest land owned was 0.25 acres while largest land owned was 20 acres. This implies limited land allocated for pasture and fodder production, and dairy house/structure of the respondent. [21] established that small landholdings limited the farmer's choice to cultivate improved forages and dairy house/structure as most available land was used for subsistence food crops.

The average herd size in the study area is 2 cows, the largest herd is 8 cows and smallest herd is 1 cow. This is lower than one reported by [20] at 3 cows in Ethiopia. Majority of respondents (26.1%) earn USD.110-150 per month. Few respondents (6.5%) earn USD.210-250 and above USD.260 (9.5%). Only 35.7% of have enough labour to undertake dairy practices.

Farmers were asked whether they had lived outside Gusiiland (land occupied by predominantly by Abagusii speaking people); 40.2% of farmers in the study area indicated that they have lived outside Gusii land, out of which 52 (65%) lived 1-6 years, while 16 farmers (20%) lived 8-12 years and 10 (12.5%) lived 13-18 years only 2 (2.5%) farmers lived 18-24 years. The results showed that 57.8% of respondents were members of farmer based associations and groups. Three types of groups exist with farmers; producer, marketing and social welfare groups; farmers who are in associations are 35.1%, 1.8% and 63.1% in producer, marketing and social welfare groups respectively. Farmers in producer and marketing group are involved in different aspects of dairy; producing and marketing. Social welfare groups do not engage in dairy related activities.

3.2 Adoption of Improved Feed-based Dairy Technologies

Table 2 presents distribution of adoption of feed based technologies studied. Use of feed structures/equipment (76.4%) and Protein supplementation (73.9%) had high adoption rate. Key informants interviews (KII) indicated that these technologies have a direct impact on amount and quantity of milk produced. On the other hand, fodder conservation technologies (24.1%), Total Mixed Ration (8.5%) and On-Farm Feed Formulation (6.5%) had the least adoption rates.

Table 2. Distribution of respondent by adoption of feed based dairy technologies (n=199)

Feed based dairy feed technology	f	% and rating
Tumbukiza method	126	63.3**
Fodder conservation technologies	48	24.1*
Legumes establishments	108	54.3**
Mineral supplementation	132	66.3**
Protein supplementation	147	73.9***
Concentrate feeding	112	56.3**
Total mixed ration	17	8.5*
On-farm feed formulation	13	6.5*
Use of feed structures/equipment	152	76.4***

*Rating Key: *Low adoption, ** Medium adoption, *** High adoption*

The low adoption of feed formulation technologies (on-farm feed formulation and Total Mixed Ration (TMR) could be because they are knowledge-intensive technology that farmers need to learn and practice over a considerable period of time. Adoption of supplementary feeding reported in the study area are higher than one reported by [22] in Zambia and [23] in Bangladesh. Both the frequency and the quality of concentrate feed depended on the farmer's ability to buy concentrate. As indicated by key informant interviews, irregular feeding of concentrates occur in the area, this is because it is expensive and was not readily available in the area.

3.3 Comparisons of Adoption Categories by Socioeconomic Characteristics of Farmers

Age showed significant difference between adopters and non-adopters for *tumbukiza* method, fodder conservation, legume establishment, protein and concentrate supplementation, TMR, home-made ration and feed structure. This is consisted with work done by [12] and inconsistent with work of [15] in Egypt on Buffalo farmers. Family size showed statistically significant difference between adopters and non-adopters of *tumbukiza*, fodder conservation, legume establishment, protein and concentrate supplementation, TMR, homemade rationing and use of feeding structures and equipment. However, family size showed no statistically significant difference between adopters and non-adopters of mineral supplementation.

Chi-square analysis revealed statistically significant difference between adopters and non-adopters of feed based technologies (*tumbukiza*, fodder conservation, legume establishment, protein, mineral and concentrate supplementation, TMR, homemade rationing and use of feeding structures and equipment) assessed.

Education of household head had statistically significant difference between adopters and non-adopters of all feed based technologies analyzed; *tumbukiza*, fodder conservation, legume establishment, protein, mineral and concentrate supplementation, TMR, home-made rationing and use of feeding structures and equipment. This is consisted with studies done by [24,25]. Education makes farmers to realize the importance and benefits of adopting new technologies. Therefore educated people can be more willing to adopt and apply the new innovations in their farms. However, chi-square analysis of labour availability did not show any statistical significant difference between adopters and non-adopters of tumbukiza method, mineral and protein supplementation; and TMR because these are considered less labour intensive and enables a farmer to use less energy himself and make him a boss, this is desired by many farmers since is left with supervision of labourers.

Chi-square analysis showed statistically significant difference between adopters and non-adopters of fodder conservation, legume establishment, protein, mineral and concentrate supplementation, TMR, homemade rationing and use of feeding structures and equipment except *tumbukiza* method in respect to cosmopolitans. These technologies are considered relatively new and cosmopoliteness exposes farmers to new technologies and practices. On the other hand *tumbukiza* method has been promoted aggressively by the Directorate of Livestock Production hence all farmers have an equal chance of adopting it.

Table 3. Results of chi-square analysis between adoptions categories of feed based technologies and socioeconomic characteristics of farmers

Feed based dairy technologies	Age		Gender		Family size		Experience	
	x^2	p	x^2	p	x^2	p	x^2	p
Tumbukiza method	6.15	0.01*	0.13	7.22^{NS}	22.63	0.01*	11.94	0.04**
Fodder conservation	2.54	0.64^{NS}	0.47	0.07^{NS}	14.54	0.05**	9.82	0.02**
Legume establishment	2.00	0.74^{NS}	0.23	0.09^{NS}	8.02	0.03**	13.56	0.02**
Mineral supplementation	6.32	0.01*	0.12	0.08^{NS}	3.17	0.98NS	2.36	0.01*
Protein supplementation	8.39	0.00*	2.07	0.1^{NS}	10.94	0.03**	7.46	0.01*
Concentrate supplementation	10.89	0.00*	1.07	2.01^{NS}	22.65	0.01*	2.94	0.01*
TMR	5.70	0.02**	1.56	3.02^{NS}	2.68	0.01*	6.77	0.04**
Home made ration	2.67	0.01*	0.88	0.62^{NS}	12.24	0.01*	0.81	0.04**
Feeding structure	9.32	0.05**	4.19	0.48^{NS}	17.14	0.00*	9.72	0.02**
Feed based dairy technologies	**Education**		**Labour availability**		**Cosmopolitans**		**Group membership**	
	x^2	p	x^2	P	x^2	P	x^2	P
Tumbukiza method	2.62	0.02**	0.24	0.63^{NS}	0.07	0.79^{NS}	2.33	0.03**
Fodder conservation	1.68	0.03**	1.09	0.30**	1.61	0.02**	0.07	0.07^{NS}
Legume establishment	6.16	0.01*	3.94	0.05**	1.52	0.02**	4.93	0.03**
Mineral supplementation	0.21	1.00^{NS}	0.02	0.88^{NS}	1.33	0.03**	2.42	0.02**
Protein supplementation	2.78	0.02**	0.85	0.36^{NS}	0.06	0.01*	3.31	0.01*
Concentrate supplementation	1.54	0.02**	7.32	0.01*	0.33	0.01*	1.33	0.03**
TMR	2.95	0.05**	0.15	0.70^{NS}	0.50	0.02**	0.59	0.44^{NS}
Home made ration	2.95	0.05**	5.84	0.02**	0.00	0.01*	7.53	0.01*
Feeding structure	16.92	0.00*	2.02	0.03**	9.68	0.00*	9.19	0.00*

*** Significant at 5% level, * significant at 1%, NS-Not Significant*

There was also statistical significant difference between participation in farmer level group activities and adoption of tumbukiza, legume establishment, protein, mineral and concentrate supplementation, homemade rationing and use of feeding structures and equipment. This is consistent [25] in Kenya. However, there was no statistical difference with adoption of fodder conservation and TMR. From those who participated in farmer groups, participation on social welfare groups seemed to encourage adoption of mineral supplementation (87%). Participation in marketing groups enhanced adoption of mineral supplementation (60%), *tumbukiza* nappier method (88%) and use of feeding structures/equipment (88%).

4. CONCLUSION

Adoption of feed based technologies varies greatly. Interventions to promote dairy should exploit the opportunities available in feed based technologies and address the circumstances under which adoption decisions are made.

The level of adoption of feed based technologies by smallholder farmers is still unsatisfactory and is highly dependent on age, family and land size, level of education, monthly income, labour availability, social exposure and participation, herd size and experience. Efforts should be made to enhance access of farmers to land, cheap labour, education or literacy programmes and social exposure.

There was no significant difference in adoption with gender of household head. A look at the broader perspective of rural development is necessary. All players should also develop the rural non-farm sector in order to increase people's income and diversify out of agriculture. This is because demand for livestock products is income elastic.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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