Analysis of Institutional Factors Influencing Adoption of Zero-grazing Dairy Farming Technology among Smallholder Farmers in Bondo Sub County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author GOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ES and LN supervised all the study. All authors read and approved the final manuscript.

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ABSTRACT

Adoption of zero-grazing addresses challenges faced by smallholder farmers. In Bondo Sub-County adoption of zero-grazing technology has remained low at 4-8 percent despite its introduction in the area in 1990s. No in-depth analysis has ever been conducted on the factors responsible for low adoption of this technology. The purpose of this study was to analyze institutional factors influencing adoption of zero grazing dairy farming technology. The study was carried in Bondo Sub-County, Kenya between February to November 2018. A study was conducted on a sampled population of 279 from a target population of 4253 smallholder farmers. These consisted of adopters and non-adopters of zero-grazing dairy technology. Purposive, proportionate, simple random and systematic sampling techniques were used to select households. Structured questionnaire was administered

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during primary data collection. Descriptive and inferential statistics were used to analyze the data. The double hurdle model was used in the study to measure the adoption and performance of zero grazing dairy technology. Institutional factors that had significant (p-value 0.000< 0.05) influence on adoption of zero-grazing dairy technology were access to extension services, frequency of extension officer's visits, group membership and distance to nearest market. In conclusion access to extension services, frequency of extension officer's visits, group membership and distance to nearest market influenced adoption of zero grazing farming technology in Bondo sub County. Platforms for farmers' training should be enhanced through employment of more extension workers. The institutions supporting dairy farming should be strengthened.

1. INTRODUCTION

In Kenya, agriculture is the mainstay of the economy directly contributing 35 per cent of the Gross Domestic Product (GDP) annually and another 25 per cent indirectly. The sector accounts for 65 per cent of Kenya's total exports and provides more than 70 per cent of informal employment in the rural areas and 18 per cent of formal sector [1]. Agriculture in itself is also a market for industrial goods such as machinery, equipment and fertilizers used in the farming process. It promotes and creates various off-farm activities such as transportation, research programmes that look for better and improved methods to be applied in farming and livestock activities. Agriculture ensures a constant food supply and food security for the population. It also saves the country funds that would have rather been used in importing food from other countries this in turn has a positive effect on the country's balance of payments and there is surplus money to invest in other areas of the economy such as social overheads, roads and hospitals [2]. Above all, agriculture contributes towards rural-urban balancing, through the creation of employment in the rural areas thus discourages rural to urban migration and this helps in the better distribution of incomes and balanced use of social amenities. Through all this multiplier effects, agriculture is perceived as an engine of economic growth and development.

Investment in technologies such as zero-grazing dairy farming, agricultural mechanization, irrigation, and greenhouses, with computer-controlled technology, provides ideal conditions for high quality crops. Kenya has also adopted genetic engineering that has allowed new plants to be bred that resist drought and diseases while giving higher yield. Introduction of agricultural value-chain approach also has a prospect of improved future agricultural productivity.ref?

Over the years, agricultural production in Kenya has been facing challenges that have contributed to reduced productivity. Alila and Alila [3] noted that the performance of Agriculture slackened dramatically over the post-independence years from an average of 4.7 percent in the first decade to only below 2 percent in the 90s. This decline culminated in a negative economic growth rate of -2.4 percent in 2000. In the year 2010 agriculture grew by 6.3 percent as opposed to contractions of 4.1 percent and 2.6 percent experienced in 2008 and 2009 respectively (KNBS, 2011). Today, however, the challenges in agricultural production are much more complex and much more immediate. Global issues such as climate change and food insecurity need to be addressed simultaneously. This means that agricultural innovations must necessarily emerge out of complex decision making process that weigh immediate concerns of feeding the world's expanding population. Kenya's agriculture is mainly rain-fed and is entirely dependent on the bimodal rainfall in most parts of the country. A larger proportion of the country, accounting for more than 80 percent is semi-arid with annual rainfall average of 400 mm. Drought are frequent and crops fail in one out of every three seasons [2]. Kenya's agriculture is predominantly small-scale farming mainly in the high potential areas, production is carried out on farms averaging 0.2-3ha, mostly on commercial basis. This small-scale production accounts for 75 percent of the total agricultural output and 70 percent of marketed agricultural produce.

In general, the adoption of improved agricultural technologies is said to be a vital pathway out of poverty for many farmers in developing countries [4-5]. However, adoption does not happen immediately as a lot of factors need to be considered. To support the adoption of zero grazing at the national level, the Republic of Kenya has put in place policies, which advocate for intensification of agricultural production aimed

at increasing output and productivity [6]. In addition, at the international level, in recent years, developing countries including Kenya have received increased attention on adoption of agricultural technologies [7]. Adoption of new technologies is viewed as the key to agricultural development [8].

Bondo Sub-county is one of the many regions in Kenya that experience food insecurity due to low agricultural production that has been attributed to the harsh environmental conditions, but at the same time, low uptake of agricultural innovations. For the last 10 years, various agricultural innovations have been introduced in the area through agricultural extension but with minimum success. These includes, new seed varieties, inorganic fertilizers, zero grazing livestock production method, agricultural mechanization, modern irrigation techniques and agribusiness value chain strategy. This notwithstanding, Bondo Sub-county continues to experience chronic food shortages with over 50 percent of food being bought from markets outside the Sub-county. Milk deficit is a common occurrence in the Sub-county since many farmers are still using traditional livestock keeping methods that have low returns. Dairy farming is an important livelihood strategy for smallholder farmers in Kenya especially for those in rural areas as it provide food security and livelihoods for rural households. It is therefore important for smallholder farmers to invest in reliable dairy technology to ensure that they have a constant flow of milk to provide for deficit market demand. These among other factors have triggered this study to interrogate what underlies the low uptake of agricultural innovations that intended to improve food production in Bondo Sub-county that is suffering from chronic food shortage conditions.

2. METHODOLOGY

2.1 Description of Study Site

The study was done in Bondo Sub-county, Siaya - Kenya. Bondo is one of the six Sub-counties that make Siaya county. The Sub-county has a total area of 1328 km^2 of which 577.2 km^{2}is land surface, while 751km^2 is covered by water. It borders Siaya Sub-county and Busia County to the North-West, Kisumu to the East and Rarieda Sub-county to the East and, Homabay Sub-county across the Lake on the South-East and South, to the West lies the Republic of Uganda (see Appendix I). Bondo Sub-county lies between 0'26' to 0' 90' South of the Equator and from longitude 33' 58' E and 34' 35' W. There are three administrative divisions namely Usigu, Maranda and Nyangoma, and twenty six sub-locations. The Sub-county has six electoral wards and one constituency known as Bondo.

The altitude ranges 1140-1400 metres above the sea level with temperature ranges of 15-33ºC. The area receives annual rainfall of 800-1600 mm p.a. The population is about 144,780 with an average farm size being about 3.5 acres. Agro-ecological zone are LM2-LM3 and LM4 being dominant. Dominant soil types in West and South Sakwa, Usigu- are ferrasols. North Sakwa and Central Imbo have luvisols with low- moderate fertility. Yala Swamp in Usigu division has gleysols, which are water logging, fertile and variable. Major food crops includes: Maize, Sorghum and Beans. Major cash crops are Cotton and Horticulture grown along the Lake Victoria. Major Livestock are Zebu cattle, goats, sheep and local poultry. Fishing is also a major livelihood activity contributing about 50 to the Livelihood needs.

2.2 Research Design

The study adopted descriptive survey research design. The design was found suitable for this study since it provided insights and understanding of the factors influencing adoption of zero-grazing dairy farming technology among smallholder farmers in Bondo Sub-county. Descriptive research also includes fact finding and making enquiries of different kinds of information, such as information on age, sex, marital status, education, occupation and many others. Another reason why descriptive survey was used because it described the state affairs as it exists at a particular time. The main characteristic of this method is that the researcher had no control over the variables and could only report what had happened or what is happening. The data in this research were derived from both observational situation and through questionnaire.

2.3 Theoretical Framework

De Souza Filho (1997:82) suggests that farmers are influenced by various economic and non-economic factors to make decisions regarding the adoption of agricultural technologies. Farmers will hesitate to adopt a technology if income increase is expected to be low and if costs of the technology outweigh the benefits.

Other common exploratory variables include farm size, risk and uncertainty, human capital, labour availability, credit and supply constraints. According to El-Osta and Morehart (2000), farmers have been able to succeed financially through increased productivity and lower per unit costs as a result of the contribution that technological advances make to the dairy industry. These advances have been categorized as capital-intense such as genetically superior dairy cows and management-intense practices such as improved nutrition and feeding commonly known as zero-grazing.

However, these are not applicable to those smallholder farmers that are already constrained financially and do not have the appropriate breeds. These limitations have been observed among smallholder farmers in their quest to increase farm productivity (Zvomuya, 2007). Research and technology directed at addressing constraints such as feeding, appropriate breeds selection, animal health and other constraints that if addressed will lead to improved productivity. This has been done through a number of projects initiated by Ministry of Agriculture, Research organizations such as Kenya Agricultural and Livestock Research Organization (KALRO) which has invested in ensuring that smallholder farmers are given assistance in improving their farm practices. Byerlee and Polanco [9] suggest that although transferring technology as a package allows interactions among components and emphasizes the large difference in yields between traditional and improved methods, it comes at a cost as farmers are constrained by capital and have to consider the risks associated with it.

2.4 Sample Size and Sampling Procedure

The target population was dichotomous in nature, as such it comprised of the farmers who practice zero grazing and farmers who do not. The list containing farmers who practice zero-grazing and those who do not was obtained from the sub-county livestock office. This formed the sampling frame. It consisted of 4253 small-scale livestock farmers with less than 10 acres of land situated in Bondo sub-county. The sample size was determined using formula given by Nassiuma [10] for household, as given in equation one.

$$n = \frac{Z^2 pqN}{e^2(N-1)+(Z^2 pq)} \quad (1)$$

Where N = sample size, p = population proportion with the characteristic of interest, $q = (1 - p)$, N = Size of the population, e = margin of error, Z = critical value at the desired confidence interval. This formula is applicable for sample size where target population is below 10,000.

Bondo sub-county was purposively selected from the six sub-counties in Siaya County. Bondo sub-County was selected because it is one of the sub-Counties in Kenya where National Dairy Development project was initiated. In the six wards of Bondo sub-County proportionate sampling technique was used to determine the number of small-scale farmers that were sampled. In each ward Simple Random Sampling technique was used to select the first respondent, then systematic sampling technique was used to select the rest of the respondents. Out of 4253 small-scale farmers 294 were randomly selected using simple random sampling technique. However, 17 farmers were not considered in the final data analysis because of poor response, which includes many unanswered questions. Structured questionnaires were administered during primary data collection. The study had a sampling frame of 277 small scale dairy farmers drawn from the six wards of Bondo sub-county.

2.5 Pilot Testing of the Instrument

Questionnaires were administered to thirty farmers (10 of total participants) in Rarieda sub-county which neighbours Bondo sub-county the respondents were selected two weeks before the main study. They were asked to respond to the questions as the researcher bserved whether questions measured what was expected to be measured, how long it took to interview one respondent, whether response choices were appropriate, whether the tool collected the information needed among other things. Necessary adjustments were made to the tool where necessary. To facilitate this, the researcher had to seek permission from local leaders, for example, the chief, ward administrator and assistant County Commissioner.

2.6 Reliability and Validity of the Instrument

Validity is the accuracy and meaningfulness of inferences, which are based on the research results. It is the degree to which results obtained from the analysis of the data actually

represent the phenomenon under study. The following measures were taken to ensure validity [11]:

1. Questionnaires were pre-tested on a pilot survey and amendments made to suite respondents.
2. Data collection was conducted within shortest time possible so as to minimize the possibility of the occurrence of major events in the area that could have affected the opinion and attitude of a section of the respondents in the course of the study. Validity involves ensuring the use of adequate sampling procedures, appropriate statistical tests and reliable measurement procedures.

Test-retest reliability estimator was used to ensure reliability; Reliability in this study was tested by administering questionnaires to thirty farmers in the neighboring Sub-county of Rarieda. The questions that were found to be vague were restructured to make them more understandable to the farmers.

2.7 Data Analysis

2.7.1 Descriptive analysis

To describe the features of generated data descriptive statistics were provided. The statistics were continuous and categorical variables. Descriptive analysis is a method that provides statistics used to describe the basic features of the data in a study. The statistical measures were summarized by central tendency (mean, mode, median), dispersion and variance.

Different descriptive statistics were used depending on whether the outcome variable is continuous or categorical. They provide simple summaries of the characteristics of the sample such as measures of central tendency, dispersion, and variability. They often provide guidance for more advanced quantitative analyses. However, they have limitation of not showing the relationship among the variables and the influence that each variable may have on the response. In this study, measures of central tendency such as the mean values and measures of dispersion such as the minimum and maximum (range) and standard errors were produced for continuous variables. For categorical variables descriptive statistics (the percentages) were used to describe and summary the social- economic variables that were used in the various models.

2.7.2 Logit model

Logit model was used in analysing factors influencing adoption of zero-grazing technology. The logit model predicts the outcome of dairy technology. The dependent variable was Prob (Adoption = 1| X) where X is the set of independent variables $p(Q_i=1)$.

$$P_i = \frac{1}{(1+e^{-z})} = \frac{e^z}{(1+e^{-z})} \qquad (2)$$

$$Z = x\beta x + u. \qquad (3)$$

The probability of not adopting the locally produced adapted technology is:

$$1 - P_i = \frac{1}{(1+e^z)} \qquad (4)$$

From equation (1), the odds ratio is specified as

$$\frac{P_i}{(1-P_i)} = e^{x\beta+u} \qquad (5)$$

Table 1. Measurements of variables expected signs

Variable	Type	Description	Expected sign
Adoption	Dummy	Adoption of zero grazing technology (1=adopter; 0=otherwise)	
Training	Categorical	Training on zero grazing technology	+
Extension services	Categorical	Availability of extension services on zero grazing technology	+
Frequency visit	Categorical	Number of times a farmer is visited by an extension officer per year	+
Group membership	Dummy	Group membership of the farmer	+
Distance	Continuous	Distance in kilometer to the market	-

Source: Researcher, 2019

2.7.3 Model specification

The empirical model of the effect of the explanatory variables on adoption of zero grazing technology among smallholder farmers was specified in linear relationship as:

$$
\begin{aligned}
Y_{i1} = {} & \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \\
& + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \\
& \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \\
& \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + \varepsilon \quad (6)
\end{aligned}
$$

Where Y_{i1} is the adoption of zero grazing technology, β_0 is the intercept, $\beta_{i's}$ are the coefficients of the equation, X_1 is the age, X_2 the gender, X_3 the education level, X_4 the family size, X_5 the farm experience, X_6 the farm size, X_7 cost of technology, X_8 farm income, X_9 off farm income, X_{10} cost of labor, X_{11} training, X_{12} the extension, X_{13} frequency of visit, X_{14} the land tenure, X_{15} the credit access, X_{16} the distance to the market, X_{17} the group membership and ε the error term.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Response rate of questionnaires issued

To collect data, 294 questionnaires were issued. Out these 279 were filled correctly and returned. Therefore the response rate was 94.9 percent as shown in Table 2.

3.1.2 Descriptive statistics

The descriptive characteristics of respondents were grouped as continuous and categorical variables. Descriptive statistics were used to summarize the social characteristics of the farmers in the study area. Summary statistics was also done to show the sample characteristics and to remove outliers.

3.1.3 Extension service visits

As indicated in Table 3, majority of the samples respondents were aware of zero grazing farming technologies at 77.4 percent while those unaware of zero grazing farming technologies were only 22.6 percent. Extension services on availability of information will influence an individual to adopt or not to adopt zero grazing technologies. Regarding adoption of zero grazing technologies it was revealed in Table 3.

3.1.4 Diagnostic tests

The following diagnostic tests were done before testing the study hypotheses; Multicollinerity and Normality test.

3.1.5 Test for multicollinearity

Two or more independent variables might be correlated with each other. This situation is referred as collinearity. There is an extreme situation, called multicollinearity, where collinearity exists between three or more variables even if no pair of variables has a particularly high correlation. This means that there is redundancy between predictor variables. Presence of multicollinearity, regression model becomes unstable. In this multicollinearity was tested by computing a score called variance inflation factor (VIF), which measures how much the variance of a regression coefficient is inflated due to multicollinearity in the model. The smallest possible value of VIF is one (absence of multicollinearity). As a rule of thumb, a VIF value that exceeds 5 or 10 indicates a problematic amount of collinearity (James *et al.,* 2014). The results in Table 4 shows that all the variables under this study had VIF less than 5. Therefore, there was no multicollinearity.

Table 2. Response rate of questionnaires issued

	Number	Percentage
Received questionnares	279	94.9
Not received questionnare	15	5.1
Total Issued	294	100

Source: Researcher, 2019

Table 3. Extension services

Description	Frequency	Percent	Cumulative percent
Aware	63	22.6	22.6
Not aware	216	77.4	100.0

Source: Authors compilation, 2019

Table 4. Test of multicollinearity using variance inflation factor (vif)

Variable	VIF	1/VIF
Training	1.46	0.684277
Frequency of visit	1.23	0.811005
Distance to market	1.14	0.880095
Extension Service	1.07	0.930785
Group membership	1.04	0.960715
Mean VIF	**1.19**	

Source: Researcher, 2019

Table 5. Results for normality using shapiro-wilk test

Variable	Obs	W	V	z	Prob>z
Training	279	0.99896	0.207	-3.68	0.99988
Extension service	279	0.99977	0.046	-1.199	0.1167
Frequency of visit	279	0.95487	8.989	1.136	0.1271
Group membership	279	0.98879	2.239	1.885	0.0297
Distance to market	279	0.79093	41.771	1.73	0.084

*W and V are Shapiro-Wilk and Shapiro-Francia test statistic for normality respectively. Z is the test statistic for standard normal distribution; Source: Researcher, 2019

Table 6. Logit regression results

Number of obs = 279
LR ch2(19) = 232.0700
Prob > Chi2 = 0.0000
F (19,260) = 3.8400
Pseudo-R^2=71.90

Variables	Coefficient	Std .Err	z	P > |z|
Training	-2.2071	0.8668	-2.55	0.001
Extension services	1.5882	0.6953	2.28	0.022
Frequency of extension service	-1.5638	0.6806	-2.3	0.022
Distance	0.0903	0.0403	2.24	0.025
Constant	4.6928	4.7062	1.00	0.319

Source: Researcher, 2019

3.1.6 Tests for normality

In this study, Shapiro-Wilk normality test was used. This test assesses normality by calculating the Shapiro-Wilk of Shapiro-Francia 'W' statistic between the data and the normal scores of the data. It null hypothesis H_0: Data is Normally Distributed. And according the results presented below, the variables were normally distributed. Therefore, the study proceeded to test for hypothesis using z-statistic.

3.1.7 Regression results and test of hypotheses

Institutional factors which included farmers training, access to extension services, frequency of extension visits, distance to the nearest market and membership to farmers group do not significantly influence adoption of zero-gazing dairy farming technology in Bondo sub-county. Results showed that frequency of extension visit significantly determined adoption of zero-grazing farming technology (p – value 0.022 < 0.05). The coefficient of frequency of extension visits was 1.5639 indicating that when frequency of extension visits increase by one unit, the likelihood of adoption is likely to increase by 1.56 units holding other covariates constant. Distance had a positive and significant coefficient (p-value 0.025 < 0.05). Training had positive and significant effect on adoption of zero-grazing dairy technology (p – value 0.011 < 0.05). The coefficient is 2.2071 implying that when training increases by one unit chances of adoption of zero-grazing technology increases by 2.2071 units. Group membership had a positive and significant coefficient of 1.6301 (p-value-0.40 < 0.05) impliyng that a unit increase in group increases the chances of adoption of zero

Table 7. Logistic regression

Number of observation = 279
Population size = 279
Design df = 278
F (19,260) = 3.84
Number of strata
Prob >chi2 = 0.0000

Adoption	Odds Ratio	Std .Err	z	P > |z|
Training	0.1100	0.0887	-2.740	0.007
Extension	4.8952	3.4930	2.230	0.027
Land tenure	0.7277	0.2542	-0.910	0.364
Credit access	0.5570	0.3744	-0.870	0.385
Distance to market	1.0945	0.0467	2.110	0.035
Group membership	0.1958	0.1261	-2.530	0.012
Constant	109.1672	441.6405	1.16	0.247

Source: Authors' compilation, 2019

grazing technology by 1.6301 units. Therefore, the third hypothesis was rejected and concluded that institutional factor affects adoption of dairy technology in Bondo Sub County.

From Table 7, factors that significantly increase the chances of adoption of zero grazing technology were; availability of extension services with odds ratio 4.895, distance (1.0945), and group membership (0.1959). Their probabilities were significant since the p –values were less than 5 percent level of significance.

3.2 Discussion

Institutional factors such as availability of technology, extension visits, frequency of extension visits, distance to market did not have significant effect on adoption of zero-grazing dairy farming technology. Distance referred to the location of the household from the point of purchase of dairy supplies such as animal drug and artificial insemination services. Distance also relates to the point of sale of dairy products such as cooling plants. The shorter the distance to market, the easier the access to markets and purchase of dairy input supplies. Market distance showed a positive and significant relationship with adoption of zero grazing technologies in the study area (p- value = 0.025 < 0.05. This study supports the findings of (Fentaw, 2017) and (Tegegne, 2018). However, this study disagrees with the findings of (Dereje, 2006 and Rahmeto, 2007) who argued that as market distance increases, adoption and intensity of adoption were expected to decrease. (Bulale, 2000) and (Kassa, 2006) showed that distance to market is negatively and significantly related to adoption of zero grazing technologies by farmers. Proximity

to market is an important determinant of adoption, presumably because the market serves as a means of exchanging information with other farmers (Maddison, 2006).

When integrated farmer field school program was implemented to empowered farmers with scientific knowledge, skills, positive attitudes and suitable technology adoption increases. The implication is farmers' participation in the learning process, technology transfer, adoption of new technology and productivity. The empirical evidence showed that farmers who participate in the program have significantly increased in paddy productivity. The ultimate goal of the farmers' training process, especially among small-holder farmers is to free them from the shackles of poverty through improving their cognitive abilities and practical practices as well [12-19]. Training on improved livestock technologies creates its awareness and is expected to affect its adoption positively. The result concured with the findings of Kaaya *et al.* [20], Lemma et al. [21], Quddus [22] and Dehinenet et al. [23] and with the hypothesized results.

Group membership such as cooperative or self-help groups that a farmer was a member an important source of information and in this case a farmer who was a member of one group or a multiple member of several groups has the advantage of acquiring as compared to a farmer who does not belong to any group. A farmer belonging to a group has social capital allowing trust in terms of information and idea sharing among group members and therefore enhances the chances of adoption of new technologies [24] as farmers within a social group learn the

advantages of taking up new technologies. A farmer who belongs to a group has increased chances of getting credit and therefore being a member of group has a positive relationship with adoption of zero grazing dairy technologies [25,26]. Factors common to the adoption study identified as positively associated with increased adoption, were increased extension activity [27].

4. CONCLUSION

The results showed that institutional factors such as training of farmers, frequency of extension visits, access to extension services, membership to farmers' group and distance to the nearest market significantly influenced adoption of zero-grazing dairy technology.

5. RECOMMENDATIONS

Farmers' training institutions should be supported to provide frequent training and education facilities in the study area. Field days will improve level of awareness among the farming community due to the improved training packages hence willingness to adopt the technology. Accessibility to farm credits should be enhanced so that many farmers may be encouraged to adopt zero grazing dairy farming technology. Competing interests

6. LIMITATION OF THE STUDY

This study was limited to analysis of factors influencing adoption and performance of zero-grazing dairy technology among smallholder farmers in Bondo sub-county. The main limitations of the study were time factors, logistical constraints, reliability of information received from the respondents based on the study objectives and conservativeness of the respondents.

CONSENT AND ETHICAL APPROVAL

During data collection in the field, the following ethical issues were considered. The respondents were assured of confidentiality of the information given and that the information would be used for research purpose only. The respondents were guarded against any adverse discrimination on the basis of the study especially non-adopters. Study benefits, rights of respondents were explained to the respondents before administration of the questionnaires. The opinions of respondents were respected and observed, time lines were agreed upon and handled courteously. For enumerators, professionalism and ethical conduct was followed to the letter. Enumerators respected the culture, gender rules and taboos of the individuals, groups and the community. Ethical consideration is necessary to maintain the integrity of the study as well as the integrity of the researcher [28]. Research permit was obtained from National Commission for Science technology and innovation (NACOSTI) secretariat that allowed the researcher to undertake the activity in the field.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX
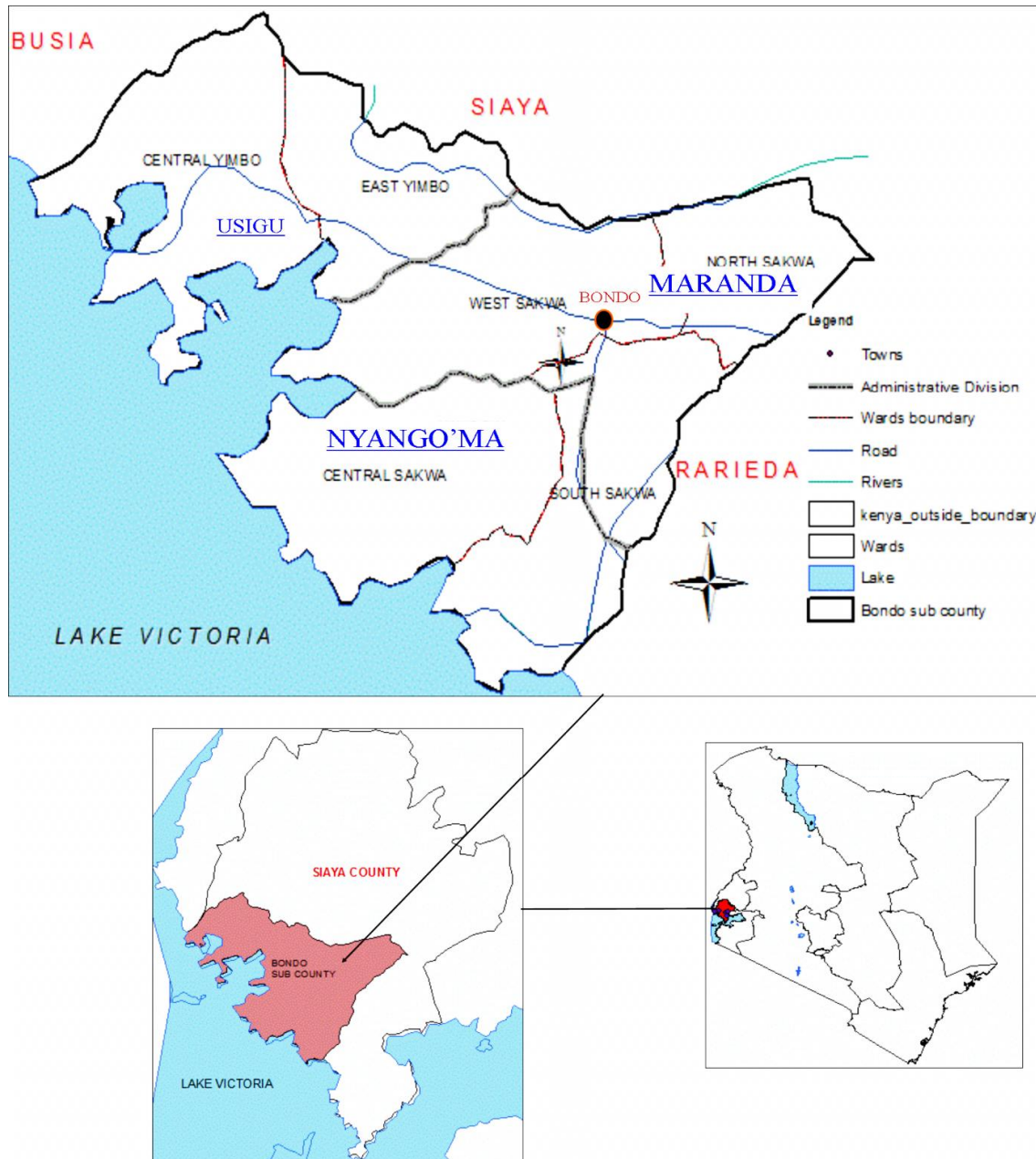
Appendix 1. Map of Bondo sub-county
(Source: Modified from Ministry of agriculture, Bondo Sub-county January, 2016)

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