Chuka University
info@chuka.ac.ke | 020 231 0512 / 020 231 0518

FACTORS AFFECTING PROFITABILITY OF AGRIBUSINESS ACTIVITIES: A CASE STUDY OF SMALLHOLDER PIG FARMING IN THARAKA-NITHI COUNTY, KENYA

Micheni, PaulineKananu[1], NyarikiKipropS.Ibrahim[1]andKosgeiGeoffreyKosgei[1]
Department of Agricultural Economics, Agribusiness Management and Agricultural Education and Extension, Chuka University, P. O. Box 109-60400, Chuka, Kenya
pkmicheni@chuka.ac.ke; isamoita@chuka.ac.ke; gkosgei@chuka.ac.ke

ABSTRACT

The research study examined the influence of institutional arrangements and management factors on profitability of smallholder pig farming in Tharaka-Nithi County, Kenya. A two-stage sampling technique was employed in selection of 80 smallholder pig farmers and analyzed using descriptive statistics and stochastic frontier production function. The study revealed that male (75%) respondents dominated were within the active age, had 6 years' pig farming experience with basic education. The results of Stochastic frontier production revealed that feed costs ($p<0.01$) and breed type ($p<0.05$) negatively reduced profit efficiency of the respondents while herd size ($p<0.05$) and veterinaryand drug costs ($p<0.01$) positivelyinfluenced profit efficiency. Inefficiency was increased byGender ($p<0.1$) and Debt Asset Ratio ($p<0.01$) while information trust ($p<0.05$) and experience reduced. The mean profit efficiency was 0.40 exhibiting low profit efficiency in the study area, efficiency level could be increased by 60% through better use of available resources, adoption of modern technology and transaction costs reduction. Thiswould be acquired if good management practices and marketing channels are adopted. The gamma parameter (γ)was 0.63 meaning 63% net revenue variation is due to profit inefficiencies. The study contributes to Agribusiness field and would improve policies associated with agribusiness development in Kenya.

Keywords: Institutional arrangements, Management factors, Stochastic Frontier Analysis, profit inefficiency

INTRODUCTION

The rising population and urbanization have pushed demand for animal protein to a new high. There is a disparity between the rate of food production and demand. This has led Kenya to import pork valued at USD 700,000 since the country produces an estimated 12,000 tons of pig meat worth KES 1.2 billion. In the last five years, the number of pigs slaughtered has increased by about 8% from 360,000 to 388,200 (ILRI, 2019). Inability to provide the required amountofanimalproteinindietsofthepopulaceis a majorcauseoffooddisparity(FAO,2012). In Kenya, the Livestock sector contributes to 50% of employment and 12% to Kenya's' Gross Domestic Product (GDP). This sector is comprised mostly of dairy, meat, eggs, wool, hides and skins.

The consumption of meat has been rapidly increasing over the last decade with an expectation of reaching 13.3 million tons by 2025 (Shibia *et al.,* 2017). As most urban areas continue to grow, consumption of meat (beef, chicken, mutton, goat, pork and camel) is expected to keep on increasing from the current average of 19 kg percapita per year (USAID, 2012). Pork could play an important role in effectively reducing the inadequacy of animal protein in the diets through pig farming. Pig production has been increasing in the last decade especially in rural areas using different production systems. The most common production systems are free range and intensive confinement (Nguhiu *et al.,* 2018). Also, with the improved farming methods, quality inputs, reliable and efficient markets, credit access and favourable policies have led to improved productivity. Unfortunately, in Kenya the SHFs are not well organized and lack good agricultural practices leading to low yields, eventually very low returns. SHFs lack business orientation, meaning they do not operate their farming enterprise as a business (Micheni *et al.*, 2020).

Over the years, the number of pigs beingslaughtered inKenya has beensteadilyrising. Witha povertylevel of65% in Tharaka-Nithi County, Pig farming plays an important role in risk diversification and livelihood security of smallholder and households as they present an important asset useful in generating income for purchase of farm

inputs, school fees payment and covering emergency cash needs (Mutua *et al.*, 2010). The small-scale pig farming enterprise has been found to be very profitable when good husbandry practices and management skills are applied (FAO, 2012). Proper selection of the breeding stock as well as organized breeding programmes are needed to facilitate geneticimprovementsoastoimprovepigproductivityinKenya(Mutua *etal.*,2010;Maitima*etal.*,2010). However, smallholder pig farmers in Tharaka-Nithi County obtain varying and dismal profits from their enterprise. The dismal profits have been attributed to a number of productivity and market related constraints ranging from diseases, poor nutrition and poorly organized markets. With good management skills and efficient institutional arrangements, pig production improves, increasing income and eventually increase profit levels of farmers. This can only be achieved if the pig sub-sector is carried as a business (Levy *et al.,* 2014).

Development of the pig value chain is important as it has an effect on the farmers' profits as all the key chain actors offer support to each other to improve efficiency and competitiveness (KIT*et al.,* 2006). The sub sector in the county is largely informal with poorly organized markets, limited technology, information and services. Additionally, lack of feed quality control measures, disease risks that wipe out pig herds during outbreak periods lead to stunted growth which reduce market value. Exchange of good information in the produce market is also affected by lack of farmer organizations in the pig sector. This leads to high transactions costs due to low binding relationships between smallholder farmers and traders (Key *et al.,* 2000). Therefore, to minimize these high transaction costs, smallholder farmers need to establish efficient institutional arrangements.

A few studies have determined the influence of management factors and institutional arrangements on smallholder pig farmers profit efficiency. Most examined the effect of farm and farmer conditions, marketing, social, cultural, technological and institutional factors on profit efficiency at farm level (Abdulai and Huffman, 1998; Rahman,2003; Ogundari, 2006; Hyuha, 2006; Costales, 2006; Ogunniyi, 2011; Maganga *et al.,* 2012 and Kadurumba, 2014). However, it's not only the management factors and institutional arrangements that influence profit efficiency of smallholder pig farmers and extent of influence but also the identification of the critical factors that influence profit efficiency is an important priority for research. Thus, there is a need for research to establish which management factors and institutional arrangements that need to be targeted for smallholder pig farmers to be profit efficient in Tharaka-Nithi County. This study attempts to fill this knowledge gap.

STUDYAREA,RESEARCHMETHODOLOGYANDDATAANALYSIS
The study was carried out in Tharaka-Nithi County, Kenya. A two-stage sampling technique was adopted for the selection of smallholder pig farmers in the study area. The first stage involved purposive selection of Maara constituency because of prominence of pig farmers in the area as well as good agro-ecological zone suitable for pig farming. The second stage involved stratification random sampling of 16 smallholder pig farmers from each of the five wards making a total of 80 by use of snowballing method to trace the farmers within the stratified areas.Primary data were collected through semi-structured interview schedules and data obtained from the farmers were analyzed using descriptive statistics and stochastic frontier production function.

Empiricalmodelspecification
StochasticFrontierProductionFunction(SFPF) wasappliedintheanalysisofdata.Toestablish whichfactorsledto profit inefficiency, Stochastic Frontier Approach was used. It accounts for the random error and the inefficiency component (Jacobs, 2000). The functional form of the stochastic profit frontier was determined by testing the sufficiency of the Cobb-Douglas which is highly restrictive by fitting it with the less restrictive translog, this is in line with the work of Nganga *et al.,* (2010).

The stochastic profit model used is as shown in **equation 3** which is basically input-output transformation and transactioncostsmodel(North,1990)whichisthelinearizedCobb-Douglasproductionfunctionwhile **equation4**is the inefficiency model. The econometric model was typically defined to be:

$$Y_i = x_i\beta + e_i \tag{1}$$

$$Y_i = \beta_0 + \sum_{i=1}\beta_i X_i + V_i - U_i \quad \text{(Cobb-Douglas function)} \tag{2}$$

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + V_i - U_i \text{(Translogfunction)} \tag{3}$$

Where: $\ln Y_1$= Normalized profit (net revenue per kilogram of output sold); X_1= Feed cost (kg); X_2=Wage rate (include wage rate for both hired and family labor) (man-days); X_3= Breed type; X_4= Herd size; X_5= Search costs and X_6= Drug/Veterinary costs (Kshs); $B_0, \beta_1,,, \beta_6$= Parameters to be estimated;

U_i = Degree of inefficiency which is half-normal distributed (iid $N|(0, \sigma u^2)$. $U_i$is closely related to the profit

inefficiency which may arise from management factors and institutional arrangements;

V_i = statistical disturbance term that is caused by factors outside the scope of the farmers which is assumed to be identically and normally distributed with a mean of zero (iid) and constant variance of $V \sim N$ ((o, $\sigma 2v$) and independent of U.

The coefficient of the variables x_1, x_2, x_3, x_4, and x_5 are the estimates from profit function maximum likelihood and are interpreted as the elasticities of the variables. The coefficients are all correctly signed. Stochastic frontier model was used to determine the relationship between the pig Net Revenue and the inputs used by the selected smallholder pig farmers.

The objective of this study was analyzed using the inefficiency model where profit inefficiency (u) was the dependent variable and the inefficiency factors were the independent variables

The expression of inefficiency model is specified below:
$$U_i=\delta_0+\delta_1 z_1+\delta_2 z_2+\delta_3 z_3+\delta_4 z_4+\delta_5 z_5+\delta_6 z_6+\delta_7 z_7+\delta_8 z_8+\delta_9 z_9+\delta_{10} z_{10} \tag{4}$$

Where: U_i – the inefficiency of the ith farm; $\delta_0,..,\delta_9$ = Are parameters to be estimated; z_1=Age; z_2=Gender; z_3 =Schooling years; z_4= Group membership; z_5=Management type; z_6=Trust (price); z_7= Trust (Information); z_8= Debt Asset Ratio; z_9= Experience; z_{10}=Record Keeping. A half normal distribution of the inefficiency variance was used in the estimation.

The variance of the random errors, σ_v^2 and that of the profit inefficiency effect σ_u^2 and the overall variance of the model σ^2 are related thus: $\sigma^2 = \sigma^2 + \sigma^2$, measure the total variation of profit from the frontier which can be attributed to profit inefficiency (Battese and Corra, 1977). Battese and Coelli (1995) provided log likelihood function after replacing σ^2 and σ^2 with $\sigma^2=\sigma_u^2+\sigma^2$ and thus estimating gamma(γ) as: $\gamma=\sigma^2/\sigma^2+\sigma^2$. The parameter γ represents the share of inefficiency in the overall residual variance with values in interval 0 and 1.

A value of 1 suggests the existence of a deterministic frontier, whereas a value of 0 can be seen as evidence in the favor of OLS estimation (Kumbhakar and Lovell, 2000; Greene, 2008). Lambda (λ) that is (σ_u/σ_v) was also computed to assess the goodness of fit and correctness of the specified normal/ half-normal distribution assumption. It was also used to explain the disparities of pork output among smallholder pig farmers.

The study will use the average wage county wage rate as a proxy for the wages of the family workers. The average wage is the average wage of the hired workers in the pig farms in Tharaka-Nithi County. This is computed according to the rule that a worker would spend 2 hours in a day at the pig farm only.

RESULTS AND DISCUSSION
Pig management Practices and Institutional arrangements
The management practices and Institutional arrangements of the sampled smallholder pig farmers are presented in **table 1**. The table shows the mean age to be 44 years. This implies that most of the farmers are of middle age, therefore they own risk bearing abilities and innovativeness. At this age the farmers have great mental capacity to cope with daily challenges and demands of farming business. The average number of years spent in school was 10 years implying that the pig farmers were educated and have positive influence on adoption of improved technologies and exploitation of opportunities in pig production.

Majority (75%) of the farmers in the study area were males, while 25% were females indicating that men are more involved in production than females in the study area. In the African context males as the heads of households and owners of resources make major decision on production and who increases profit efficiency because they decide on procurement and use of production inputs. Females in this study area contribute to labour in light farm operations such as serving of feed, water and cleaning of the piggery. Farmers have higher preference for large white (61%) to other breeds. Also, the mean herd size of 4 pigs implies that pig production in the study area is on small scale level.

The study reveals that majority of the pig farmers practiced penning (68%) which is a semi intensive management system, 32% practiced stall-feeding (intensive system) in which pigs are confined in clean pigsty and balanced food given to them. Smallholder pig farmers in the study area sold pigs to traders directly (60%) who offered exploitative prices compared to local consumers at 40% where high prices were offered with high search and contracting costs.

The study showed that 59% of smallholder pig farmers were not members of any farmer group compared to 41%

who were members. Those in farmer groups benefited from trainings which made them adopt newtechnologies and follow management practices recommended by extension workers and other trainers.

Table1:Distributionofselectedmanagementandinstitutionalarrangementsfactorsofrespondents(N=80)

Parameter	Frequency	Percentage	Mean	StdDev.
Age(Years)			44	12
SchYears			10	4
Experience			6	5
Gender				
Man	60	75		
Woman	20	25		
Total	80	100		
TypeofPigBreed				
Crossbreeds	27	34		
Hampshire	3	4		
Landrace	1	1		
Largewhite	49	61		
Total	80	100		
Herdsize			4	2.56
Trainingsattended			2	0.690
Managementtype				
Penning	54	68		
Stallfeeding	26	32		
Total	80	100		
Buyertype				
Localconsumer	32	40		
Trader	48	60		
Total	80	100		
Trust(price,Inform)				
Yes	39	49		
No	41	51		
Total	80	100		
Groupmembership				
Yes	33	41		
No	47	59		
Total	80	100		

Source:Computedfromfieldsurveydata.

ProfitEfficiencyofpigproducersinthestudyarea

Maximumlikelihoodestimates oftheparametersinthestochasticfrontier modelarepresentedin **table2**below.The results ofthe productionfunctionshowed that most ofthe inputsused were statisticallysignificant at different levels except for labour wages and search costs. The coefficient of feed costs is rightly signed and statistically significant(p <0.01) with coefficient of -0.255 meaning 1% increase in price of feeds would decrease net revenue level of the enterprise by 25% which is consonance with the findings of Kadurumba *et al.* (2014). The breed type coefficient of pig was negative and statistically significant (p <0.05) with coefficient of -0.100 meaning 1% increase on use ofpoor breeds would depress net revenue level of the enterprise by 10%.Herd size was positive and statistically significant at (p <0.005) level with coefficient of 0.080 though inelastic meaning 1% increase in the number of pigs will increase net revenue by 8% and this was consistent with the study of Aminu and Akhigbe-Ahonkhai (2017). Lastly, Veterinary and drugs costs was positive and statistically significant at (p <0.01). The coefficient which was elastic in nature appeared to be a major determinant of profit level of pig enterprise in the studyarea. This however, implied that a 1% increase in price of veterinaryand drugs would increase net revenue of the enterprise by50% this is in consonance with the findings of Angkana*et al.* (2019) who found that strengthened veterinary service systemto quality animal health information and potential alternative interventions to antibiotic use including farm management improvement, vaccines and immunodulators. The coefficient for cost of labour was 0.444 and not statistically significant thus appeared not to be a major determinant in profit efficiency of pig enterprise in the study area but have direct relationship. A unit increase in wage rate increases net revenue level by 0.444. The coefficient for search costs was -0.052 which was inelastic and appeared not to be a major determinant of profit efficiency ofpig enterprise in the study area. Therefore, a unit increase in search costs reduced net revenue level by 0.052.

Table2:MaximumLikelihoodestimatesfortheparametersofthestochasticfrontierproductionforpigproduction

Variables	Parameter	Coefficients	P>|Z|
Constant	β_0	-4.647	
Feedcosts	B_1	-0.255	0.000***
Labourcosts	B_2	0.444	0.256
Breedtype	B_3	-0.100	0.004**
Herdsize	B_4	0.080	0.001**
SearchCosts	B_6	-0.052	0.254
Vet/DrugCosts	B_7	0.505	0.000***
InefficiencyModel			
Constant	δ_0	-0.811	0.000***
Age	δ_1	0.119	0.458
Gender	δ_2	0.067	0.054*
Schoolingyears	δ_3	0.068	0.205
Groupmembership	δ_4	-0.291	0.477
Managementtype	δ_5	-0.003	0.993
Trust(Price)	δ_6	-0.059	0.909
Trust(information)	δ_7	-0.814	0.008**
DebtAssetRatio	δ_8	5.007	0.000***
Experience	δ_9	-0.003	0.009**
Records	δ_{10}	0.237	0.685
Sigma-squared	δ^2	4.320	0.000***
Gamma	$\sigma u/\sigma s$	0.630	0.000***
Log-Likelihoodfunction			-95.954
Waldchi2(8)		66.70	0.000***

***Significantat1%,**5%,*10%

Determinantsofprofitinefficiencyinpigproduction

The result of the inefficiency model in table 2 shows that gender was positive and significant at p <0.10. Thisimplies that profit inefficiency increases with gender suggesting that female headed households are more profit efficientthanthe maleheaded householdssincetheyare moreinvolvedinfarmoperations concurringwiththestudy of Mutua *et al.* (2010).Trust in market information was negative and significant at p<0.05, implying that profit inefficiency declines with lack of trust in market information. Transaction costs rise from information asymmetry where farmers have to incur more costs to search for better customers and prices and these costs include; personal time, travel expenses, and communication costs. This is consistent with the study of Holloway *et al.* (2000) who found that information asymmetry lead to opportunism resulting to mistrust amongst the players in the milk value chain. The finding agreed with the study of KIT *et al.* (2006) who concluded that the higher the level of trust between business partners in the marketing channel, the better are the conditions of good business performance.

Debt Asset ratio was positive and statistically significant at p<0.01. This implied that profit inefficiency increased with higher debt asset ratio. The higher the ratio means that farm business liabilities are more compared to assetsand thus need to be balanced. High ratio makes farm business to be insolvent and hinders attracting more credit (Kaase et al., 2003). Caroll et al. (2006) opined in their own study that dairy farms with low debt asset ratio in UK were more efficient. The results on pig rearing experience was found to be negative and significant at 5%. This suggests that specialization is developed overtime leading to improved production methods and higher profit efficiency. This finding is in agreement with those of Etimand Edit (2014), that increased experience in agricultural production enhances critical evaluation of relevance of better production decisions including efficient utilization of productive resources. Age variable had a positive sign with coefficient of 0.119 but not statistically significant.These results are consistent with the findings of Kadurumba et al., (2014). He revealed that older farmers are less willing to adopt new practices and modern inputs. Furthermore, young farmers are likely to have some formal education, and therefore might be more successful in gathering information and understanding newpractices which, in turn will improve the profit efficiency through higher levels of technical and allocative efficiency. Formal education commonly measured in years of schooling had no statistically significant relationship between the two variables. This is consistent with the study of Weir (1999) who concluded that farmers with some form of formal education didn't exhibit higher levels of profit efficiency in the study area.

Distribution of profit efficiency

Table 3 presents the individual profit efficiencies of the sampled pig farmers using the estimated stochastic frontier model. The predicted profit efficiencies differ substantially among the farmers, ranging between 0.094 and 1. The estimates are skewed to the left and the mean profit efficiency was estimated to be 0.40

Table 3: Deciles frequency of profit efficiencies of smallholder pig farmers

Efficiency level	frequency	Relative percentage
<0.25	27	33.75
0.26-0.50	28	35
0.51-0.60	11	13.75
0.61-0.70	2	2.5
0.71-0.80	2	2.5
0.81-0.90	3	3.75
0.91-1.00	7	8.75
Total	80	100
Minimum		0.094
Maximum		1
Mean		0.402

Source: Computed from field survey data.

This implies that pig farmers in the study area were producing at about 40 percent of the potential production level, indicating that the production level was about 60% below the frontier. According to a study by Etim and Udoh (2014), this is an indication of product wastage due to inefficiency of resource use by the farmers. The result also suggests that profit efficiency in pig production in the study area could be increased by 60% through better use of available resources and use of more variable inputs to boost production.

CONCLUSION

This study was conducted to assess factors that affect profitability of smallholder pig farmers in Tharaka-Nithi County, Kenya. The study revealed that majority of the sampled respondents were males within the economically active age group. The trusts on market information as well as experience of the household head were found to influence pig profit inefficiency negatively. Which signify that they contributed in increasing the level of profit efficiency. Lastly, Debt Asset Ratio influenced profit inefficiency positively on the farms in the study area. Meaning that it contributes towards reducing profit efficiency. The study has indicated that pig farmers were not fully profit efficient. Individual levels of profit efficiency revealed substantial profit inefficiencies. Although there is considerable potential for enhanced profitability, it is capable of creating employment, augmenting income and improving the standard of living of the people.

RECOMMENDATIONS

- Pig producers should be organized into groups such as producer organizations or cooperative societies which are avenues to achieving the necessary economies of scale and thus reduce information asymmetries and build up countervailing market power.
- Based on the findings of the study, the following policy recommendations are made: Adequate training programme on pig production (to familiarize them with innovations) and basic finance management skills like the optimal level of debt-asset ratio and debt utilization.
- Pig production in the area is male dominated. Women empowerment programmes should be initiated as they provide significant opportunities for financial access to enable them afford better breeds, quality feeds and other inputs to adopt new farming techniques and also have a voice in management of farm enterprises. Women also need to be encouraged to participate in pig production to increase their income and enhance their livelihoods.
- The major keyplayers in the sector should come up with a coherent and integrated response to address the core challenges faced by smallholder pig farmers. The government can work in partnership with other stakeholders to ensure coordination and cooperation across different national institutions and agencies, at central and local level, private sector organizations, producer organizations and development partners.
- The study focused on factors influencing profitability of smallholder pig farms, thus would recommend a further research on smart farming application in smallholder pig farming which could be used to support

integrative management approach. In redesigning the study, capturing the effects related to smart solutions insmallholder pig farming could be considered.

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