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Challenges and contributions of crop production in agro-pastoral systems of Borana Plateau, Ethiopia

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Abstract

Uncertain climatic conditions, reduced access to grazing land and water, and reduced mobility affect the sustainability of livestock systems in Ethiopia. As a result, pastoralists look to other sources of income, including crop production, to reduce their vulnerability to changes. There is disagreement about whether integrating crops into pastoralist systems will be a positive experience. Therefore, this study investigated the challenges and contributions of crop production from Borana agro-pastoralists in southern Ethiopia. A multistage sampling technique produced surveys from 60 households. The collected data showed that Borana agro-pastoralists were highly involved in crop cultivation as one promising alternative means of livelihood but participants held strongly to traditional mobile herding regimes. A majority of the respondents (68%) replied that crop cultivation increases availability of grain and feed sources (straw), thereby improving their food security and minimizing morbidity and mortality loss of animals during the dry season. However, most respondents indicated that livelihood activities were influenced by a number of internal and external factors, most importantly low rainfall, pests, and the lack of inputs and markets. The study concludes there is a greater need of agro-pastoralist participation in crop cultivation to enhance their livelihood.

Keywords: Borana, Challenge of cropping, Livelihood diversification, Feed resources

Introduction

Pastoralism is a way of life based on raising livestock, particularly cattle, small ruminants, and camels. Pastoral systems are important to many people in Africa's vast arid and semi-arid areas (African Union 2010) where the availability of rainfall is unpredictable and erratic. For example, in Ethiopia, arid and semi-arid areas account for 60% of the total available land and pastoralism is the sole means of living for about 10% of the total population (Tegegne et al. 1999; Hogg 1997). More than one million people derive their living from pastoralism in the Borana region in Ethiopia and Kenya, one of the most famous examples of sustained pastoralism in the world (Helland 2001). However, even such strongly established systems are vulnerable to economic, political, demographic, and environmental factors that force locals to search for additional ways to

earn an income as they watch historical pastoralist traditions fade over time (Fratkin 2001).

As opportunities in pastoralism decay, livestock holdings per household declines, increasing the gap between rich and poor (Teklu et al., 2015 Factors constraining livestock mobility and their implications on rangelands and livelihood of Borana pastoralists, Forthcoming). Crop production is one of the major sources of income diversification available to pastoralists and ironically one of the most important competitors to the pastoralist way of life (Tache, B., 2000. Individualizing the Commons: Changing resource tenure among the Borana Oromo of southern Ethiopia, unpublished). Introduction and expansion of cropping activities in pastoral lands is ongoing in Ethiopia, particularly in the Borana Plateau (Tache, B., 2000. Individualizing the Commons: Changing resource tenure among the Borana Oromo of southern Ethiopia, unpublished; Oba, G. 1998. Assessment of indigenous range management knowledge of the Booran pastoralists of southern Ethiopia). Ethiopian policy-makers generally accept and support pastoralist transitioning to more, if not all, crop production (Mohammed,

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M., 2004. A comparative study of pastoralist parliamentary groups: Case study on the pastoral affairs standing committee of Ethiopia, unpublished).

Cropping is a controversial option for pastoralists in Ethiopia. On the one hand, government studies argue that transforming pastoralism to a sedentarized farming system diversifies pastoralists' income, enables them access to modern education and health, provides manure fertilizer, increases feed availability, minimizes the need of animal slaughtering for food, and ultimately improves livelihoods (Mohammed, M., 2004. A comparative study of pastoralist parliamentary groups: Case study on the pastoral affairs standing committee of Ethiopia, unpublished; Fratkin and Smith 1995; Smith 1999). While Coppock (1994) and Angassa and Oba (2008) argue that expansion of crop cultivation into pastoral areas has constrained mobility by removing the most productive lands from the grazing herds and has eroded pastoralist populations. Furthermore, shifting to crops is difficult due to a shortage of labour lack of sufficient traction animals, and unreliable rainfall to cultivate crops. As a result, these authors argue, sedentarized farming systems mean the pastoral community becomes poorer than under traditional pure pastoralist systems.

The contrast in studies that examine the future of pastoralism highlights the need to understand more about the contribution and challenges of crop cultivation, crop income, crop residue management, and feeding systems in pastoralist systems. Despite the rapid changes in pastoral systems in Southern Ethiopia, particularly in the Borana region, there is little published about how individual pastoralists see the costs and benefits of adding a cropping component to their households. Little is known, for example, about the contribution of crop production to the household or how additional fertilizer and crop residues might benefit the household. Accordingly, based on an in-person household survey, the objectives here are (i) to identify major determinants of crop production in pastoralist households and (ii) to assess the contribution of crop production to the household economy of agro-pastoral communities.

Study area

The study area is located in the southern part of the Ethiopian lowlands, between 3°36' and 6°38' north

latitude and 3°43' and 39°30' east longitude. The total land area is approximately 95,000 km², ranging in elevation from 1,000 to 1,600 m above sea level (McCarthy et al. 2002). The climate is arid and semi-arid. Rainfall is bimodal, with a long rainy season from March to May and short rains from September to November, followed by a long dry season. Rainfall is variable with strong effects on range productivity. Average annual rainfall varies from 353 to 873 mm (McCarthy et al. 2002). Droughts occur once every 5 to 10 years Coppock (1994). The Borana Zone consists of eight districts covering 275 'Gendas' (the lowest administrative unit), with 19 urban centres, of which 10 have an official town administration. According to a new organizational structure, the Borana Zone has been divided into two zones, the Borana and Gujji. The Borana Zone is the southern part and has eight districts, namely Gelana, Abaya, Bule Hora (the previous Hagera Mariam), Yabello, Arero, Moyale, Dire, and Teltele; Yabello is the zonal capital (Additional files 1, 2 and 3).

Methods

A multistage sampling technique was employed to select sample households and collect the necessary data for the study (Table 1). In the first stage, two representative districts, Yabello and Dire (Figure 1), were selected. The sample covers over 15% of the Borana Zone and represents agro-pastoral communities where crop farming is widely practised. In the second stage, peasant associations (PAs) in each district were systematically categorized into agro-pastoral and pastoral on the basis of their livelihood system, as determined from a reconnaissance survey and discussions with district-level pastoral development government offices. In the third stage, four peasant associations (4PAs) were selected randomly and then households in each selected PA were categorized into three socio-economic classes, i.e. rich, medium, and poor (locally determined by number of livestock owned, size of cultivated land, and other capital assets). With a sample of about 5% of the total households in the 4PAs (total number households is estimated to be 1,184), the total sample size was 60 households. Accordingly, 15 households were chosen from each of the four selected PAs; the 15 sample households were distributed by the three socio-economic classes in each PA as shown in Table 1. Finally, a random

Table 1 Household groups in wealth categories for sampled agro-pastoralists in the Borana Zones 2013/2014

No.	District	PAs selected	Households by wealth class		
			Rich	Medium	Poor
1	Yabello	Did-yabello	3	5	7
		Obda	3	7	5
2	Dire	Holi-Samoro	3	5	7
		Aromso	3	5	7
Total			12 (20%)	22 (36.7%)	26 (43.3%)

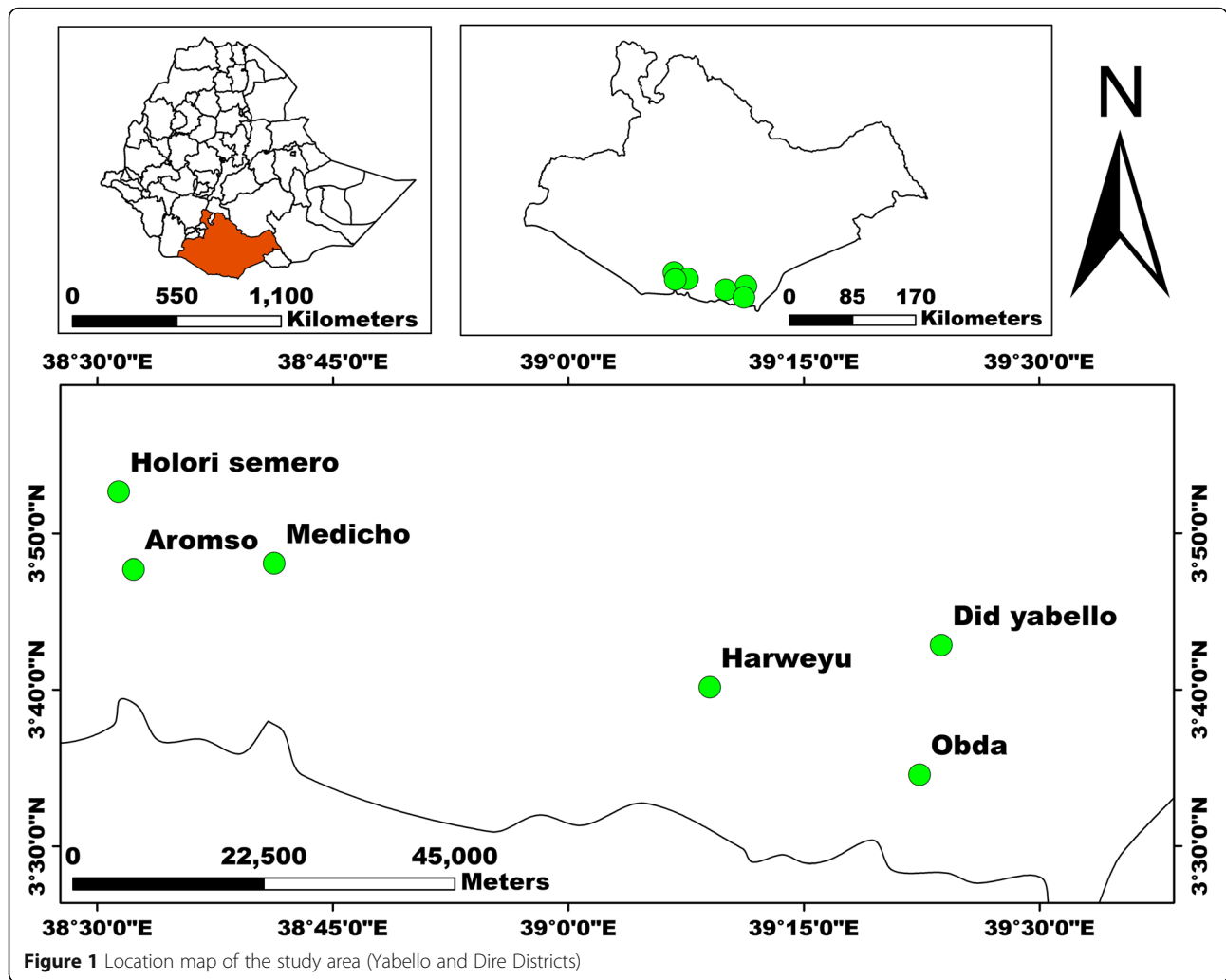


Figure 1 Location map of the study area (Yabello and Dire Districts)

sampling method was used to select the sample households from each socio-economic class in each of the four PAs for the detailed household survey, in order to balance the sample across our regional and social strata in proportions reflective of the whole community.

A semi-structured questionnaire was prepared and translated into the local language (*Afan Oromo*). The questionnaire was pre-tested in two households from each PA. The questionnaire was amended based on the feedback from the pre-test. Four data enumerators were trained on appropriate data collection methods and norms for approaching respondents. The survey was administered through interviews. For a more complete picture of the agro-pastoralist livelihood in relation to the research problem, separate focus group discussions (FGDs) also were conducted. Two FGDs, one in each district, with 8 to 10 participants were organized; each represented all socio-economic classes, both genders, and participation by the Ministry of Agriculture and local *Genda* Administration.

Table 2 Sex, age, and educational status of sampled respondents ($n = 60$)

Factors	Classification	Frequency	Percent
Sex	Male	53	88.3
	Female	7	11.7
	Total	60	100.0
Age	18 to 25	5	8.3
	26 to 35	12	20.0
	36 to 45	18	30.0
	>45	25	41.7
	Total	60	100.0
Educational level	Illiterate	32	53.3
	Primary school	22	36.7
	Secondary school	4	6.7
	Higher	2	3.3
	Total	60	100.0

Table 3 Socio-economic characteristics (mean \pm SD) of the sampled respondents 2013/2014

Variables	Wealth categories						Total	
	Poor		Medium		Rich		N	Mean \pm SD
	N	Mean \pm SD	N	Mean \pm SD	N	Mean \pm SD		
Household size (no.)	26	6.46 \pm 2.59	22	7.36 \pm 2.48	12	8.75 \pm 2.96	60	7.25 \pm 2.72
Cultivated area (ha)	26	1.08 \pm .622	22	2.59 \pm 1.69	12	3.33 \pm 1.97	60	2.12 \pm 1.68
Total cultivated crop production (kg)	26	515.31 \pm 606.53	22	1061.36 \pm 949.18	12	1191.67 \pm 1107.17	60	850.80 \pm 891.55
Total livestock (no.)	26	14.58 \pm 12.91	22	45.91 \pm 33.46	12	141.00 \pm 76.12	60	51.35 \pm 61.57

N number of respondents, SD standard deviation

The socio-economic characteristics and sources of livelihood strategies in relation to household groups (i.e. rich, medium, and poor), key household external and internal factors constraining crop production, were collected through the household survey and focus groups. Data analysis includes descriptive statistics, such as mean value, percentage, crosstab, and frequency. A chi-square test was used to examine the relationship between demographic factors (i.e. educational level, sex, and age), wealth categories according to livestock numbers, and crop residue biomass increments that followed crop cultivation practices. Finally, data were ranked using index analysis to determine the importance of individual attributes.

Results

As shown in Table 2, 53 men (88.3%) and 7 (11.7%) women were interviewed. The age of the respondents ranged from 18 to over 45 years. Just over half, 53.3%, were illiterate (Table 2).

Demographic and socio-economic characteristics

As shown in Table 3, socio-economic characteristics of the agro-pastoralists vary based on their wealth categories. Accordingly, the average cultivated land holding was significantly higher for richer compared to poor households and ranges from 1.9 to 3.3 ha and 0.6 to 1.1 ha for rich and poor respondents, respectively, whereas the average number of livestock ranges from

76 to 141 and 12 to 14 (in number) for rich and poor respondents, respectively (Table 3).

Livelihood strategies of the agro-pastoralists

As shown in Table 4, the households had diversified income sources. Raising livestock (92%) and crop production (90%) were the most important income sources, but livestock trade, causal labour, and remittances have also become important (contributing 18%, 8%, and 15% of the total income for the households, respectively). Participants in the focus group discussions explained that their cultivated cropland included maize, haricot beans, teff (*Eragrostis tef*, a type of cultivated grain), wheat, and barley. In some cases, vegetables were cultivated.

Major factors affecting crop production

Choice of crop cultivated involvement in crop cultivation, productivity, and livelihood activities are influenced by a number of internal and external factors as presented in Table 5. According to respondents, the major factors constraining crop production are external and include lack of rainfall (the rainfall pattern is highly erratic and rains often do not occur at the expected time), presence of different harmful agricultural pests, and lack of access to well-functioning markets. Some internal constraints are lack of agricultural inputs and land competition (Table 5). During the group discussion with key informants, participants stated that rainfall shortages (both during the long and short rainy seasons),

Table 4 Livelihood activities adopted by the sampled Borana agro-pastoral households ($n = 60$)

Types of activities	Frequency	Percentage
Animal husbandry	55	92
Crop cultivation	54	90
Livestock trade	11	18
Sale of forest products	3	5
Causal labour	5	8
Rental house in town	4	7
Beekeeping	1	2
Remittance	9	15
Pension allowance	2	3

Table 5 Major factors mentioned by respondents as hindering crop production in the study area

Factors	Frequency	Percentage
Lack of rainfall	54	90
Presence of agricultural pests	41	68
Lack of agricultural inputs	49	82
Lack of capital	3	5
Lack of market accessibility and information	34	57
Land competition	41	68
Increment of population density	29	48
Lack of sufficient training	2	3

Table 6 Benefits of crop production mentioned by respondents (n = 60)

Benefits	Frequency	Percentage
Increase food availability for household consumption	53	88
Diversify income level of the household	56	93
Create social reciprocity networks	12	20
Increase seed availability for planting	41	68
Grain storage for food security	49	82
Create grain loans opportunity	4	6.7
Crop residue used as an alternative feed sources	49	81.7
Increase livestock production and productivity	35	58

Multiple responses

land privatization, decrement (decrease of grazing lands in terms of size), and population growth, as well as issues over climate change, are seen as crucially constraining factors of crop production and productivity.

Contribution of crop cultivation for the livelihoods of agro-pastoral communities

Although livestock production is the dominant mode supporting the respondents’ livelihoods, crop production is also practised to some degree in the two districts covered by the assessment. Many respondents and key informants indicated that the practice is gradually expanding from the agro-pastoral to the pastoral areas. Most of the respondents (Table 6) reported that crop cultivation has brought many advantages for the local communities. On the one hand, cultivation is used as a coping mechanism against drought and, as a source of income, reduces the need for livestock sales for purchasing food and crop residue for livestock feed. On the other hand, many of the respondents and key informants indicated that crop cultivation can undermine their ability to cope with drought because cultivated areas usurp key grazing areas and, of course, yields little or no food when rainfall is low. Our secondary data confirms incremental cropland coverage in both districts from the 2011/2012 to 2012/2013 years (Figures 2 and 3).

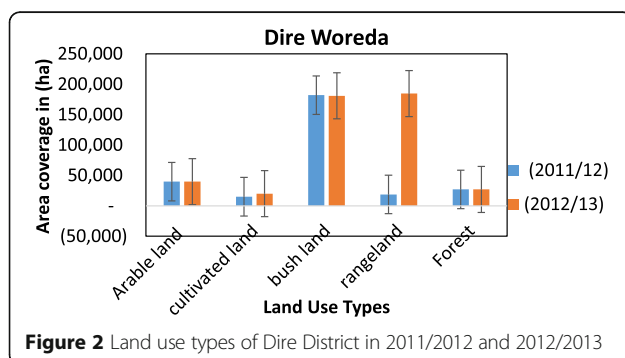


Figure 2 Land use types of Dire District in 2011/2012 and 2012/2013

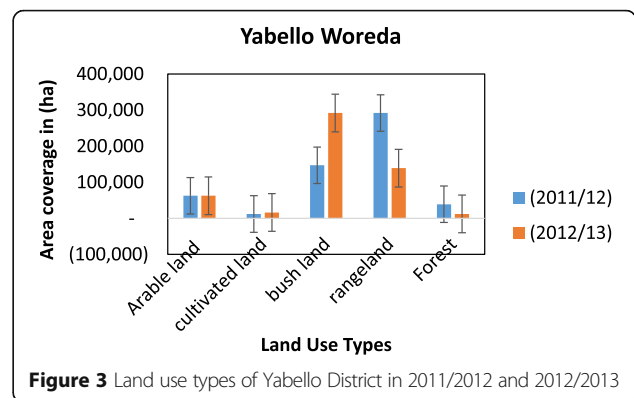


Figure 3 Land use types of Yabello District in 2011/2012 and 2012/2013

As shown in Table 7, 68% of respondents replied that crop cultivation increases their food availability, whereas 32% did not report benefiting from these activities due to failed crop production from lack of rainfall and prolonged droughts. The respondents were also asked if they could increase livestock owned and if they had better livestock feed availability when they have cultivated crops. About 80% and 75% of respondents, respectively, felt cultivation offered these benefits, especially concerning milking cows and oxen.

A chi-square test showed there was a significant relationship between wealth of households and livestock owned when participants engage in crop cultivation, while there was no significant difference between gender, educational level, and age class (Table 8). We also analysed the relationship between demographic factors and availability of crop residues for livestock feed. A chi-square test showed that there was a significant relationship for the wealth category and gender of households (i.e. crop residues), but there was no significant difference for educational level and age class (Table 9).

Feed sources, feed management, and feeding systems

The use of livestock feed resources varied between rainy and dry seasons, with respect to quantity and type of feed (Tables 10 and 11).

Crop residues play a vital role as a source of livestock feed. However, prolonged drought and political insecurities, including civil war and ethnic conflict, have all affected the ability of pastoralists to keep their herds on pastures, and thus created a niche for crop residue as an important alternative feed source for their livestock. With respect to crop residues and stubble grazing, the results show that maize (85%) took a leading role and was followed by teff (61.7%) amongst produced crops in the area (Table 12). Maize and teff are produced extensively in the region, and the residue is palatable for livestock as reported by key informants during group discussion.

Table 7 Relationships mentioned by respondents between crop cultivation and livelihood improvements

Activities	Responses	Frequency	Percentage
Increase food availability	Yes	41	68
	No	19	32
Livestock number increment	Yes	48	80
	No	12	20
Increases feed availability	Yes	45	75
	No	15	25

During group discussion with key informants, they stated that there is satisfactory potential of feed sources in the Borana Zone to supply both dry season and wet season feed demands, including natural pasture, diversified browser species, subsistence crop residues, and stubble grazing from cropland, especially during the early dry season. However, livestock production was constrained by not having year-round feed supply, both in quality and quantity across the study area. Furthermore, key informants commented that they have currently received different training from both governmental and non-governmental offices on how to conserve and use crop residues, especially during the dry season.

Discussion

The results of our survey showed that the agro-pastoralists in Borana communities are highly involved in crop cultivation as a response to environmental changes, population growth, and changing political conditions. In addition, studies by other authors have indicated that uncertain climatic conditions, reduced access to

Table 8 Chi-square statistics of the relation between demographic factors and livestock owned following crop cultivation practices

Demographic factor		Livestock owned followed crop cultivation					
		Yes	No	χ^2	df	Probability	Sig.
Wealth category	Rich	11	1	7.442	2	.024	*
	Medium	20	1				
	Poor	18	9				
Gender	Male	45	8	3.183	1	.074	ns
	Female	4	3				
Educational level	Illiterate	23	9	4.651	3	.199	ns
	1st school	20	2				
	2nd school	4	0				
	Higher school	2	0				
Age	18 to 25	3	2	3.532	3	.317	ns
	26 to 35	11	1				
	36 to 45	16	2				
	>45	19	6				

ns not significant, *significant at $p = 0.05$

Table 9 Chi-square statistics of the relation between demographic factors and using crop residue as livestock feed

Demographic factor		Do you use crop residue as livestock feed source					
		Yes	No	χ^2	df	Probability	Sig.
Wealth category	Rich	11	1	14.081	2	.001	*
	Medium	20	1				
	Poor	14	13				
Sex	Male	43	10	9.111	1	.003	*
	Female	2	5				
Educational level	Illiterate	21	11	3.682	3	.298	ns
	1st school	19	3				
	2nd school	3	1				
	Higher school	2	0				
Age	18 to 25	3	2	4.243	3	.236	ns
	26 to 35	7	5				
	36 to 45	16	2				
	>45	19	6				

ns not significant, *significant at $p = 0.05$

grazing land and water, and reduced mobility threatens the sustainability of livestock systems in Ethiopia. As a result, pastoralists look to other sources of income, specifically crop production, to reduce their vulnerability to these new changes (Fratkin 2001; Fratkin and Robin 2003). Authors are divided on the merits of integrating more cropping into pastoralist regimes, but our data indicated growth and interest in cropping. For example, a recent study on pastoralists from northern Afar, Ethiopia, reported that livestock rearing and crop production were the main income sources for the agro-pastoralist household groups (Tsegaye et al. 2013).

Over two thirds of respondents replied that crop cultivation contributes an integral part of their livelihood, as far as food production is concerned. In general, crop cultivation plays an integral part in the improvement of the Borana agro-pastoralists' livelihoods, including increased feed availability for their livestock production and productivity. According to Adugna and Aster (2007), studies in the Dire District of Borana Zone

Table 10 Respondents' rank of using different feed resources during the wet season in the study area (%)

Types of feed sources	Rainy season			
	VI	IM	LI	NI
Natural pasture	58.3	25	16.7	–
Crop residue	–	–	13.3	86.7
Browse species	88.3	1.7	–	10
Stubble grazing	–	–	38.3	45

VI very important, IM important, LI less important, NI not important

Table 11 Respondents' rank of using different feed resources during the dry season in the study area (%)

Types of feed sources	Dry season			
	VI	IM	LI	NI
Natural pasture	41.7	33.3	8.3	16.7
Crop residue	80	5	–	15
Browse species	38.3	–	–	61.7
Stubble grazing	95	16.7	5	–

VI very important, IM important, LI less important, NI not important

showed that cultivated land, pastureland, and bush land cover 1.2%, 27.5%, and 33% of the total land area of the district, respectively. Whereas the current status indicated that cultivated land accounts for 4.4% of the total area of the districts (Figure 2). Similarly, in the Yabello District, the area covered by crop cultivation showed a slight difference in the years of 2011/2012 and 2012/2013. This finding is also supported by Coppock (1994). Crop production is a recent experience for most pastoralists of the southern rangelands and is increasing over time.

The major factors constraining crop production in the Borana Zone include lack of rainfall, grazing land decrements, presence of different harmful agricultural pests, lack of access to well-functioning markets, population growth, lack of agricultural inputs, land competition due to crop cultivation, and issues over climate change. Similarly, Coppock (1994) indicated that the Borana system appears to be becoming more unstable and less reliable for supporting livelihoods due to both external and internal factors. Despite these problems, key informants stated that if the production activity is properly handled, crop and livestock production can complement each other as sources of food and cash income. In this way, if grain is produced on each farm, there is reduced need for selling animals to buy grain for human consumption or slaughtering animals as sources of food. Thus crops can supplement the family diet and cash income of the agro-pastoralists. Moreover, crop residues can be used as feed for animals and the manure can be used as a fertilizer, thereby enhancing soil fertility and crop

Table 12 Preference ranking by respondents of crop residue and stubble grazing for livestock in the study area (%)

Types of crop residues	Respondents preference (n = 60)			
	VI ^a	IM ^a	LI ^a	NI ^a
Maize	85	3.3	–	–
Haricot bean	35	–	–	5
Wheat	31.7	–	3.3	3.3
Teff	61.7	5	–	–

VI very important, IM important, LI less important, NI not important

production. Animals also provide traction power for land cultivation for crop production.

In addition to various benefits of crop production, a majority of respondents indicated that crop residues play a fundamental part in increasing livestock feed availability for them, especially during the dry season. According to Williams et al. (1997), crop residues are considered as by-products in crop production but are a vital source of livestock feed in the mixed crop-livestock system. In addition, some respondents explained that currently they have gained substantial knowledge and skills from local government offices and from the local communities about conservation mechanisms and feeding systems.

Conclusion and recommendation

This study was designed to evaluate the challenges and contribution of crop production in the agro-pastoralist region of the Borana Zone in Southern Ethiopia. In the Borana area, there is a general trend of shifting from a pure pastoral to an agro-pastoral production system. Likewise, we found that crop cultivation is one means of creating additional income and plays an integral part in the livelihoods of agro-pastoralists. As many respondents indicated, crop cultivation provided many advantages. Currently, the agro-pastoralist communities harvest a substantial production of both grain and crop residues. They have started practising crop conservation activities like haying the crop residue to overcome dry season feed shortages. A shortage of and erratic nature of rainfall, frequently recurring droughts, and population growth are the main constraints affecting crop production in the study area.

Furthermore, as indicated by a substantial number of respondents, a lack of market accessibility and information, land competition, lack of agricultural inputs, and presence of agricultural pests were also mentioned as hindering crop production. Even though the agro-pastoral communities have received training, more training in hay-making techniques and providing them with appropriate tools or any logistic support would contribute to reducing problems related to livestock feed shortages during the dry season. This would help improve food security and the livelihood of the pastoralists by preventing or at least minimizing morbidity and mortality losses of animals during the dry season.

Currently, agro-pastoralists are engaged in crop production as one alternative means of their livelihoods. Therefore, they need to be supported by logistical and/or capacity-building programmes on farming techniques and suitable species and varieties of crops to increase the production and productivity of crop production. Moisture stress is the major limiting factor for crop production in the study area. Thus, the use of early maturing varieties and moisture conservation techniques are possible

strategies to alleviate the problems. However, the expansion of cultivation in rangelands should be viewed with caution. In addition, market-related issues and land competition were identified as major constraints. Accordingly, there is a need for more conducive market access and provision of market information for pastoral communities about credit, supply of agricultural inputs, and conducive market areas for exchange.

Additional files

Additional file 1. The area of Borana Zone which was assessed by this study. (PDF 1369 kb)

Additional file 2. The area of Borana Zone which was assessed by this study. (PDF 1416 kb)

Additional file 3. The area of Borana Zone which was assessed by this study. (PDF 1003 kb)

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Authors' contributions

AT and BT contributed to the conception, design, data collection, and analysis and drafted the manuscript. Furthermore, AT and BT contributed the questionnaire design, conducted the pilot, participated in data collection, provided information about the study area, and proofread the manuscript. DH provided professional and technical guidance in the conception and the overall structure of the manuscripts. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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