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DO EXTENSION SERVICES INFLUENCE MILK PRODUCTION AMONG DAIRY FARMERS' COOPERATIVES?

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ABSTRACT: *Dairying is viable for smallholders but suffers from high transaction costs hence the need for cooperatives that aid farmers to access various services. Agricultural extension disseminates knowledge, physical inputs, credit and builds farmer' capacity for collecting bargaining and marketing their produce. A descriptive study design was adopted, 200 participants were selected using multi stratified random sampling. Secondary and primary data were collected using a semis-structured checklist and structured questionnaire respectively. Mean productivities for farmers who used or didn't use extension services were compared using an independent samples t-test statistics. Dairy farmers who accessed business training, artificial insemination, improved fodder and concentrates increased milk production. Access to extension services explained 25.5% of the variations in milk production per cow per day. Dairy farmers are operating profitably with average monthly revenue ($215) versus expenditure ($58).interventions aimed at supporting dairy farmers to increase milk production should prioritize cooperatives and extension services.*

KEY WORDS*: Cooperatives, extension, inputs, services, production.*

INTRODUCTION

Agricultural extension is the dissemination of knowledge, physical inputs and other services to farmers. Extension programs were originally conceived to extend research-based knowledge including technology transfer, broader rural development goals, management skills, and informal education to the rural farmers towards improving farm productivity and livelihoods. Traditionally, extension in developing countries focused on training farmers, transferring technology and increasing production (Davis *et al.*, 2010). Today extension goes beyond; technology transfer to facilitation, training to learning and helping farmers form groups, deal with marketing issues, and partner with a broad range of service providers (East African Dairy Development Project (EADD), 2016).

The scope of agricultural extension services has been changing to respond to the ever-growing challenges of increasing food production (Obaa *et al*., 2005) necessitating a paradigm shift from the traditional public extension systems which are seen as outdated, top-down, paternalistic, inflexible, subject to bureaucratic inefficiencies and unable to cope with the dynamic demands of modern agriculture to extension services that provide human capital-enhancing inputs as well as information to improve dairy farmers income and farm profitability (Garai *et al*., 2017).

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Extension services to dairy farmers include training, access to physical inputs and services. In Uganda dairy cooperatives also offer services including credit, milk marketing, veterinary inputs supply, farmer trainings, link farmers to markets and other actors along the agricultural value chain, information, skills and technologies. The extension system has undergone reforms including privatization, decentralization and delegation of service delivery responsibility to NGOs, farmer organizations and other grass root institutions (Bashaasha *et al*., 2011, Makoni *et al*., 2014).

Dairying is a viable investment for many smallholders in East Africa. However, the high transaction costs for dairy production and marketing limit their participation (Kabbiri *et al*., 2016). Inadequate veterinary extension services undermine the dairy sector objective of increasing milk production (Makoni *et al*., 2014). Thus farmers have formed cooperatives to improve access to services, undertake collective processing and marketing of agricultural products (Sumelius *et al*., 2013). There are over 300 registered dairy cooperatives in Uganda which were formed with an objective of facilitating collective marketing (DDA, 2014). Agricultural extension through cooperatives is merited for farmer education and dissemination of new technologies (EADD, 2015a) although the role and contribution of extension services towards improved milk production is not known. The study assessed the role of extension services in increasing milk production among dairy farmers' cooperatives.

Cooperatives working with the EADD Project have extension structures including extension workers, model farmers, savings and credit cooperative organizations (SACCOs), veterinary drugs and feed stores, women and youth groups, dairy interest groups (DIGS), and mobilization committees intended to increase access to veterinary inputs, animal health services, artificial insemination (AI), farmer trainings on production enhancement technologies (PETS), advisory and financial services. The dairy farmers in the project area access various inputs including feeds such as concentrates (dairy meal), acaricides, veterinary drugs, milk cans, farm equipment especially spray pumps and dairy breeding stock (EADD, 2015).

Theoretical underpinning

Several extension approaches have been promoted but overall performed dismally (Wellard *et al*., 2013). The study was informed by the stakeholders' theory and the theory of change. The stakeholders' theory suggests that economic organizations belong to a variety of groups or stakeholders in society. Stakeholders are the individuals and groups who are influenced or have an influence on the activities of the cooperative. Besides the cooperative members, the communities in which they operate, their suppliers and service providers must all be considered to ensure effectiveness and sustainability of dairy cooperatives (Gijselinckx, 2009). The theory of change is a framework that links the problem (low milk production) with the results to be achieved and the best approach to achieve the results and outcomes. We cannot achieve the change (increased milk production) unless the beneficiaries utilize the various outputs (extension packages) delivered through the dairy cooperatives.

METHODOLOGY

The study adopted the descriptive cross-sectional research design to investigate the relationship between the variables (Sekaran, 2000). To achieve the study objectives,

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relationships between utilization of extension services and milk production were tested, milk production being the dependant variable. Qualitative data was collected to gather in depth information about the variables and it was analysed by categorizing into thematic areas. A consent form was availed to all respondents of the study which assured them anonymity and confidentiality. The study was conducted in the districts of south-central Uganda, EADD Project area and respondents were obtained using multistage stratified random sampling from each selected dairy cooperative using proportional sampling i.e. Mitala Maria (93), Ssembabule (110), Nabitanga (120) and Gulama (80). The strata comprised of EADD producer Organizations (POs). Stratified sampling was preferred because dairy farmers within the same stratum have similar characteristics. Stratifying also facilitated proportionate representation of each farming system in the sample. Simple random sampling was used to select 4 POs; 2 from Sembabule (Nabitanga and Lugushulu), 1 from Mpigi (Mitala Maria) and 1 from Masaka (Guama) dairy farmers' cooperatives respectively. The study population comprised of members and non-members of the dairy farmer cooperatives. Respondents were selected within a radius of 8 Kilometres from the selected dairy cooperative constituting its catchment area. The formula used to calculate the sample size n was,

$$n = \frac{N}{1 + N(e)^2}$$ Where; $N = \sum_{k=1}^{k=4} N_k$, $n = \sum_{k=1}^{k=4} n_k$

N_k is the population size of the k^{th} Stratum n_k is the sample size of the k^{th} stratum n is the total sample size for the 4 strata e is the level of significance and equal to 5%
N is the total population size allocated proportionally to the four different strata estimated at 176 but researchers adjusted upwards to 200 farmers. However, 199 farmers were interviewed.

Primary data was obtained from personal interviews (PIs) using a structured questionnaire administered to the respondents by trained enumerators. For triangulation purposes, key informant interviews (KIIs) were also conducted with leaders of dairy cooperatives and producer organizations. Secondary data was obtained from the EADDP 2008 baseline report, annual evaluation reports, relevant reports from NGOs in the study area, district local governments, milk registers at cooperative offices and farmer profiles.

Primary data from the questionnaires were cleaned, coded, entered into Microsoft Excel; exported and analysed in STATA. Data were summarized using percentages, means and standard deviations. Relationships between utilization of different forms of extension services and milk production were subjected to a t test to compare mean productivities between the dairy farmers who utilized a particular form of extension service and farmers who didn't.

$$\mathbf{t} = \frac{\overline{\mathbf{X}}_1 - \overline{\mathbf{X}}_2}{\sqrt{\frac{(\mathbf{n}_1 - 1)\mathbf{s}^2_1 + (\mathbf{n}_2 - 1)\mathbf{s}^2_2}{\mathbf{n}_1 + \mathbf{n}_2 - 2}\left[\frac{\mathbf{n}_1 + \mathbf{n}_2}{\mathbf{n}_1\mathbf{n}_2}\right]}}$$

Where t is the test statistic and $\overline{\mathbf{X}}_1$ and $\overline{\mathbf{X}}_2$ are the mean milk productions for the farmers who use and don't use extension services from cooperatives respectively.

$\mathbf{n}_1$ and $\mathbf{n}_2$ are sample sizes for farmers who use and don't use cooperative extension services respectively.

$\mathbf{s}^2_1$ and $\mathbf{s}^2_2$ are the sample production variances for the farmers that use and don't use cooperative extension services respectively.

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Multiple logistic regression analysis (MLRA) was used to determine the combined effect of the utilization of extension services from different sources on milk production. Milk production (M_p) was the dependent variable whereas frequency of access of extension services from cooperatives (C_1 and C_2 for accessing cooperative extension at least twice and at most thrice respectively), frequency of access to extension services from private providers (P_1 and P_2 for accessing private extension at least twice and utmost thrice respectively), frequency of access of extension services from NGOs (N_1 and N_2 for accessing NGO extension at least twice and utmost thrice respectively), use of AI (A) and use of improved fodder/concentrates (FC) which were significant at bivariate level. Putting all the above factors together, a linear model (1) was generated as follows:

$$M_p = \beta_o + \beta_1 C_1 + \beta_2 C_2 + \beta_3 P_1 + \beta_4 P_2 + \beta_5 N_1 + \beta_6 N_2 + \beta_7 A + \beta_8 FC + e_i \ldots\ldots\ldots (1)$$

Where the variables in the model are defined as;

M_p is milk production per cow per day

β_o is milk production when no form of extension is used/accessed

β_i is the effect of the i^{th} explanatory variable on the dependent variable (i = 1, 2, …, 8) and e_i is the error term.

RESULTS AND DISCUSSIONS

Extension services and milk production

By comparing the means of milk production per cow per day, the relationship between extension services and milk production was determined (Table 1).

Table1. Comparison of milk production by training access

Training	Status	No. of farmers	Milk /Cow	Std. Err.	p - value
Animal health	Not trained	50	7.8	0.5	0.577
	Trained	134	8.2	0.4	
Feeds	Not trained	38	8.0	0.6	0.906
	Trained	146	8.1	0.3	
Breeding	Not trained	40	7.5	0.6	0.279
	Trained	144	8.2	0.3	
Business	Not Trained	85	7.4	0.4	0.026
	Trained	95	8.7	0.5	

Significant milk production differences were observed between farmers who attended and didn't attend business trainings with the former producing on average 1.3 litres more than the latter ($P < 0.05$) as shown in Table 1.

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Table 2. Extension services, input usage and milk Production

Service	Status	No. of farmers	Milk /Cow	SE	p - value
Vaccination	Not	62	7.7	0.4	0.341
	Used	125	8.3	0.4	
Dairy Finance	Not Used	68	8.1	0.5	0.605
	Used	94	7.8	0.4	
Milk marketing	Not Used	49	8.2	0.6	0.181
	Used	109	7.4	0.3	
Improved feeds/Concentrates	Not Used	98	7.4	0.4	0.001
	Used	45	9.8	0.6	
Advisory	Not Used	55	7.3	0.5	0.228
	Used	71	8.2	0.5	
Breeding	AI	41	10.4	0.7	0.000
	Bull	146	7.4	0.3	

Usage of improved fodder and or concentrates enhanced milk production significantly (P< 0.05) with the farmers who used producing on average 2.4 litres per cow per day more than those who did not use. Usage of AI for breeding was associated with a significant (P < 0.05) difference in milk production per cow per day with the farmers who used producing 10.4 Litres per cow per day as opposed to 7.4 litres per cow per day for farmers used bulls for breeding (Table 2).

Milk production and the different sources of extension services

Table 3. Milk production by access of extension services from different sources

Extension source	Frequency of access	Milk/Cow	SD	P-value
NGO	None (n = 117)	7.3	3.8	0.002
	Utmost twice (n = 58)	9.2	4.0	
	Thrice & above (n = 12)	10.2	4.8	
Government	None (n = 119)	8.2	4.1	0.662
	Utmost twice (n = 63)	7.8	3.9	
	Thrice & above (n = 5)	9.4	3.8	
Private provider	None (n = 38)	7.1	2.7	0.020
	Utmost twice (n = 89)	7.8	4.3	
	Thrice & above (n = 59)	9.2	4.1	
Lead farmer	None (n = 130)	8.3	4.0	0.533
	Utmost twice (n = 43)	7.6	4.5	
	Thrice & above (n = 14)	7.5	2.2	
Cooperative	None (n = 59)	6.3	3.2	0.000
	Utmost twice (n = 71)	8.0	3.8	
	Thrice & above (n = 57)	10.0	4.2	

The higher the frequency of access to extension services the higher the amount of milk produced per cow per day for farmers who used NGOs (P < 0.05), Private (P < 0.05) and cooperatives (P < 0.05) as shown in (Table 3).

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Table 4. Overall Extension services access versus milk production

Milk production per cow per day	Coefficient	SE	P-value
AI use	1.8	1.00	0.081
Concentrate/ Improved fodder use	0.8	0.94	0.401
Training in business Skills	-0.1	0.79	0.889
Cooperative extension use frequency			
Utmost twice	0.6	0.88	0.512
Thrice & more	3.7	0.86	0.000
Private extension use frequency			
Utmost twice	1.1	0.90	0.221
Thrice & more	2.9	0.97	0.004
NGO extension use frequency			
Utmost twice	0.2	0.85	0.829
Thrice & more	1.2	1.60	0.458
Constant	4.6	0.98	0.000

Prob > F = 0.000, Adjusted R^2 = 0.2547

A linear regression model combining independent variables that influenced milk production per cow per day significantly at bi-variate level were assessed. Overall, the model is a good fit (Prob > P = 0.00) and access to extension explains 25.5% of the variations in milk production per cow per day (Table 4). At no extension, farmers would produce 4.6 litres per cow per day keeping other factors constant. Using extension services from dairy cooperatives at least once a month had a potential of increasing milk production per cow per day by 3.7 litres keeping other factors in the model constant. Usage of AI for breeding increased milk production per cow per day by 1.8 litres compared to using a bull. Private sector and farmer cooperatives were the major providers of extension services.

Organizing dairy farmers into cooperatives in Uganda and using them as platforms to provide extension services has potential for increasing milk production. Dairy farmer cooperatives were the major providers of trainings and extension services with support from NGOs like Heifer International Send a Cow, Caritas Maddo Diocese and Government of Uganda through signed memorandum of Understandings (MOUs). These sessions are mostly free of charge and cooperatives play a role of mobilization of farmers (Ndambi *et al*., 2007).

Heifer International under the EADD project facilitated cooperatives to recruit extension officers by providing extension grants and linkages to several service providers through the hub model approach in the selected dairy farmer cooperatives (Makoni *et al*., 2014). In addition to tick control, curative treatments, vaccination, AI, purchase of veterinary drugs, feeds, dairy loans and advisory services are important inputs to the dairy farmers. Almost all farmers control ticks and pay for curative treatments given the economic importance of cattle diseases in the region. Animal health services are the most accessed services by dairy farmers (EADD, 2015).

Use of animal health services like deworming, curative treatments, procurement of veterinary drugs and acaricides has increased from 2015 to the study period. Increased access to extension

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services by dairy farmers was attributed to the implementation of the Heifer hub model comprising of cooperatives in the study area where dairy farmers are organised to collectively market their products and also access services like credit, veterinary drugs, and farm equipment through a check off system.

Dairy cooperatives have the capacity to create employment, increase access to services to rural communities (Birchall, 2003). Non-members also accessed services such as milk marketing, AI and other veterinary inputs from the cooperatives. Breeding services (AI and improved bulls) were the least utilized services. Farmers find AI services too expensive and inaccessible in the rural areas. Presence of tick borne diseases such as east coast fever (ECF) also discouraged famers from improving their herds with exotic breeds that are very susceptible to such diseases thus the slow uptake of AI.

As much as dairy cooperatives are popular milk marketing outlets, the prices they offer are not competitive compared to the alternative selling outlets. However, farmers still sell through the cooperatives because they are accessible, provide a sure market during both dry and wet seasons when dairy farmers too little or surplus milk respectively. Dairy cooperatives have signed contracts and created linkages with the major milk processors like Brookside dairies to collect and deliver milk to the processing plants (Makoni *et al*., 2014; EADD, 2016).
Access to extension services is essential for farmers to improve production and productivity of their dairy herds. Majority of farmers had accessed extension services for less than three times in the previous 3 months implying low accessibility. Farmers seem to prefer to access extension services from various channels with the cooperatives providing linkages to private sector, NGOs, and Government. Hence farmers who belong to dairy cooperatives have higher access to extension services than non-members.

The government of Uganda supports the notion that privatization of agriculture financing, delivery of extension services, and decentralization of authority to lower levels of government, including delegation to farmer cooperatives can increase access to extension services (Bashaasha *et al*., 2011). NGOs provide extension services at the lowest cost of Uganda Shillings 89 per farmer while private extension services are the most expensive at an average of Uganda Shillings 34,733 per farmer. This is so because most of the NGO services are either free or subsidized. During the cost of milk production survey 2015, results indicated that animal health services and purchased feed were the extension services that took a big percentage of the cost of producing a litre of milk.

Farmers under the intensive production system incurred highest cost on feeds. Under extensive, the highest cost was on Animal health. Private extension services are the most expensive due to cost of inputs (acaricides and veterinary Drugs) besides the professional fees for diagnosis and treatment (Leyland & Catley, 2002), while government and NGOs mainly provide subsidized or completely free extension services, for instance the government program of OWC distributes free inputs, and NGOs provide free farmer training through cooperatives.

Curative treatment costs are the highest followed by anthelmintics and acaricides. Animal health services are very important to dairy farmers given many endemic diseases hence the high expenditure on acaricides. Comparing this to the revenues generated from milk sales, dairy farmers are operating profitably with an average revenue of Uganda shillings (UGX) 840,000 ($215) compared to expenditure of 224,630 ($58) for service costs to take care or

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improve their herds per month. Milk for home consumption and ghee making is not factored into the farm revenue. The cost of the service does not influence its usage; the most expensive services i.e. curative treatment, anthelmintic and acaricides were accessed by majority of farmers compared to advisory services and feeds which were the cheapest but used by few farmers, 23% and 24% respectively. The service or input usage is driven by need rather than cost.

Milk production per cow was estimated at average of 6.5 litres per cow. Since 2013, milk production has been increasing, from 3.5 litres/cow as per end of EADD phase 1 project report, 4.5 at baseline for EADD Phase 2 report, 6.5 at midterm evaluation and now 8.1liters/cow, indicating that efforts of government, NGOs, private sector and farmer cooperatives are yielding results. The slight difference in production between wet season and dry season is attributed to the adoption of climate smart technologies by farmers such as introduction of paddocks, fodder banks, utilization of crop residues, feed conservation and good stocking rate practices (Nalubwama *et al.*, 2016).

Only training in dairy business skills significantly increased milk production probably because it helped farmers to focus on training as a business or stimulated mind set change. A possible explanation for insignificant changes in milk production per cow per day between farmers who trained and those that didn't could be that farmers trained but didn't practice the knowledge and technology or the trainings offered were irrelevant or farmers had no access to the needed inputs to enable them adopt production enhancement technologies acquired from the trainings.

Besides training, farmers need other forms of extension services like artificial insemination, good quality breeds, feeds and veterinary drugs to achieve increased milk production. Usage of improved fodder and or concentrates enhanced milk production with the farmers who reported use, affirming the saying that a cow is like a factory what you put in, is what you get out. The higher the frequency of access to extension services, the higher the amount of milk produced per cow per day from farmers that used NGO, private and cooperative extension services. Farmers, who never accessed extension services across channels, produced less milk per cow per day as opposed to those who accessed extension at least once. Extension services received through dairy cooperatives were more effective than those procured by farmers directly from the private practitioners because of the different loyalty schemes introduced by the cooperatives including access to interest-free loans, check off systems on input sales, cooperatives being close to the farmers, quality assurance and farmer owned extension system (EADD, 2015b).

A dairy cooperative is a one stop centre which offers a holistic extension package for farmers. The most accessed extension services were from private sector (29.5%) and dairy cooperatives (28%). EADD (2008) baseline study showed that 36.8% of farmers were using private service providers. Probably the change indicates a growing number of farmers accessing extension services from cooperatives. Extension services are very important in increasing milk production. Overall, access to extension services explained 25.5% of the variations in milk production per cow per day. Access to extension services from cooperatives at least once every month increased milk production per cow per day by 3.7 litres keeping other factors in the model constant.

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Implications for research and practice

Extension services are an important input into the dairy production process. Most NGOs have adopted the farmer led extension approaches through producer organizations. Cooperatives are the best way to deliver extension services to dairy farmers. Dairying is viable for smallholders but suffers from high transaction costs hence the need for cooperatives that aid farmers to access various services. Government, NGOs and private sector should promote the formation and strengthening of dairy farmer cooperatives to facilitate dairy development and improve livelihoods of rural dairy farmers. Using multi-stakeholder approach to deliver extension services is more effective in increasing milk production using dairy cooperative as an entry point to reach out to farmers and is highly recommended. The cooperatives extension model if employed well can positively influence milk production in Uganda. There is need to strengthen dairy cooperatives.

CONCLUSIONS AND RECOMMENDATIONS

Access to extension services through dairy farmers' cooperative at least once every month increased milk production. Extension services received through dairy farmer cooperatives are more effective than those procured by farmers directly from the private service providers, NGOs and Government. The higher the frequency of access to extension services by farmers the higher the amount of milk produced per cow per day.

Animal health services including tick control, deworming and curative treatment were the most accessed while breeding was the least accessed. Curative treatment costs were the most expensive form of extension services with advisory services being the least expensive. Cooperatives can deliver more impactful extension services than other sources including government, private sector and non-government organizations. Breed was very important in determining milk production. Dairy farmers should be supported to access improved breeding services through promotion of artificial insemination or use of high-grade bulls.

Future research

Future studies should tease out the influence of other confounding factors such as seasonality, duration of lactation and parity of the lactating cows.

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