International Journal of Economics, Commerce and Management
United Kingdom ISSN 2348 0386 Vol. VII, Issue 4, April 2019

http://ijecm.co.uk/

EFFECTS OF BREEDING AND ANIMAL HEALTH MANAGEMENT ON THE COMMERCIALISATION OF SMALLHOLDER DAIRY FARMING IN ZIMBABWE

Tawedzegwa Musitini
Department of Agricultural Economics and Extension,
University of Fort Hare. P Bag X1314, Alice 5700, South Africa
towersmusitini@yahoo.co.uk

Abbysinia Mushunje
Department of Agricultural Economics and Extension,
University of Fort Hare. P Bag X1314, Alice 5700, South Africa
amushunje@ufh.ac.za

Joseph Muroiwa
Department of Agricultural Economics and Extension,
University of Fort Hare. P Bag X1314, Alice 5700, South Africa
josemuroiwa@gmail.com

Abstract

This study examines the extent to which breeding and animal health management affect the commercialisation of smallholder dairy farming in Zimbabwe. A total of 225 smallholder dairy farming households, randomly selected from 11 small-scale dairy cooperatives in Zimbabwe were analysed using descriptive statistics and the ordinary least squares (OLS) regression model. The study used average daily milk yield (litres/cow) as a proxy for determining smallholder dairy commercialisation. Indigenous cow breeds though suitable to the local climatic conditions have inferior dairy characteristics. On the other hand, exotic dairy cow breeds have higher lactation periods and higher milk yields thereby making them better suitable for commercial dairy farming. Given the poor dairy characteristics of indigenous cow breeds and

the challenges associated with managing exotic breeds among smallholder farmers, the study recommends crossing exotic and indigenous breeds to obtain mixed breeds which are both adaptive to the local conditions and have higher yields. Concerning the relationship between milk yields and animal health management, the results show that farmers who regularly vaccinate their cows against common infections obtain higher milk yields than the farmers who vaccinate their cows less frequently. The study also recommends regular vaccination of cows against common infections.

Keywords: Smallholder farming, vaccination, milk yields, commercialisation

INTRODUCTION

Smallholder dairy farming promotes access to regular income for rural households who usually access money once a year after the sale of harvested crops (Ngongoni, Mapiye, Mwale, & Mupeta, 2007; Pandey & Voskuil, 2011). Furthermore, the milk produced by smallholder farmers contributes significantly to the nutrition and health of the people in rural areas (Marius et al., 2011; Pandey & Voskuil, 2011). The dairy animals also provide social security for the rural dwellers by acting as a source of financing unexpected or periodic expenditures (Afzal, 2010). Moreover, smallholder dairy farming can also serve as a form of economic empowerment for vulnerable groups such as women and youth by encouraging them to participate in income generation ventures (Ngongoni et al., 2007; Afzal, 2010). In 2017, the Food and Agriculture Organisation (FAO) of the United Nations reported a significant increase in the demand for milk and other dairy products in Africa over the past few years thereby creating a unique opportunity for smallholder milk producers who constitute the bulk of dairy farmers in this region (FAO, 2017b). Several reasons including the rapid population growth, increasing urbanisation, and changes in diets are responsible for the increasing demand for dairy products in Africa (Delgado, Rosegrant, Steinfeld, Ehui, & Cour, 1999). However, despite the growing demand for milk and other dairy products, smallholder milk producers in Africa are failing to realise the opportunities offered by this demand due to several limitations (Kandjou, 2011).

Unlike the dairy sector in the developed countries that have shifted towards bigger herd sizes and higher milk productivity per cow, the situation in Africa has remained poor (FAO, 2013). Moreover, most smallholder dairy farmers in developing countries have tiny herd sizes which also produces uneconomically low yield volumes. A report by the FAO in 2010 revealed that the average global mean dairy herd size for smallholder farmers is approximately two cows that give an average milk yield of 5.5 litres per cow per day (FAO, 2010). Similarly, a study on smallholder

dairy farming in northern Malawi conducted by Tebug (2012) revealed that on average smallholder farmers in Malawi had an average of 2 cows per farmer with each cow producing an average yield of about 8 litres per cow per day. In Kenya, smallholder dairy farmers own 1-5 heads of cows producing an average yield of 3 - 8 litres of milk per cow per day (Kipkirui & Otieno, 2017; USAID, 2018). In Zimbabwe, smallholder farmers own 1-3 cows, with each cow producing an average yield of 4 - 8 litres of milk per day (Ngongoni et al., 2007; Marius et al., 2011; Mugweni & Muponda, 2015). With such low cow herd sizes and milk yield levels reported among the smallholder dairy farmers in developing countries, more effort is required to enhance productivity, effectiveness, and profitability of smallholder dairy farming in such countries.

Among other reasons, inappropriate breeding and the poor care for the dairy cows have been identified as the major factors limiting the productivity, profitability and commercialisation of smallholder dairy farming in these countries (Marius et al., 2011; SNV, 2012; Kipkirui & Otieno, 2017). A report on enhancing investment attractiveness in Kenya's dairy sector produced by the USAID in 2018 reveals that majority of smallholder dairy farmers have limited knowledge and experience of the quality animal husbandry required to enhance the competitiveness and profitability of this sector (USAID, 2018). A related study conducted by Tebug (2012) identified a shortage of veterinary and extension services, high disease incidences, inadequate knowledge and experience on disease management as the major causes of poor animal health management among the smallholder dairy farmers which ultimately affect yields, profitability and the ability of smallholders to commercialise.

It is evident from previous research conducted in many countries that a successful dairy enterprise requires good breed selection, appropriate animal husbandry practices and effective disease and parasite control (Pandey & Voskuil, 2011). A study by Kipkirui & Otieno (2017) on the factors influencing milk production among small-scale dairy farmers in Kenya identified improved breeds as a crucial driver for change in milk production among smallholder producers. Moreover, a study by Aweke (2017) on significant production challenges of dairy cows in Ethiopia identified animal health management challenges as one of the many factors that negatively affect the economic efficiency of dairy cows among the smallholder producers.

Although the literature on the role of breeding and animal health management among smallholder farmers in developing countries is substantial, the review of the literature on the effects of breeding and animal health management on smallholder dairy farming in Zimbabwe revealed a few gaps. Firstly, most of the studies have focussed on the general determinants of milk productivity on smallholder dairy farmers without focussing on the performance of different cow breeds. Secondly, most of the studies on smallholder dairy management grouped all the aspects of management like record keeping, nutrition, breeding, and animal health management

in one study. This study uniquely distinguishes itself from other studies on smallholder productivity and commercialisation conducted in Zimbabwe by exploring the performance of different cow breeds and examining the effects of health management at the farmer level on milk yields. To the best of the author's knowledge, no study on smallholder dairy farming in Zimbabwe has examined the productivity of different cow breeds at the farmer level. This study examines the milk productivity of the different breed categories; exotic milk breeds, mixed breeds, and indigenous cows. Overall, the study aims to ascertain their suitability and profitability under the smallholder farmer conditions. The study also explores the milk productivity performance of cows under different cow health management and vaccination conditions

RESEARCH METHODOLOGY

The data for this study includes the 225 households randomly selected from the 11 small-scale dairy cooperatives in Zimbabwe. A two-level multistage sampling technique was applied to select the respondents for this study. First, 21 smallholder milk cooperatives were identified as functional during the period of data collection. Form these, 11 cooperatives were selected using simple random sampling. With simple random sampling method, each component of the population is selected independent of one another, and without replacement thus no item can be selected twice (Latham, 2007; Personal, Archive, Kundurjiev, & Salchev, 2011). Second, the probability proportional to size was used to decide the number of units to be reached in each cluster. Finally, simple random sampling was again used to select the survey respondents in each cluster. Table 1 below summarises the final sample for the locations and number of farmers interviewed in each area.

Table 1: Summary distribution of respondents reached for this study.

Province	Dairy Project	District	Location of the dairy project	Respondents		
				Female	Male	Total
Mash East	Chikwaka	Goromonzi	Juru GP	5	12	17
	Domboshava	Goromonzi	Damboshawa	4	13	17
	Chitomborwizi	Chinhoyi	Crawford Farm	-	13	13
	Marirangwe	Beatrice	Marirangwe BC	5	33	38
	Murehwa	Murewa	Murewa 44 BC	8	4	12
Manicaland	Rusitu Dairy	Chipinge	Rusitu Valley	8	34	42
	Upperand	Chipinge	Rusitu Valley	3	12	15
Masvingo	Hamaruomba	Masvingo	Mushagashe BC	7	20	27
Midlands	Gokwe	Gokwe	Gokwe GP	1	19	20
Mat South	Mzingwane	Umzingwane	Mawabeni BC	6	12	18
	Claremont	Umzingwane	Bulawayo	2	4	6
Total	**11**	**8**	**11**	**49**	**176**	**225**

The study used a structured questionnaire to collect data using one-to-one interviews with the head of the households that owned small dairy farms. The questionnaire used had both closed-ended and open-ended questions. The questionnaire designed had clear objectives and was structured into sections to ensure that all relevant issues are addressed. In addition to the question about the basic demographic information, size, composition, wealth status, farm size, cattle breed, lactation period, and other related details, the households were asked questions about animal health management and vaccination. The questionnaire content validity was reviewed by a panel of experts associated with dairy farming and agricultural economics, and their suggestions were used to modify the items of the instrument. This was to ensure that the instrument measured what it intended to measure; items were worded, and statements were not ambiguously stated. A pre-test was conducted with 20 smallholder dairy farmers, to establish the reliability of the instrument.

The study applied a causal modelling technique to examine the impact of different factors on the commercialisation of small-scale dairy farming in Zimbabwe. The statistical analysis for this research was carried out using R software. The graphs were generated using the ggplot2 library that provides many functions to generate bar graphs, histograms, scatter plots, and other charts. Further, the LM function (which is part of the stats library) was used to perform OLS regression analysis. The Ordinary least squares (OLS) regression model was used to estimate the effect of breeding and animal health management on the commercialisation of small-scale dairy farming activities in Zimbabwe. The sample used for this study consisted of observations that were drawn randomly from the population. The simple random sampling methods were used to select the respondent; therefore, every element in the population had an equal chance of being included in the sample, therefore, making the sample random. Also, the number of observations (225) was higher than the number of parameters estimated thereby making the OLS applicable.

The OLS regression model was estimated as:

$$Y_i \quad = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5$$

Where,

Y*= Milk Yield; Xi is a vector of explanatory variables relating to the breeding and animal health management factors that include cow breed, lactation period, the frequency of vaccination, the source of drug and disease incidence. The details of the variables are presented in Table 2 below.

Table 2: Variables used in the OLS model

Variable	Variable Description	Variable Type
Y*	Milk Yield (litres/cow)	Dependent Variable
X1	Cow Breed (1=exotic breed, 2=local breed, 3=mixed breed)	Independent Variable
X2	Lactation Period (month)	
X3	Vaccination Frequency (1=every 6 months, 2=Annually, 3=during an outbreak).	
X4	Source of Drug (1=Veterinary, 2=Farmer Unions or MCC)	
X5	Disease Incidence (1=yes, 2=no)	

RESULTS AND DISCUSSIONS

Descriptive statistics

The results in Table 3 below show that more than half (54.22%) of the farmers own five cows or less and only 3.11% own more than 20 cows. These results are consistent with several other studies in developing countries which show that smallholder dairy farmers overall struggle to grow their dairy sizes (FAO, 2010; Tebug, 2012; Meja et al., 2017). The same findings were also confirmed by a report by the Ministry of Agriculture of the government of Zimbabwe produced in 2013 which identified the significant constraints affecting the smallholder dairy subsector in Zimbabwe as low calving rate, high mortality, low cattle off-take rate shortage of breeding stock and lack of finance to expand production (Ministry of Agriculture, 2013). On the contrary, the large scale commercial dairy sector in Zimbabwe usually has large herd sizes (average of 90) of pure exotic cows' breeds and their crosses producing an average of 20 litres of raw milk per cow per day (Mugweni & Muponda, 2015).

Table 3: Details about cow numbers and management in the smallholder dairy farms

Variable description	**Details**	**Count**	**% (N=225)**
Number of Cows	1	14	6.22
	2-3	63	28
	4-5	45	20
	6-10	72	32
	11-15	16	7.11
	16-20	8	3.56
	21 or more	7	3.11
Cow Breed	Exotic	9	4.00
	Indigenous	102	45.33
	Mixed	114	50.67
Lactation Period (Months)	5 or less	13	5.78
	6	92	40.89
	7	72	32.00
	8	19	8.44

Table 3...

	9	14	6.22
	10 or more	15	6.67
Periods when the farmer has no milk	Yes	127	56.44
	No	98	43.56
Milk Variation over time	Yes	187	83.11
	No	38	16.89

With only 4% of the population using exotic dairy cow breeds, the results show that despite superior dairy characteristics and high yields, these breeds continue to be shunned by the smallholder dairy farmers in Zimbabwe. A study by Hanyani-Mlambo (2000) shows that the majority of the smallholder dairy farmers in Zimbabwe continue to practice poor breeding methods where dairy cows and heifers mix with indigenous breeds resulting in open mating. This could be the reason why more than 90% of the cows used by the farmers are either indigenous or mixed breeds. The results of this study are also consistent with the findings by Mugweni & Muponda (2015) who revealed that smallholder dairy farmers in Zimbabwe use indigenous cow breeds and dairy crosses for commercial milk production. A similar study on factors affecting milk production among small scale dairy farmers in Kenya conducted by Kipkirui and Otieno (2017) also reported that the indigenous cattle breeds are more popular among the smallholder producers in Kenya as they are more resistant to infections and tick-borne diseases than exotic breeds.

The results also show varying lactations periods with the majority (more than 70%) averaging between 6 and seven months. These results are consistent with several other similar studies in similar contexts (Chinogaramombe et al., 2008; Marius et al., 2011; Muehlhoff et al., 2013; Hahlani & Garwi, 2014). Because of the different breed types and management practices, the majority of the farmers (83%) reported experiencing seasonal and periodic variations in the quantity of milk they get from their cows. In addition to affecting the farmers' cash flow, this variation also has negative effects on the markets. For business and commercial purposes, markets prefer regular as opposed to inconsistent supplies. Over half of the farmers (56.44%) reported experiencing times when they do not have milk to sell. This does affect not only the farmer's cash flow for personal use but also the ability to take good care of the animals all year round. Table 4 below summarises the data about dairy cattle vaccination and disease outbreaks. The results show that although most of the farmers (76.44%) reported experiencing some disease outbreaks in the past 12 months, usage of preventive vaccination is very low across locations. Only 43 farmers out of the 225 interviewed (19.11%) reported that they vaccinate their animals against common disease outbreaks every six months while majority; 179 farmers (79.56%) reported only vaccinating their animals during periods of disease outbreaks.

Moreover, the majority of the farmers (over 90%) rely on government veterinary services as sources of vaccination chemicals and services. Given the challenges that have been affecting the government capacity in the past few years, relying on government services for a business transaction may not be economically viable.

Table 4: Information on cattle vaccination by smallholder dairy farmers

Size	Details	Count	% (N=225)
Vaccination Source	Veterinary Services	203	90.22
	Farmer Unions or MCC	22	9.78
Disease Incidences	Yes	172	76.44
	No	53	23.56
How Frequently the Vaccination is done	Every 6 Months	43	19.11
	Annually	3	1.33
	Only during an outbreak	179	79.56

Research also shows that though available within their reach, the majority of smallholder farmers struggle to access vaccination due to financial reasons. A study by Ngongoni et al. (2007) found that although veterinary medicines were usually available in most communities through the local government veterinary extension staff, the majority of the households do not vaccinate the dairy cows due to lack of money. Furthermore, a study conducted by SNV (2012) found that low productivity as a result of poor breeding, poor animal health management, and poor feed management practices are among the most significant challenges affecting smallholder dairy farming in Zimbabwe. Similarly, a study by Marius et al. (2011) identified the use of inappropriate breeds, and inadequate managerial skills especially health management as some of the significant challenges affecting smallholder dairy farming in Zimbabwe.

The histogram plot below shows the distribution of the lactation period and milk yield which is summarised in the pair-wise correlation diagram in Figure 1. It can be observed that the distribution of respondents based on lactation period is primarily concentrated in the range of 5 to 8 months, indicating that most cattle have 5 to 8 months of the lactation period. On the contrary, the distribution of the milk yield is approximately normal with a heavy tail towards the right, indicate that some households have high milk yielding cows.

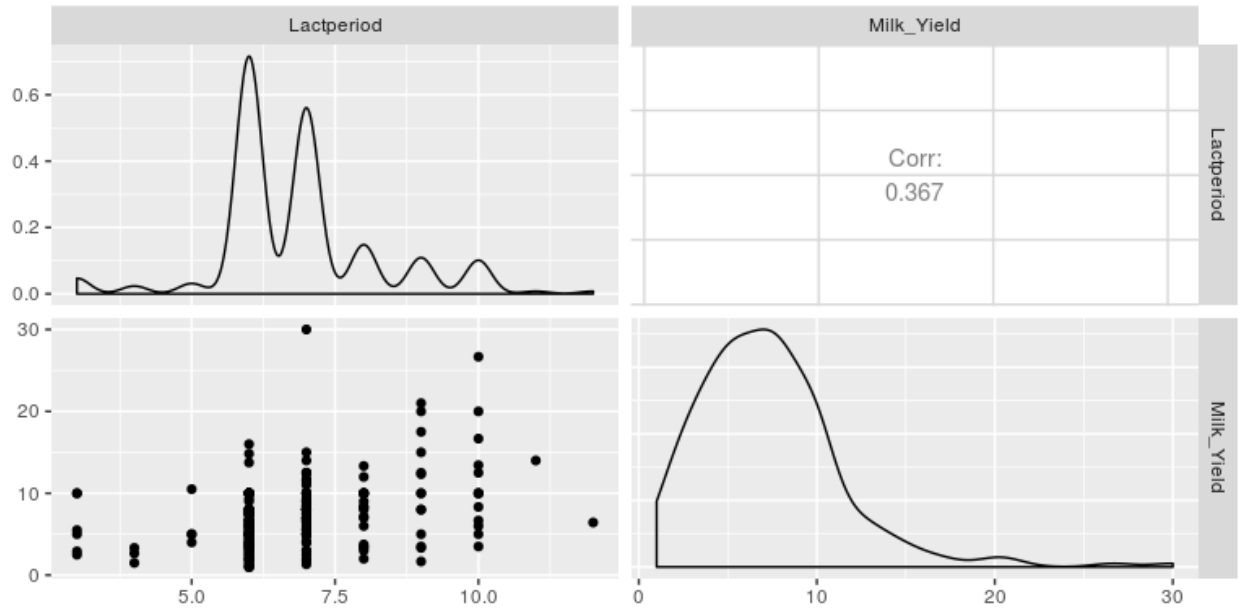

Figure 1: Distribution of Milk Yield based on Cow Breed

Examining the link between breeding and animal health management and milk yield

The OLS regression analysis model was used to examine the relationship between milk yield and the breed and animal health management variables (Table 5). The summarised results show that the correlation between the predicted and observed values of milk yield is 0.7742. If we square this value, we get the multiple squared correlations, and this indicates predicted values share 60 % of their variance with milk yield. The standard error of variance indicates the distance between the data points and the regression line. The calculation indicates that the standard errors of the regression for all the variables fell below 3%. This means that the standard variance between the observations and the regression line is below 3%. Consequently, we can use the standard error to obtain a rough estimate of the approximately 95% prediction interval. Lower values of the standard error signify that the distances/variances between the data points and the fitted values are smaller thereby making the model applicable.

The results do not show any significant relationship between the drug source and milk yield. However, farmers who vaccinate their cattle against diseases reported on average 4.237 higher milk yield than farmers who vaccinate their cattle annually. The results show that the household that reported no disease incidence within the past 12 months have 1.738-unit higher milk yield compared to households that reported disease incidence. A related study by (Ngongoni et al., 2007) on the factors affecting milk production in the smallholder dairy sector of Zimbabwe found only 12% of the smallholder dairy households in Zimbabwe followed a proper de-worming program and inoculated the cows against Quarter Evil (QE) and Contagious

Abortion (CA). The same study showed that most of the households (81%) of the households use haphazard and unsystematic de-worming methods, and there is usually no vaccination against QE and CA.

Table 5: Link between breeding and animal health management and the commercialisation of smallholder dairy farming in Zimbabwe

		Estimate	Std. Error	Z-value	P-value	95% CI (Lower)	95% CI (Upper)	90% CI (Lower)	90% CI (Upper)
(Intercept)		9.915	2.707	3.663	0	4.580	15.250	5.443	14.387
Lactation Period		0.413	0.164	2.517	0.013**	0.090	0.736	0.142	0.683
Cow Breed	Local	-10.684	1.219	-8.766	0.000***	-13.087	-8.282	-12.698	-8.671
	Mixed	-8.185	1.166	-7.017	0.000***	-10.484	-5.886	-10.112	-6.258
	Dairy	.	.	.	.	.	.	.	.
Vaccination Frequency	During Outbreak	1.813	1.936	0.937	0.350	-2.003	5.628	-1.385	5.010
	Every 6 Months	4.237	2.166	1.956	0.052*	-0.032	8.507	0.659	7.816
	Annually	.	.	.	.	.	.	.	.
Drug Source	Buy	0.005	0.718	0.006	0.995	-1.411	1.420	-1.181	1.191
	District Vet	0.401	0.817	0.491	0.624	-1.209	2.011	-0.948	1.751
	MCC	-0.992	0.937	-1.058	0.291	-2.839	0.856	-2.540	0.557
	Buy and Vet	.	.	.	.	.	.	.	.
Disease Incidence	Yes	1.738	0.782	2.222	0.027**	0.196	3.279	0.446	3.029
	No	.	.	.	.	.	.	.	.

* p-val<0.10, ** p-val< 0.05, *** p-va<0.01, r-square = 0.46, r (correlation coefficient) = 0.77, F (9,215) = 19.91, p-val< 0.01

The findings of this study imply that animals experiencing high disease outbreaks usually due to poor vaccination produces lower milk than animals that are vaccinated regularly and therefore experiencing low disease incidences. These results are closely associated with the results by the Meridian Institute (2010) which reported that the low productivity of dairy cattle often results from high incidences of endemic diseases such as trypanosomosis, tick-borne, helminthiases, and malnutrition. Moreover, a study by the Meridian Institute (2010)shows that correct drug use and other disease control mechanisms depend on appropriate diagnosis and a working understanding of the suitability of the treatment options available. However, in many developing countries, the existing methods for diagnosis of these diseases are usually too costly and inaccessible to smallholder farmers (Meridian Institute, 2010). Research also shows that Mastitis causes a great deal of loss by reducing productivity, and in some causes casing the culling of animals at an unacceptable age (Aweke, 2017). Other diseases of importance

included Quarter Evil (QE) and brucellosis, associated with stillbirth, abortions and embryonic mortality, leading to irregular oestrus cycles terminating in permanent infertility (Ngongoni et al., 2007).

The study also examined the milk yields of different breeds kept by the smallholder farmers. The results show that there is a significant and positive impact of cow breed on milk yield. It is observed that local breed cows have 10.684 units lower milk yield compared to the exotic breed cows. Similarly, the mixed breed cows have 8.185 units lower milk yield compared to the dairy breed cows. The results show that mixed cow breeds are much better than local breeds though both are significantly lower than pure breeds. Majority of farmers keep local cow breeds because they struggle to do Artificial insemination. Cross-breeding local breeds with exotic dairy genes enhances the dairy development in smallholder settings by producing high yielding breeds which are also adaptive to the local conditions(Thorpe, Muriuki, Omore, Owango, & Staal, 2000). A study by Debele & Verschuur (2014) on factors affecting the value chain in smallholder dairy farmers in Ethiopia found that local cow breeds provided an average of 2.6 litres of milk/ day/ cow whilst crossbreds produces an average of 10.5 litres per cow per day.

Similarly, a report produced by Land O'Lakes (2010) show that cross-bred cow have a higher level of productivity estimated at an average of 10 litres per cow per day which is almost ten times that of indigenous cows which are pegged at just above 1 litre per cow per day. A study on smallholder dairy farming in Northern Malawi conducted by Tebug (2012) identified the inconsistent and unreliable supply of improved animal genetics as a critical challenge affecting the competitiveness of smallholder dairy farming. Out of the 210 smallholder farmers interviewed in this study, 96 (46%) mentioned unreliable AI service, shortage of bulls to complement AI services, absence of a liquid nitrogen, shortage of high grade parent stock, uneconomic or low conception rates to AI and inadequate training and experience on breeding as key constraints affecting the genetic competence of smallholder dairy farming in Malawi (Tebug, 2012). A report by the Netherlands-African Business Council (NABC) in 2014 shows that inefficient, inappropriate and untimely artificial insemination (AI), as well as poor semen quality, is a pivotal hindrance to dairy breed improvement in developing countries.

Lastly, it is observed that there is a significant and positive impact of lactation period on milk yield. It is observed that household that reported higher lactation period for their cows have higher milk yield and the analysis results indicate that for every month of increase in the lactation period of the cows, the milk yield increases by 0.413 units. The poor genetics of dairy stock is responsible for most of the mortality and low dairy production for the smallholder farmers in developing countries (Meridian Institute, 2010). Despite producing higher yields, the

use of improved dairy breeds requires higher management including high-value feed and veterinary drugs which many smallholder farmers cannot afford (Kipkirui & Otieno, 2017). Given that dairy cows vary in their genetic makeup and potential for milk production. The smallholder dairy producers should prefer good quality animals with better genetic potential for milk production. Other than nutrition and genetic potential, the overall management of the animal is crucial for good milk yield. A study by Ngongoni et al. (2007) on the Factors affecting milk production in the smallholder dairy sector of Zimbabwe found that Indigenous cattle were the dominant livestock among the smallholder dairy farmers. The study revealed that Indigenous cattle, which are predominantly beef animals constituted 71 % of the cattle herd owned by the smallholder dairy farmers, while only 29 % were dairy cattle.

CONCLUSIONS AND POLICY IMPLICATIONS

This study has investigated the extent to which breeding and animal health management among smallholder dairy farming households in Zimbabwe affects the commercialization of smallholder dairy farming. A sample of 225 smallholder dairy farming households was analysed using descriptive statistics and the OLS regression model. The descriptive statistics indicated that almost half of the households rely on indigenous cow breeds which though adaptive to the local climatic conditions have poor dairy characteristics. Usage of pure exotic dairy breeds though very productive was very low as only less than 5% of the farmers used them. These breeds are expensive to buy and require more specialised management including high-value feed and veterinary drugs which majority of smallholder cannot manage. The farmers using mixed breeds for dairy farming achieved economically viable yield levels and given that these are better adapted to local climatic conditions, usage of these should be encouraged.

Results, however, show that smallholder dairy farmers overall struggle with proper animal breeding that is recommended for commercial dairy farming. The study revealed that challenges such as the inconsistent and unreliable supply of improved animal genetics, unavailability or poor semen quality as well as a shortage of trained and experienced AI personnel overall lead to inefficient, inappropriate and untimely artificial insemination which ultimately leads to significant hindrances in dairy breed improvement. To enhance cross-breeding of local breeds with exotic dairy genes to produce high yielding milk breeds which are also adaptive to the local conditions, there is need to promote access to improved dairy genetics and better semen quality as well as support the training of more AI personnel within the smallholder reach. While the frequency of animal vaccination had a positive impact on milk yield, the source of vaccination drugs had no significant relationship with the milk yield. The positive influence of vaccination frequency on milk yield indicates that good animal health

management plays a significant role in improving the productivity constraints facing smallholder dairy farmers. Vaccinating the dairy animals against common infections should be encouraged rather than waiting for a disease outbreak before animals can be treated. To improve the dairy herd disease resistance and reduce stress, it is recommended that the smallholder farmers are supported to select the breeds that are well suited to the local climatic and environmental conditions. The next thing is to vaccinate all dairy animals as recommended by the local animal health authorities. When replacing or increasing the stock smallholder farmers should be guided to buy animals of the known breed and health status and where applicable from traceable sources.

To prevent entry or introduction of disease and infections onto the farm, farmers should ensure that animal transport into and out of the farm does not introduce infections and diseases. It is also recommended to carefully monitor the risks from neighbours and where applicable have secure boundaries. Each farmer should develop and maintain an effective cow herd health management system that is focused on disease prevention that meets the farmers' needs as well as local, national health and environmental requirements. The system should ensure that the farmers regularly and consistently examine the animals for signs of sickness. When animals are sick, they should be attended to appropriate and quickly. The farmers should also keep accurate records of all treatments and vaccinations. To prevent the occurrence of chemical deposits and residues in milk, the farmers should use only the chemicals recommended and approved for use by the relevant authorities. In Zimbabwe, for instance, farmers should use the veterinary chemicals as prescribed by the dairy services unit of the department of livestock & veterinary services or the department agricultural technical and extension services. To ensure that smallholder dairy interventions have the most impact on enhancing livelihoods, improving dairy breeds should be accompanied by good animal health management.

LIMITATION OF THE STUDY AND SCOPE FOR FURTHER STUDIES

This study focused entirely on smallholder farmers who are affiliated to small scale dairy cooperatives and excluded all the smallholder farmers in communal and resettlement areas who are not affiliated to the existing schemes. Future studies could potentially complement the findings of this study by broadening the scope of the study to include communal and resettlement smallholder farmers who are not affiliated to existing small-scale dairy cooperatives. Data for this study was collected in one season only. Future studies could consider collecting the data in more than one season to explore seasonal variations. This study exclusively focused on smallholder farmers and excluded large scale commercial dairy farmers.

Future studies could also consider collecting data from some large-scale commercial farmers to understand the differences between the two sectors.

REFERENCES

Afzal, M. (2010). Re-designing Smallholder Dairy Production in Pakistan. Pakistan Veterinary Journal, 30(3), 187–190. https://doi.org/10.1097/QCO.0b013e3283638104,

Aweke, S. (2017). Major Production Problems of Dairy Cows of Different Farm Scales Located in the Capital City Addis Ababa, Ethiopia. Journal of Veterinary Science & Technology, 08(06), 6–11. https://doi.org/10.4172/2157-7579.1000483

Chinogaramombe, G. N. C., Muchenje, V., Mapiye, C., Ndlovu, T., Chimonyo, M., & Musemwa, L. (2008). Challenges for improving smallholder dairy production in the semiarid areas of Zimbabwe. Livestock Research for Rural Development.

Debele, G., & Verschuur, M. (2014). Assessment of factors and factors affecting milk value chain in smallholder dairy farmers : A case study of Ada ' a District , East Shawa Zone of Oromia regional. African Journal of Agricultural Research, 9(3), 345–352. https://doi.org/10.5897/AJAR2013.6967

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S., & Cour, C. (1999). Live stock to 2020 Revolution. Food and Agriculture Organization of the United Nations (Vol. 28). https://doi.org/10.5367/000000001101293427

Food and Agriculture Organisation of the United Nations (FAO). (2013). Milk and dairy products in human nutrition. Milk and Dairy Products in Human nutrition. Rome: Food and Agriculture Organisation of the United Nations. https://doi.org/10.1186/1471-2458-11-95(Accessed: 2019, January 24)

Food and Agriculture Organization of the United Nations (FAO). (2010). Status of and Prospects for Smallholder Milk Production – A Global Perspective. (T. Hemme & J. Otte, Eds.), Food and Agriculture Organization of the United Nations. Rome, Italy: Food and Agriculture Organisation of the United Nations. Retrieved from http://www.fao.org/docrep/012/i1522e/i1522e.pdf(Accessed: 2019, January 20)

Food and Agriculture Organization of the United Nations (FAO). (2017). The future of food and agriculture - Trends and and challenges. Food and Agriculture Organization of the United Nations (FAO). Rome: Food and Agriculture Organization of the United Nations. https://doi.org/ISBN 978-92-5-109551-5(Accessed: 2019, January 19)

Hahlani, C. ., & Garwi, J. (2014). Operational Challenges to Smallholder Dairy Farming : The Case of Mayfield Dairy Settlement Scheme in Chipinge District of Zimbabwe. Humanities And Social Sciences, 19(1), 87–94. https://doi.org/10.1007/s40279-018-0870-z

Hanyani-Mlambo, B. (2000). Smallholder Dairy Production and Marketing in Zimbabwe : A socio-economic study of the Gokwe, Rusitu and Marirangwe dairy development projects (No. WORKING PAPER AEE 3/2000). Harare. Retrieved from https://opendocs.ids.ac.uk/opendocs/handle/123456789/7208(Accessed: 2019, January 01)

Kandjou, M. J. (2011). Technical challenges and agribusiness prospects for developing pro-poor small scale dairy processing schemes in Omaheke region of Namibia. University of Zimbabwe.

Kipkirui, M., & Otieno, M. M. M. (2017). Factors Influencing Milk Production Project Among Small Scale Dairy Farmers in Bomet East Sub County , kenya. International Journal of Latest Research in Engeneering Technology (IJLRET), 03(09), 1–23. Retrieved from www.ijlret.com(Accessed: 2019, January 24)

Land O'Lakes. (2010). The next stage in dairy development for Ethiopia: Dairy Value Chains, End Markets and Food Security. Addis Ababa, Ethiopia. Retrieved from https://www.usaid.gov/sites/default/files/documents/1860(Accessed: 2019, January 24)

Marius, L. N., Imbayarwo-Chikosi, V. E., Hanyani-Mlambo, B. T., & Mutisi, C. (2011). Breed preferences, production performance and management of dairy cattle among selected smallholder farmers of Zimbabwe. AGRICOLA, 2–5.

Meja, H. A., Musyoka, T., & Kibaki, P. (2017). Socio-cultural features on commercialization of smallholder dairy value chain growth in Kenya. Global Journal of Dairy Farming and Milk Production, 5(3), 287–298. Retrieved from http://www.globalscienceresearchjournals.org(Accessed: 2019, February 08)

Meridian Institute. (2010). Innovations for agricultural value chains in Africa: Applying science and technology to enhance cassava, dairy, and maize value chains. Dairy value chain overview. Washington DC: Meridian Institute.

Ministry of Agriculture. (2013). Zimbabwe Agriculture Investment Plan (ZAIP): A comprehensive framework for the development of Zimbabwe's agriculture sector. Harare: Ministry of Agriculture, Mechanization and Irrigation

Development of the Government of Zimbabwe (MAMID). Retrieved from http://extwprlegs1.fao.org/docs/pdf/zim152671.pdf(Accessed: 2019, February08)

Mugweni, L., & Muponda, G. (2015). Small-Scale Dairy Farming in Zimbabwe. International Journal of Economics, Commerce and Management, III(8), 448–466. Retrieved from http://ijecm.co.uk/wp-content/uploads/2015/08/3827.pdf(Accessed: 2019, January 29)

Netherlands-African Business Council (NABC). (2014). Factsheet - Dairy sector Ethiopia. The Hague, Netherlands: Netherlands-African Business Council (NABC). Retrieved from https://nabc.nl/uploads/content/files/Fact sheet Dairy sector Ethiopia.pdf(Accessed: 2019, January 24)

Ngongoni, N. T., Mapiye, C., Mwale, M., & Mupeta, B. (2007). Effect of supplementing a high-protein ram press sunflower cake concentrate on smallholder milk production in Zimbabwe. Tropical Animal Health and Production, 39(4), 297–307. https://doi.org/10.1007/s11250-007-9018-0

Pandey, G. S., & Voskuil, G. C. J. (2011). Manual on Improved Feeding of Dairy Cattle by Smallholder Farmers: For Extension Workers and Dairy Farmers. Lusaka Zambia: Golden Valley Agricultural Research Trust. Retrieved from https://agriprofocus.com/upload/Dairy_manual_-_Feeding_(GART_Zambia,_2011)1423741222.pdf(Accessed: 2019, January 24)

Personal, M., Archive, R., Kundurjiev, T., & Salchev, P. (2011). Mp r a, (28953).

SNV. (2012). Evaluation of Smallholder Dairy Programmes in Zimbabwe.Evaluation Report. Harare. Retrieved from http://www.snv.org/public/cms/sites/default/files/explore/download/an_evaluation_of_smallholder_dairy_production_in_zimbabwe.pdf(Accessed: 2019, January 24)

Tebug, S. F. (2012). Smallholder dairy farming in Northern Malawi: husbandry practices, constraints and prevalence of major production and zoonotic diseases. University of Kiel. Retrieved from https://www.tierzucht.uni-kiel.de/de/forschung/dissertationen-1/Dessertation_Tebug.pdf

Thorpe, W., Muriuki, H. G., Omore, a, Owango, M. O., & Staal, S. (2000). Development of smallholder dairying in Eastern Africa with particular reference to Kenya. Africa, 10.

United States Agency for International Development (USAID). (2018). Policy brief: enhancing investment attractiveness in Kenya's dairy sector. Nairobi, Kenya. Retrieved from www.feedthefuture.gov(Accessed: 2019, January 21).