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Determinants of pastoral communities for adoption of forage production technology in Yabello rangeland, Southern Ethiopia

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Nowadays, adoption of forage enhancement technology is considered a primary action plan for enhanced livestock production through increasing forage production among pastoralist communities in the rangeland of Yabello. In addition, a number of factors help in determining adoption of these practices that varies with different socio-demographical issues within the pastoral household. This study focused on identifying major threatening factors, both directly or indirectly, that affects practicing the new technology and on enhancing the forage production activity in Yabello rangeland of Southern Ethiopia. Data were collected from 210 households and 6 extension workers, making 216. The interviewers used direct interviews as well as group questionnaires and the data were analyzed using SPSS. From the data, one can understand that the threatening factor, which includes gender, level of education, social participation as well as access and implementation of extension services, played key roles in adaptation of technology and in the long-run enhancement of forge quality and quantity. In general, based on the data, it is recommended that awareness creation concerning the value of participating both for local and governmental as well as socially in Yabello rangeland can be offered.

Key words: Forage production, pastoralists, Yabello, technology adoption**,** threating factors.

INTRODUCTION

Major rangelands of Ethiopia are found around the border area bounded by the peak land (Alemayehu, 2004). The local grass and crop residues are the major feeding source for livestock farming in Ethiopia (Kassahun et al., 2008; Alemayehu, 2003) aided by the use of different feeding systems which includes communal or private natural grazing and browsing, cut and- carry feeding, as well as hay and crop residues. The amount and quality of forage product is seasonal, meaning that season is a detrimental factor to both the existence and quality of forage in the Yabello (Kidake et al., 2016). Scarcity of feeding source, mainly during the dry season, results in reduction of livestock products (Joosten et al., 2014). The indigenous knowledge of pastoral communities has been significant in conservation, wise utilization and rangeland use

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system in Ethiopia, mainly in Yabello. In addition, this indigenous management practice used to cope up fluctuating climate conditions, grazing intensity and durability of the existing range resource, since they used management strategies depending on the season. The source of this indigenous knowledge is their cumulative result of day-to-day practice, observation and fighting with nature to sustain themselves (Tilahun et al., 2017), and it plays a great role on the livestock farming activity. Nowadays, rangeland degradation has become a bottleneck problem and has led to decline of utilization of rangeland (Hasen, 2013). Drought, erratic rainfall, bush encroachment, over population, overstocking and different anthropogenic factors are among the root cause of rapid rangeland degradation in Yabello (Gemedo et al., 2006). This leads to shortage of both quantity and quality of forage in Yabello (Daniel, 2010). Shortages of forage due to rangeland degradation became the primary determinant factor for livestock farming in the Yabello rangeland area (Ayana et al., 2012) and this results in increased mortality rate and decline of livestock productivity and poverty in the pastoralist community (Joosten et al., 2014). Accessibility and quality of forage can play significant roles for successful livestock production and living standard of the pastoralists (MacOpiyo et al., 2013). To scale up both quality and quantity of livestock productivity modernizing forage production techniques, adopting technology and other extension service is mandatory (Manyeki et al., 2015). Therefore, to overcome this problem in a sustainable manner, technology integration and adaptation methods were introduced in the pastoralist area of Ethiopia, in collaboration with the Chinese government (project name; Technology integration and demonstration of rangeland rehabilitation in lowland of Ethiopia), mainly in the Yabello rangeland. However, adoption of these technologies has been faced with different determinant factors, and there were no background studies done in Yabello pastoral area. Therefore, the study focused on assessing major determinant factors impact on practice and adaption on technology and production of forage in the Yabello rangeland.

MATERIAL AND METHOD

Study area

The study area included Dida Tuyura, Danbal-Waccu and Arero kebeles of Yabello district, Borana zone in southern Ethiopia. The study took place in 2019. The study area is situated in 566 km south of Addis Ababa along the Addis-Moyale road. The area of Yabello town is 5426 km^2, and is located between 4°30'55.81''N and 5°24'36.39''N latitude, and 7°44'14.70''E and 38°36'05.35''E longitude. The elevation of the area is mostly 1000 to 1500 m; with the maximum elevation is 2000 m. The area has a bi-modal rainfall regime, with mean annual rainfall ranging from 400 mm in the south to 600 mm in the north. Approximately 73% of the rainfall occurs from March to May, and the remaining 27% from September to November (Dalle et al., 2015). The potential evapotranspiration is 700 to 3000 mm (Billi et al., 2015). The study area is dominated by savannah vegetation, containing a mixture of perennial herbaceous vegetation.

Sampling procedure and data collection

Three (3) kebeles (Dida Tuyura, Danbal-Waccu and Arero kebele) were purposively selected from Yabello district based on past experience, showing willingness to adopt various technologies directly or indirectly used for scale up forage production including the current (Technology integration and demonstration of rangeland rehabilitation in lowland of Ethiopia) ongoing project. In each of the three kebeles, 70 households were sampled using systematic random sampling and 210 respondents' were chosen and interviewed. In addition, from each kebele, two (2) agricultural and livestock extension workers were selected from 6 professionals used both for interviewed data collection and also as guidance for method design and strength of ways for data collection. In total, data were collected from 216 individuals. Face-to-face interviews, by translating into the local language with the help of local experts were carried out by the researcher, and questionnaires given to each respondent in the local language (ormoigna) was filled containing what they know and understand and was collected. The obtained data both focal group discussion and key informant interviews were cross checked (Nyaoga and Magutu 2016). Selection of key informants was mainly based on their age, forage production experience, willingness of acceptance implementation of the service given by local extension worker, and livestock production capacity. To ensure that respondents had some experience, those selected were at least 28 years of age or older.

Data analysis

The data was managed using Microsoft Excel, while computer based data coding, storage and retrieval mechanisms were implemented. Both quantitative and qualitative statistical analysis was completed using SPSS (statistical package for social science) software. Influential factors on forage production were done using binary logistic regression model.

Variables

The dependent variable used in the Logit regression model was used in forage production. The samples classified as producers and non-producers were based on the data obtained from the respondents and were assigned the value "1" for producer, while "0" for non-producer.

As we have seen from Table 1, those independent variables either positively or negatively have the chance to affect the dependent variable, that is, enhancement and adoption of forage production technology in the study area.

Experience age

The age of a responsible person within the household can play a key role in understanding and ease adaptation and internalization of the emerging technology (Lugusa, 2015). Previously studied data indicated that the older the age of household head, there would be decline in the rate of adaptation and internalization of the emerging technologies, interest and motivation. This indicates that age and exercising new technology is likely inversely related (Omollo, 2017). This implies that in comparing younger household farmers with older ones, younger ones are more flexible and can easily adapt to

Table 1. Estimated impact of determinant factors on participation and adaptation forage production technology.

Variable	Given values	Its impact on involvement of forage improvement
Age	Number of years	-
Gender	Male=1, Female=2	±
Education	0=No education, 1=Primary, 2=Secondary, 3=Tertiary	+
Land size	Number of acres	+
Envelopment of group participation	1= Yes, 0=No	+
Herd size	In TLU	+
Availability of extension service of extension service	1=Yes, 0=No	+

change that helps to improve their income source. So based on this past experience, we estimated that age has inverse relationship with adoption of forage production technology in the study area and assigned values based on respondents age interval. The intervals are as follows: 1 if 30 years or less, 2 if 31 to 40 years, 3 if 41 to 50 years, 4 if aged between 51and 60 year, 5 for 60 to 70 years and 6 if above 70 years.

Gender of household head

In most African countries, Ethiopia inclusive, females have limited opportunity to access and participate in household farming practice such as livestock production as compared to their male counterpart. This result in cultural habit of non-involvement of females in the local dissection, leading to both resource and knowledge gap for technology adaptation and practice (Wasonga, 2009). The current study began with the hypothesis that males had more cumulative knowledge to involve and adapt forage production technology as compared to female household heads; thus, the value 1 was assigned for males and 2 for females.

Level education

Value is placed on accomplished level of formal education of the responsible household. Level of education has acceptance within the community and help to easily fit and understand the emerging technology (Muyanga, 2008). This done through creating better understanding of the new technology and apply it without any doubt. As a result, household level of education has a positive impact on forage technology adaptation and practice. The following is assigned as follows for this study based on the formal education level: 0 = educated, 1 = primary education, 2 = secondary education and 3 = household heads with tertiary education.

Household land size

Land size of the household determines the amount of land planned for the purpose of forage production. That means, if the household have more/large land size, the land size planned for forage production purpose will be large and if it is a small land size then the part that is used for forage production will be small. This hypothesis indicates that the land size has positive linkage with forage production and its technology adaptation. The assigned value of 1 is for 10 acres or less, 2 for 11 to 20 acres, and 3 if greater than 20 acres for this study.

Membership to forage producing and participating group

If the households were put together in the form of a group, it helps both the pastoralist and the government body to provide facilities, credits, extension and information which makes it easy both for practice and adoption of the new technology in the community (Salasya et al., 1996). According to previous studies, the data for this case, sharing of experience was estimated to have positive impact on adaptation of technology. The assigned value placed on membership of the household for different social and governmental groups are as follows: 1 = for members to such groups, while 0 = for non-members of a group.

Household herd size

The number of livestock in a certain family is a symbol of financial status of that family and we hypothesized that participation in forage production with adoption of new technology has a direct positive linkage with such livestock number in such family. It was measured in terms of TLUs, where 1 TLU valued as 250 kg for mature live animal (Wasonga, 2009). The study values are given as follows:

one bull is equivalent to 1.29TLU, a cow = 1TLU, a calf = 0.4 TLU and a sheep or goat = 0.11 TLU. TLU conversion was done based on the standardization of different animal kinds and classes into a universal one (Wasonga, 2009).

Access to extension services

Capacity building of pastoralists was done by providing both technical skills and knowledge used as key for easy adaptation and internalization; thus, the emerging technologies and expectation for this study's extension services had positive impact both in the adaptation and implementation of the emerging technology mainly used for forge production. The value based on household accessibility of the offered extension service was assigned as follows: 1 =for household heads with access to extension services and 0 =for household heads with no access to such services.

Application of binary Logit regression model

The expected response of the variables for this study had two values, due to its nature, that is 1 if the respondent was producing forage by using technology and 0 if otherwise. Such variable values were estimated using Logit or Probit models through maximum likelihood approach. Its normal distribution error was assessed using Probit model and a logistic distribution of the error term done by using Logit model, since the parameters show consistency (Ravallion, 2001).

The equations were described by behavioral model here below (Gujarati, 1995).

$$Yi = f(ti) \quad (1)$$

This shows linkage between field observation (f) and its stimuli index (ti) where,

$$t = bo + \sum bi \quad (2)$$

Sum up the ith observation result (Yi) at a given value (1 = producers and 0 = non-producers). Comparison of threshold index (ti*) with the stimuli index (ti), where, ti*>ti indicated that there is more pastoral community involved in forage production by adapting the new technology, and if ti*<ti shows the participation of pastoralist was less. Such involvement of the pastoralist community sum up the equation given below:

$$\{Pi = (e^{ti}) / (1+ e^{ti})\} \quad (3)$$

Determinant factors estimated have impact either directly or indirectly on the involvement of pastoralist on adoption of the technology and can enhance forge production described as follows:

$$Y = \ln\{P(Xi) / (1-(P(Xi)\} = \beta i Xi + \varepsilon_i \quad (4)$$

(Y = shows the ratio of probability of participant (P) with non-participant (1-P) in the adaption of technology to enhance forge production, βi= coefficient of determinant, Xi = estimated impact by the determinant factors and ei= observed error)

The linear regression model for current data re-writes as follows:

$$Y= \beta 0 - \beta 1AGH \pm \beta 2GEH + \beta 3EDH + \beta 4SZL + \beta 5HLS + \beta 6SMFP + \beta 7AES+ \quad (5)$$

The model was described using coefficient of determination (R^2), adjusted with chi square value, ways of impact of the determinant factors on forage production and number of variables.

Multi-collinearity statistical test: Variance Inflation Factor (VIF)

Alignment of variables, using the binary Logit model, which is called multicolliniarity, happens where either two or more independent variables are directly linked. Multicolliniarity ocured when the impact level of the determinant factors where needed (Koustoyiannis, 1973), through testing the Variance Inflation Factor (VIF) and then either by discarded or combined. Some of the factors during analysis developed a thrifty model and the VIF was re- write as follows (Long (1997):

$$VVIIF = 1/1 - RRi^2 \quad (6)$$

(Ri^2= is the R^2 of the artificial regression with the *ith* independent variable as the dependent variable).

RESULTS AND DISCUSSION

Result of multi-colliniarity test

The determinant factor VIF, that is within the interval of 1.051 and 1.886 at a mean of 1.381 as explained below in Table 2. The VIF value were less than five given enough information and explanation in the Logit model (Maddala, 2001), since there was no more impact of multicolliniarity.

Impact of respondents features

The impact of respondents' background features on adoption and internalization of existing technology and its application is explained below in Tables 3 and 4. Age had no significant impact in using the emerging technology to use forager production, where their mean age 50.47±10.28 and 50.94±11.94 years for producers and non-producers, respectively. Whereas, the level of education had showed significant impact on using the emerging technology to use forager production, and the mean of educated year; were 9.14 ± 3.99 and 5.80 ± 4.13 for producers and non- producers, respectively. Pastoralist that had more land size less adapted and practiced the new technology to improved their forage production. This implies that land size had significant impact on adoption of new technology as explained in the table below. Large herd size was 19.97 ± 29.75 TLU and 17.47 ± 25.79 TLU for those who had smaller land size.

As mentioned earlier, among the respondents that participated in adoption of technology and forage production, the male headed were more involved in the new technology and production, which is 74 and 55.3%, respectively. This may have resulted from involvement of those respondents within a certain community and group participation (74 and 23.5%) producers and non-producer respondents (Table 3). According to the data obtained from the respondents, those highly involved in both adaptation and practice of the new technology had the chance to access skill up training and services provided by the concerned body as compared to those respondents who did not practice; with a proportion of 78.6 and 18.8%, respectively. Those listed variables in Table 3 directly or indirectly impact on the adaptation, internalization and practice of the new technology, that help to increase both the quality and quantity of forage in Yabello rangeland pastoralist which is in agreement with Kaliba et al. (1998).

Data obtained from binary Logit regression

From the determinant factors tested in this model,

Table 2. Multicolliniarity test for the explanatory variables included in the model.

Variable	Tolerance (1/VIF)	VIF
Age	0.776	1.288
Gender	0.951	1.051
Education	0.706	1.416
Household land size	0.530	1.886
Group membership	0.797	1.254
Household herd size	0.724	1.381
Access to extension services	0.718	1.392
Mean VIF	-	1.381

Table 3. Statistical explanation (mean value) of the estimated determinant factors in the model.

Variable		Producers(N=1 31)	Non-producers (N=85)	Chi- square	p- value
Age of respondents		50.47±10.28	50.94±11.94	47.684	0.526
Years of education		9.14±3.99	5.80±4.13	53.699*	0.000
Household land size (acres)		33.93±41.54)	48.72±57.54	96.620*	0.007
Household livestock number (TLU)		19.97±29.75	17.47±25.79	53.373	0.421
		Frequency (%)	Frequency (%)		
Gender of households head	Male	97 (74.0)	47 (55.3)	8.157*	0.004
	Female	34 (26.0)	38 (44.7)		
Community envelopment	Yes	97 (74.0)	20 (23.5)	52.989*	0.000
	No	34 (26.0)	65 (76.5)		
Skill up service availability	Yes	103 (78.6)	16 (18.8)	74.518*	0.000
	No	28 (21.4)	69 (81.2)		

Table 4. Logit model estimates for the determinants of household's participation in forage production.

Variable	β	Wald	Exp (β)	Marginal effect	p-value
Age	-0.034 (0.021)	2.688	0.966	0.008 (0.005)	0.104
Gender	0.878** (0.420)	4.367	2.407	0.200 (0.976)	0.040
Education	0.141* (0.052)	7.326	1.151	0.003 (0.115)	0.007
Household land size	-0.007 (0.005)	1.537	0.993	-0.001 (0.001)	0.217
Household herd size	0.015** (0.008)	2.988	1.015	0.003 (0.002)	0.085
Group membership	1.318* (0.403)	10.699	3.736	0.289 (0.085)	0.001
Access to extension service	2.333* (0.414)	31.706	10.306	0.492 (0.074)	0.000
Constant	-1.235 (1.340)	0.850	0.291	-	-

Statistical significance level: *1%, **5% and ***10%; Chi-square (DF=7) = 117.99 (p<0.001); -2log likelihood=171.577; Cox and Snell R^2 = 0.421; Nagelkerke R^2 = 0.570; N=216; Standard error in parentheses.

majority of them showed significant impact on adaptation of technology and practice to improve their way of life. The respondents participation were highly impacted on forage production quality and quantity, that is 57% (R^2= 0.57). In the study area, practice and production of forage are mainly done by males in the households, due to past cultural trends; thus, gender has positive impact ($p<0.05$) on their participation. This resulted to difference in wealth ownership and division between the males and females in the house. Man showed dominance on basic resources like land, livestock and finance (Olila, 2013). In addition, this finding could be associated with the high labor requirements of the practice and the domestic responsibilities of women in the societies which lead to limited time to obtain different skill up workshop training and awareness creation access (Kidake et al., 2016).

However, this implies that if the envelopment and participation of both male and female become balanced, there will be more chance for adaptation of the technology and there will be change in their method through improving the forage production needed by the livestock.

As seen from the data, if the respondent's level of education is high, participation and risk taker of the household to adapt and practice the new technology will be high. This means that the level of normal education within the household have significant ($p < 0.05$) impact on the likelihood improvement through modernize fodder production compared with none or less educated family members. Inclusion of respondents and government awareness creation also had significant ($p < 0.01$) impact on both adaptation and practice of the new technology to change their way of life. In general, those who had the chance to access that service showed better skill to adopt and implement the emerging technology and improve their living standard. Groups had the chance to adapt and practice the new technology more (49%) as compared to individuals (29%). This is due to the fact that groups are given priority for awareness creation and skill service regarding different benefits related to labor, time and financial cases (Olila, 2013). Such services would be offered to governmental or non- governmental bodies for the pastoralist found in Yabello rangeland area. On the other hand, respondents who had more number of livestock have more initiation to adapt and practice new technology for forage production in order to support their large number of livestock. This implies the number of livestock also had significant ($p < 0.05$) impact on practice technology. The Alarming rate of climate change was conceded as the primary case for loss of natural forage and following the challenges for supporting huge number of livestock. This has led to adapting and practicing alliterative technology, which has led to avoidance of pastoralist mobilization for those who have more livestock as a result of shortage of forage. Currently, mobilization restriction has been developed due to different cases. This situation could be regarded as a catalyst for development of forage farms by livestock keepers with larger herds.

Conclusion

In general, the result of the present study indicated that gender, participation of governmental and non-governmental awareness creation stage, as well as facilities and extension services are root case factors that impact adaptation and participation of forage production of the respondents in Yabello. Those who are involved in the above facilities take higher risk and are committed to practicing new technology that help to improve forage production and their way of life in the long run. This is due to the fact that, extension workers and other supporting organizations prefer to reach out to the producers through organized groups. On the basis of the results of this study, interventions aimed at facilitating households' participation in forage production should support formation and strengthening of forage producing groups as a way of enhancing information sharing, as well as increasing producer's access to agricultural information and extension services. So, based on this finding, it is recommended that precipitation in any given extension service and other awareness creation combined with their background knowledge can help change their way of life with the ultimate goal of ensuring sustainable and efficient forage production for livestock in the dry season.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interest.

REFERENCES

Alemayehu M (2003). Country Pasture/Forage Resource Profiles. Food and Agriculture Organization of the United Nations (FAO). Web site: http://www. fao. org/ag/agp/agpc/doc/counprof/ethiopia/ethiopia. htm

Alemayehu M (2004). Rangelands Biodiversity: Concepts, Approaches, and the Way Forward. Addis Ababa, Ethiopia.

Ayana A, Gufu O, Adunya T (2012). Bush Encroachment Control Demonstrations and Management Implications on Herbaceous Species in Savannas of Southern Ethiopia. Tropical and Subtropical Agroecosystems 15:173-185.

Billi P, Alemu Y T, Ciampalini R (2015). Increased frequency of flash floods in Dire Dawa, Ethiopia: Change in rainfall intensity or human impact? Journal of Natural Hazards 76(2):1373-1394.

Dalle G, Maass BL, Isselstein J (2015). Rangeland condition and trend in the semi-arid Borana Lowlands, southern Oromia, Ethiopia [J]. African Journal of Range & Forage Science 23(1):49-58.

Daniel J (2010). The extent of Bush Encroachment and Its Impacts on Selected Soil Properties in Borana Rangeland, Ethiopia. MSc. Thesis, Hawassa University Wonndo Genet College of Forestry and Natural Resources, Integrated Watershed Mangement.

Gemedo-Dalle T, Isselstein J, Maass BL (2006). Indigenous ecological knowledge of borana pastoralists in southern Ethiopia and current challenges. International Journal of Sustainable Development and World Ecology 13(2):113-130.

Gujarati DN (1995). Basic Econometrics.4th. Edition. MacGraw-Hill, inc. New York pp. 100-343.

Hasen YM (2013). The influence of land use and cover changes on the pastoral rangeland systems of southern Ethiopia - How much woody cover is enough? Ph.D. Thesis, University of Hohenheim.

Joosten K, Ekodere P, Miano G (2014). Best Practice Brief- Fodder production in Baringo County. Article available at: http://asalsmarkets.wikispaces.com/file/view/Best+practice+brief++Mayiani+fodder+gro up+(2).pdf. Accessed on 13/03/2017.

Kaliba AR, Verkuijl H, Mwangi WM, Mwilawa AJ, Anandajayasekeram P, Moshi AJ (1998). Adoption of maize production technologies in central Tanzania. CIMMYT Retrieved from: http://www.tanzaniagateway.org/docs/adoption_of_maize_production_technologies_in_ central_tanzania.pdf. Accessed on 17/10/2016.

Kassahun A, Snyman HA, Smitt GN (2008). Livestock grazing behaviour along a degradation gradient in the Somali region of eastern Ethiopia. African Journal of Range and forage Science 25(1):1-9. Retrived from: http://www.tandfonline.com/doi/abs/10.2989/AJRFS.2008.25.1.1.379. Accessed on 11/12/2015.

Kidake BK, Manyeki JK, Kubasu D, Mnene WN (2016). Promotion of range fodder and fodder production among the pastoral and agro-pastoral communities in Kenyan rangelands: Experiences and lessons learnt. Livestock Research for Rural Development 28. http://www.lrrd.org/lrrd28/8/kida28151.html

Long J (1997). Regression models for categorical and limited dependent variables. Thousand Oaks, CA: Sage Publications.

Koustoyiannis A (1973). "Theory of Econometrics." Macmillan Press Ltd.

Lugusa KO (2015). Fodder Production as an Adaptation Strategy in the Drylands: A Case Study of Producer Groups in Baringo County, Kenya. MSc Thesis, University of Nairobi.

MacOpiyo L, Irungu P, Elhadi YM (2013). Study of Livestock, Fodder, Milk Production And Marketing In Arid And Semi-Arid Lands Of Kenya Under - "Promotion And Strengthening Enterprises And Market Systems In Drought-Prone ASAL Areas" Baseline Report For Kajiado, West Pokot and Narok Counties.

Maddala GS (2001). Introduction to Econometric, 3rd edition. Wiley and Sons Inc., 32 p.

Manyeki JK, Kirwa EC, Ogillo PB, Mnene WN, Kimitei R, Mosu A, Ngetich R (2015). Economic analysis of natural fodder rehabilitation through reseeding in the southern rangelands of Kenya. Livestock Research for Rural Development 27:49.

Muyanga M (2008). Household Vulnerability to Transient and Chronic Poverty: Evidence from Rural Kenya. Tegemeo *Working Paper* No. 21, Tegemeo Institute of Agricultural Policy and Development, Egerton University.

Nyaoga RB, Magutu PO (2016). Constraints management and value chain performance for sustainable development. Management Science Letters 6(2016):427-442.

Olila DO (2013). Economic Evaluation of Factors Affecting Farmers Participation in Development Groups: A Case of Trans-Nzoia County, Kenya. Journal of Agricultural Economics, Extension and Rural Development: ISSN-2360-798X: 2(6):074-081.

Omollo EO (2017). Analysis of fodder production and marketing in the Rangelands of southern Kenya (unpublished data).

Ravallion M (2001). "The Mystery of the Vanishing Benefits: An Introduction to Impact Evaluation. "The World Bank Economic Review 15(1):115 -140.

Salasya B, Odendo M, Odenya J (1996). Adoption of improved sorghum and other Production technologies in Busia District Kenya. Proceedings of the 5th KARI scientific conference.

Tilahun A, Teklu B, Hoag D (2017). Challenges and contributions of crop production in agro- pastoral systems of Borana Plateau, Ethiopia. Pastoralism 7(1):2.

Wasonga VO (2009). Linkages between Land-use, Land Degradation and Poverty in Semi- Arid Rangelands of Kenya: The Case of Baringo District. PhD Thesis, University of Nairobi.