Factors affecting adoption of exotic dairy breeds by smallholder dairy farmers in Zimbabwe: Case of Chikwaka Communal Area.

E. Mutandwa*, S. Mukotami, C.T. Gadzirayi, J. Chihiya and J.F. Mupangwa

Department of Agriculture, Bindura University of Science Education, P Bag 1020, Bindura, Zimbabwe.
*Corresponding author: emutandwa@buse.ac.zw

Accepted 5 October 2006

Abstract

The broad objective of this study was to assess factors critical to the adoption of exotic dairy breeds among smallholder dairy producers in Chikwaka communal area in Mashonaland East Province. A total of forty smallholder farmers, owning exotic and indigenous dairy breeds were selected purposively and randomly, respectively. Data was collected using a structured questionnaire. Key informant interviews were held with relevant stakeholders in dairy production. Jersey and Friesland were the most preferred breeds largely because of their higher milk output (52 %), milk quality (19 %) and high calving rates (29 %). Access to proper infrastructure such as milking parlors, credit and appropriate exotic dairy production training are the necessary conditions for the adoption of exotic dairy breeds. However, formulation of exotic dairy programs based on these factors should be analyzed in a context that takes cognizance of the requirements of the World Trade Organization regarding subsidies and capacity to sustain programs in the long term.

Keywords: Adoption, dairy production, exotic breeds, smallholder.

Introduction

The dairy industry has conventionally been one of the most important sub-sectors in agriculture with its products contributing to improvement of the nutritional value of the human diet. Since the country's attainment of independence, this sector has been instrumental in the generation of foreign currency and raw materials for other industries as well as in the creation of employment thus enhancing the standard of living of dairy farmers (Titterton, 2000). However, in recent years the dairy sector has been facing major challenges that have seen milk output declining from a peak of 256 million litres in 1996 to approximately 97 million litres of milk in 2004 thereby reducing its visibility in terms of economic development (DZL, 2004). Plummeting milk productivity is mainly attributed to the structural changes in the agrarian sector, which ushered in more smallholder farmers who generally operate under resource-constrained conditions. This scenario has resulted in milk supply bottlenecks necessitating national efforts to revamp the sector.

Prior to the land and agrarian reforms in the country, large-scale commercial producers dominated milk production. According to estimations by the National Association of Dairy Farmers (NADF), there were about 450 commercial farmers who supplied nearly all the national milk needs before the structural re-organization of the agricultural sector (DZL, 2004). Only a small proportion of milk output came from ten smallholder dairy schemes set up through the Dairy Development Programme (DDP) based in communal, small-scale or resettlement areas. DDP is a government initiative which started in 1983 and is meant to increase the participation of smallholder farmers in the country. The program is driven under the auspices of the Agricultural Rural Development Authority (ARDA), which was given the mandate to spearhead this process. Smallholder farmers in most parts of the country were operating traditionally, that is they kept cattle as a source of draught power, manure, wealth and status. With suitable infrastructure and better management, this sector has the potential of producing about 250 million liters of milk per year (FAO, 1996). As part of its indigenisation program, the government of Zimbabwe (GOZ) adopted the concept of smallholder dairying as a possible means of increasing milk production to bridge the increasing gap between milk demand and current milk output in the country. Through a series of economic initiatives including the National Economic Development Priority Program (NEDPP), the government identified a number of constraints militating against the attainment of higher milk productivity. The constraints facing the dairy sector are not only multi-pronged but they are firmly

intertwined with the volatile macro-economic developments in the country. Some of them are *inter alia,* lack of knowledge about suitable breeds and high costs of feed (AREX, 2005).

A prognosis of the smallholder dairy industry of Zimbabwe in the millennium shows that most landholders own indigenous breeds mainly the Hard Mashona type whilst a few farmers have exotic breeds. Collated statistics on the current composition of the national herd are sketchy. However, milk production and milk quality are failing to meet satisfactory targets for the market mainly due to the dairy breeds being kept by these smallholder farmers. Indigenous cows produce approximately a quarter of the mean lactation yield obtained from exotic cows. This is because of the poor genetic potential for milk production and milk compositional quality (Titterton, 2000).

Whilst the performance of exotic dairy breeds which include Jersey, Friesland, Holstein, Guernsey and many others is desirable, anecdotes indicate that their adoption by smallholder dairy farmers is still very low. Given this information and assuming that farmers are rational and profit driven, one expects adoption of exotic breeds in the short and long term such that they effectively become integral to the smallholder dairy production landscape of the country. The objective of the study was to ascertain factors affecting adoption of exotic dairy breeds amongst smallholder dairy farmers.

Theoretical foundations and random utility models used in the study

In modeling the utility or satisfaction derived from the use and integration of a given exotic breed into the smallholder animal production system, true economic values are not directly observable (Dasgupta and Dasgupta, 2004). This is because the true value that the farmer places on a breed will depend on its use as a form of traction, resistance to local disease pestilences, contribution to food security through consumption of milk products and sale of milk, and its value as a store of wealth and prestige. When there is a change in economic parameters associated with the introduction of a new technological innovation such as the exotic breed, the central question is related to how much compensation, whether it is paid or received, would make the decision maker indifferent about the change. Thus the change in welfare associated with this development is used as the basis for economic valuation process.

When an individual farmer faces a change in a non-market good of a measurable attribute, for example milk quantity derived from the exotic breed q from $q0$ to $q1$ (with $q1>q0$), the indirect utility function u after the change becomes higher than the status quo. Now the, status quo can be represented econometrically as follows:

$$u_{1j} \quad u_i(y_i, z_j, q^0, \quad _{oj})$$

On the other hand, the changed or final state (linked to the introduction of exotic breeds) is shown by:

$$u_{2j} \quad u_i(y_i, z_j, q^1, \quad _{ij})$$

In this case, Y_i, refers to the farmer's income, Z_j is a vector of the farmer's socio-economic variables and attributes of choice, and $_j$ is the stochastic error term representing other unobserved utility components.

The farmer would opt and pay for an exotic breed if the following condition holds:

$$u_i(y_i \quad p_i, z_j, \quad _{ij}) \quad u_0(y_i, z_j, \quad _{oj})$$

P_i is the payment or monetary investment associated with the new breed. Since, the random components of the preferences are not known with certainty, it is only possible to make probabilistic statements about expected outcomes. Thus the decision by the farmer to adopt an exotic breed is the probability that he/she will be better off if the exotic breed is used. This is represented as follows:

$$\Pr ob(Yes_i) \quad \Pr ob\,(u_i(y_i \quad p_i, z_j, \quad _{ij}) \quad u_o(y_j, z_j, \quad _{ij})$$

Since the above utility functions are expressed generally, it becomes critical to specify the utility function as additively separable in deterministic and stochastic preferences. Using, this argument, the function becomes:

$$u_i(y_i, z_j, \quad _{ij}) \quad u_i(y_i, z_j) \quad _{ij}$$

where the first part of the right hand side is the deterministic part and the second part is the stochastic part. The assumptions that $_{□□}$ are independently and identically distributed with mean zero describes the most widely used distributions. Two widely used distributions are the normal (probit) and logistic (logit). In this study, the statistical dichotomous choice data is modeled by superimposing a probability function. The dependent variable takes the value one if smallholder-farming households are willing to adopt exotic cattle breeds or zero if they are not willing to adopt.

Economic theory suggests that preferences for exotic cattle breeds would differ across farmers with different socio-demographic characteristics, and opinions about exotic breeds as well as the existence of an auspicious policy, which supports their use

among smallholder farmers. There are factors that are specific to the individual farmer and these include age, gender, farming experience, exposure to training and income status. Higher levels of training and income are expected to have a positive bearing on the farmer's decision. On the other hand, increasing age may be negatively associated with the decision to adopt (Adesina, 1994).

At the farm level, factors such as climate, the size of farm, availability of fodder and labour are important in influencing the farmer's decision-making process. Generally, availability of appropriate feeding regimes, labour to carry out
activities such as milking, feeding of cows and dosing, and the existence of auspicious weather and climatic conditions are expected to increase the probability of adopting exotic dairy breeds.

Institutional factors are shaped by the existing set of government policies. The macro-economic policy can influence the affordability of credit windows of opportunity through the prevailing interest rates. National programs directly aimed at providing exotic dairy herds to farmers or providing the necessary support services in the form of research and development, and dairy training are also essential in shaping and developing positive farmer perceptions and attitudes towards exotic dairy breeds. Thus the decision by the farmer to use exotic dairy breeds is affected by factors that are closely intertwined (Hanyani-Mlambo et al., 1998). In this paper, the model takes into account the respondent's awareness, education, household size, availability of credit and extension as independent variables.

Materials and Methods

Description of study site

The study was carried out in Chikwaka communal area, which is 50 km northeast of Harare. It is located in Goromonzi district in Mashonaland East Province in natural region II of Zimbabwe. Natural region II is one of the prime agro-ecological zones of Zimbabwe. Both crop and livestock agriculture can be done in this area. Rainfall of approximately 800-1200 mm per annum is received in a normal rainy season. Temperatures range from 20-28 degrees Celsius. The soils are varied but the heavy clays and sandy loams are the most eminent soil types characteristic of this region making it suitable for a wide range of crops including tobacco, maize and other key crops. Vegetation is mainly the savanna with a few trees and shrubs and *Hyparrhenia* grasses species.

Sampling frame and sampling process

The sampling frame consisted of 112 smallholder dairy farmers who supply ARDA DDP Chikwaka Milking center with milk. A sample of 40 smallholder farmers was chosen to cover at least 30 % of the total population to ensure statistical estimation. Purposive sampling was used to select and identify farmers who possessed exotic dairy breeds on their farms. This was used to capture a sample that has the desired characteristics. On the other hand, simple random sampling was used to select other farmers with indigenous dairy breeds operating within the same socio-economic and institutional environment. Lists obtainable from local extension officers aided the simple random sampling selection process. In this regard, 20 farmers were identified for each sub set of farmers.

Data collection tools
Structured interviews

The primary respondents of the study were smallholder dairy farmers in the Chikwaka area. A structured questionnaire was administered to cover broad areas, which included the household demography, economic, and agricultural production, constraints to diary production, sources and severity of risks faced in dairy production as well as farm specific, farmer specific and institutional factors affecting adoption of exotic dairy breeds. Knowledge and experience about exotic dairy pure breeds, exposure to proper management extension service and proper instrument and institutions and its role in providing in formation about exotic dairy pure breeds were also elicited.

Key Informant Interviews

Relevant stakeholders in dairy production were interviewed using semi-structured schedules. A list of issues, which were to be investigated, was made prior to the interview. The stakeholders included government departments such as Agricultural Research and Extension Services (AREX), Veterinary Services, Henderson Research Station breeding section and farmer organizations. The data collected included, dairy breeds suitable for the area, the breeds most preferred by the farmers and the most common diseases in the area.

Analytical Framework

The Binary Logistic regression model was used to investigate the process of adoption. Adoption was considered as a dichotomous dependent variable, which meant the farmer either adopts (1) or does not

adopt (0) the exotic breeds. The model is a linear probability model that assumes that the probability that a given individual makes a particular choice is affected by a set of attributes. In this study, the probability of farmer to adopt exotic breeds was hypothesized to be a function of farmer, farm and institutional specific factors. The mathematical properties of the model are depicted below:

Following Gujarati (2004), the model is specified as:

Where:

***X*1 = age of household head in years;**
***X*2 = gender of farmer**
***X*3 = farm size in acres;**
***X*4 = access to credit by the farmer (dummy variable);**
***X*5 = access to extension services by the farmer (dummy variable); and**
= Error term.

The dependent variable is the natural log of the probability of adopting exotic breeds (*P*), divided by the probability of not adopting it (1*P*).

Data Analysis

The statistical package for social scientists (SPSS) was used to analyze the data. Descriptive and inferential statistics were used to describe and draw meaning from the data set.

Results

Farmers awareness of dairy breeds

In assessing farmer awareness, the research was interested in firstly determining whether farmers knew about the concept of exotic dairy breeds. Secondly, it was then important to determine the nature of the exotic breeds that farmers were aware of. In general, most farmers (70 percent) knew exotic breeds. The most common exotic breeds known by farmers were Jersey and Friesland. A few farmers who used to work in former commercial dairy farms knew other breeds such as the Red Dane. Most farmers preferred the Jersey (55 %) and the Friesland (35 %). However, they were not sure of the performance of the Red Dane and were therefore indifferent about this breed. Attributes that they considered important were milk output (52 %), high calving rates (29 %) and relatively high milk quality (19 %).

Farmer attitudes towards exotic breeds

The study also sought to determine the farmer's attitudes and perceptions towards the use of exotic dairy breeds as part of their respective dairy systems. In this study, positive perception was used synonymously with high preference for exotic dairy breeds whilst the converse was true for negative perception. More than half of the sampled (62.5 %) farmers have a positive perception whilst 37.5 % have a negative perception towards the exotic dairy breeds. Aspects that contributed towards the high preference for exotic breeds were high milk output, high calving rates and better quality milk. However, some farmers indicated that exotic breeds could not be used for draught power purposes and were thus inconsistent with the draught power needs of the farmers.

Factors influencing adoption of exotic dairy breeds

The working hypothesis for this study was that farmers exposed to dairy training, extension services, proper infrastructure and credit facilities are more likely to integrate the exotic dairy breeds into their systems.

The coefficient estimates for gender, age and labor were 2.319, -1.7058 and 2.507, respectively, but not significant as shown in Table 1. Gender was specified as a dichotomous variable with 0-male and 1-female. Male-headed households were 2.3 times more likely to adopt exotic breeds. In terms of age, older farmers were less likely to consider exotic breeds. In addition, smaller households were 2.5 times less likely to adopt exotic dairy breeds.

On the other hand, regression coefficients for agricultural training, access to proper infrastructure, accessibility to credits and extension were 8.8, 3.6, 9.1 and 21.75, respectively, and significant at the 5 percent level. This implies that presence of any of these factors increases the probability or likelihood of adopting exotic breeds among farmers. Although an increase in the area under fodder increases the likelihood of adoption, the variable is not significant at the 5 percent level (Table 1).

Table 1: Results of the binary logistic regression model

Variable	B	SE	WALD	Exp (B)
Gender	-2.319	4.218	.302	.098
Age	-1.7058	2.566	.441	.182
Agric training	8.806	122.5	.005	6674
Infrastructure	3.698	227.4	.004	4970
Labor	-2.507	3.277	.584	.081
Fodder area	9.124	5.061	.250	9168
Dairy credits	12.22	122.55	.001	2029
Extension	21.751	210.352	.011	2795
Constant	-29.879	405.897	.005	.000

Discussion

The results of the study place it consistently with the rest of literature. Findings of this study are comparable with related studies such as Bath, Dickinson, Tucker and Appleman (2000) who also showed that these factors are central to the adoption of dairy breeds among farmers. Since variables such as age, gender and labour availability were not significant it means that any future national or district dairy program in Zimbabwe whose thrust is to increase exotic dairy herd use among smallholder farmers should ideally not consider gender, age and availability as critical variables for selecting households. However, the absolute value and sign of the variable for age is comparable with other studies such as that by Yaron and Dinar (1992) who noted that older farmers are usually risk averse and there is an emphasis on role and procedures. New ideas are often dismissed and experience is highly valued. Area under fodder had a positive but insignificant effect on the decision to adopt exotic breeds and this is related to the observation that most farmers put their dairy breeds under the extensive production systems with little supplementation of feeds. Bath et al (2000) noted that expansion of dairying and adoption of exotic dairy breed depends on off-farm carrying capacity for fodder crops and other crops, forest fodder and fodder-intercropping plantation.

Ideal dairy programs should consist of training and extension, credit provision and the requisite infrastructure to sustain exotic dairy breeds. Agricultural training specifically for animal husbandry is positive showing that receiving training increases the probability of adopting exotic dairy breeds, mainly because farmers would have all the necessary information required to develop their capacity in managing the exotic dairy breeds well (Hanyani-Mlambo et al., 1998). These activities include calf management, breed controlling, feeding techniques, and treating experience among others (Titterton, 2000). Accessibility to dairy credit also contributes to the process of adoption because most smallholder dairy farmers are resource constrained hence credit and subsidies boost their input base in a way that will encourage them to adopt exotic dairy breeds (Titterton, 2000). Studies show farmers with access to institutional support in form of credit tend to increase adoption of these exotic breeds because they could meet the demand of exotic dairy breeds (Yaron and Dinar, 1992). Given the volatile macro-economic developments in recent years, credit windows of opportunity whose interest rates are market determined (nominal interest rates of 150 percent in February 2006) may be prohibitive to most smallholder farmers. On the other hand, dairy subsidized programs in which farmers' access credit to purchase exotic dairy breeds at concessionary rates may not be consistent with the World Trade Organization (WTO)'s Amber box policies as they distort international prices of dairy products. They may also increase pressure on the fiscus of the country. Therefore, the dilemma associated with the formulation of an appropriate exotic dairy program that is simultaneously in line with developments in international trade cannot be under estimated in Zimbabwe.

Conclusion

The results from the study showed that most of smallholder dairy farmers are aware of exotic dairy breeds suitable for their area. In addition, farmers

indicated their willingness to have dairy farming systems composed of exotic dairy breeds. What is lacking are the necessary conditions, which ensure that exotic breeds are effectively, integrated into the small farmers dairy systems in Chikwaka communal area of Zimbabwe. A number of hindrances are militating against the effective adoption of exotic breeds by farmers and these include lack of appropriate infrastructure, training, and agricultural credit.

Acknowledgements

The authors would like to thank Agricultural Rural Development Authority Dairy Development Programme (ARDA-DDP) for granting the permission to conduct the study in Chikwaka communal area of Zimbabwe

References

Adesina, A. 1994. Pesticide Use and Policy in West Africa: an overview. In: S. Agne, G..Fleischer, H. Waibel (Eds.). Proceedings of the Gottingen Workshop on Pesticide Policies, 28 February 4 March 1994, Gottingen, Germany.

Bath D.L, Dickinson F.N, Tucker H.A and Appleman R.D, 2000. (Eds.). Dairy Cattle: Principles, Practices, Problems and Profits, Lea and Febiger, Philadelphia, USA

Dairiboard Zimbabwe Limited (DZL), 2004. Annual Reports, Harare, Zimbabwe

Dasgupta, P. and Dasgupta, R. 2004. Economic value of safe water for the infrastructurally disadvantaged urban household: a case study in Delhi, India, Water Resources Research 40 (11): 5 7.

Department of Agricultural Research and Extension (AREX), 2005. The status of Zimbabwe's agriculture, Ministry of Agriculture Publications, Harare, Zimbabwe

FAO, 1996. Report on Constraints in milk marketing in collaboration with the National Association of Dairy Farmers

Gujarati, D.N. 2004. (Ed.). Basic Econometric, 4th Edition. McGraw-Hill, New York, United States of America.

Hanyani-Mlambo, B.T., Sibanda, S. and Østergaard, V. 1998. Socio-economic aspects of smallholder dairying in Zimbabwe. Livestock Research for Rural Development 10 (2). Www.cipav.co.org/lrrd

Kotler, P. and Armstrong, G. 1994. Principles of marketing practice. Hall International Editions, Englewood Cliffs. United States of America.

Titterton, M. 2000. (Ed.). Dairy Production Module. Zimbabwe Open University, University of Zimbabwe Publications

Yaron, D. and Dinar, A. 1992. Innovation on family farms, Innovations on family farms: The case of the Nazareth region in Israel". American Journal of Agriculture Economics 74: 361 - 370.