ISRG Journal of Agriculture and Veterinary Sciences (ISRGJAVS)

ISRG PUBLISHERS
Abbreviated Key Title: ISRG. J. Agri.Vet.Sci.
ISSN: XXXX-XXXX (Online)
Journal homepage: https://isrgpublishers.com/gjavs/
Volume – I Issue-I (September- October) 2024
Frequency: Bimonthly

CROP PRODUCTION SYSTEM AND CHARACTERIZATION IN WOLAITA AND KEMBATA TEMBARO ZONES OF SNNPR

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| **Received:** 25.08.2023 | **Accepted:** 31.08.2024 | **Published:** 08.09.2024

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Abstract

This study mainly aimed at analyzing crop production system and characterization in Wolaita and Kembata Tembaro Zones. The descriptive statistics was used to analyze the data. Both primary and secondary data were collected from the study area. The multi-stage sampling techniques have been employed for this study. A total of 261 household heads have been randomly selected and interviewed with the help of pre-tested structured questionnaire. The focus group discussion and key informants interviews were conducted to supplement the formal data the traditional category of the study area was about 43.3% midland, 31.4% highland whereas 25.3% was lowland. The main extension approach used in the study area were using demonstration site, school, meeting, individual model farmer, billboard input price post, radio and FTC. Among those FTC approach is more preferred. Gender dynamism in agricultural technology use, male was highly participated in dissemination of extension services as well as during awareness creation on the improved varieties and breeds as compared to that of previous. The livelihood was mainly based on mixed farming system which is both crop production and livestock production with the share of 75% and 25%, respectively. About 84% of the respondents didn't use organic fertilizer like compost whereas only 16% use mainly for their f major staple food crops and vegetables. Therefore, the intervention is needed to improve in the crop production system to enhance production and productivity for better improvement in the livelihood of the farmers.

Keywords: *Crop Production System, Characterization, Descriptive Statistics, SNNPR*

1. BACKGROUND AND JUSTIFICATIONS

1.1. Background

Agriculture is the backbone of Ethiopia's economy. It contributes 36.2 percent of the country's gross domestic product (GDP) and 72.7 percent of employment and 70 percent of export earnings. Food producers, both pastoralists and farmers, are an integral part of the broader farming systems in Ethiopia. They support the livelihoods of a majority of the population, both on and off farms; hence they play an important role in the ongoing economic transformation. Smallholders operating one or more parcels of land, ranging from less than 0.25 ha to 25 ha of land on rare occasions, represent the majority of farmers in Ethiopia (Taffesse et al. 2011).

A farming system is defined as "a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate (Dixon *et al*, 2001). Pasquet (2007) also defined farming system as "a group of intertwined activities and lines of production that a farmer and farm household conduct according to their objectives and needs, depending on changing environmental, economic, technical and cultural conditions and constraints".

A study conducted by Bezabih et al, (2015) in West Shewa zone is located in Oromia National Regional State and, Gurage and Hadiya zones and Yem-Special district located in the Southern Nations, Nationalities and Peoples Region (SNNPR) was limited only to characterization of Vegetable Production and Marketing Systems. No other study was conducted to address the crop production system of Wolaita and Kembata Tambaro Zones of SNNPR, Ethiopia

It was indispensable to undertake crop production system and characterization study that was detrimental factor for agricultural productivity maximization, adopt and promote climate smart and market oriented production in the zones.

Therefore, this study has been focused on characterizing the crop production system in Wolaita and Kembata Tembaro Zones with the aim of producing information on the dynamisms in the crop production system in the last 10 years and, opportunities and constraints in the current crop production system.

2. OBJECTIVES OF THE STUDY

2.1. General objective

The general objective of this study is to explore the changes of crop production systems over time and identify the factors that contributed for the change across the different agro-ecologies

2.2. Specific objectives

The specific objectives are to:

- explore dynamism in crop production system and factors that contribute for the change
- assess availability, accessibility, affordability and trends of technology use practices
- explore responses of the different crop production systems to existing agriculture related policy directions, such as extension services, markets, financial services, infrastructure and others
- Explore gender dynamism in extension services, technology use, resource availability, economic capacities, food availability and other livelihood dimensions

3. METHODOLOGIES

3.1. Sample Size Determination Method

The sample size from each Woreda was determined using the formula of Cochran (1977). The formula is presented as follows:

$n_o = \frac{z^2 pq}{e^2}$

Where:- n = is total large sample size

Z = is the selected critical value of desired confidence level at 90%

P = is the estimated proportion of an attribute that is present in the population (assumed to be the maximum variability, which is equal to 50% (p =0.5) and taking 95% confidence level with 10% sampling error)

q = 1− p and

e = is the desired level of sampling error.

Then the above Cochran formula for restricted population (N) would be adjusted whenever necessary and the final sample size was:

$$n = \frac{\text{no}}{1+(no-1)/N}$$

3.2. Sampling Method

Multistage sampling method was used to select the pre-determined samples from the zone (study area) i.e., respective Woredas were selected based on agro-ecological distinction (highland, midland and lowland agro-ecologies) of each zones with the help of zonal agriculture offices. From each zone, 3 weredas were selected based on the agro-ecological distinctions (1 from each agro-ecology). Accordingly, Boloso Sore, Sodo Zuria and Abala Abaya woredas were selected from Wolaita Zone whereas Danboya and Doyogena Woreda were selected from the Kembeta Tembaro Zone. The sample size from each Kebele was drawn from the lists of sampling frame of the respective kebeles using Probability Proportional to Size (PPS).Therefore, a total of 261 households were interviewed and data was collected and analyzed.

3.3. Method of Data Analysis

The data has been analyzed using descriptive statistics like mean, frequency, chi-square, t-test as well as triangulation of qualitative data.

4. RESULTS AND DISCUSSIONS

4.1. Socio-economic and Demographic Characteristics of the Respondents

Table 1. The Socio-economic and Demographic Characteristics of Sample Households

Variables	N	Min.	Max.	Mean	Std. Deviation
Age of the respondent	261	24.00	82.00	45.75	12.53
Total family size	261	2.00	13.00	6.37	1.97
Education level of the respondent	261	.00	15.00	5.13	4.15
Valid N (listwise)	261				
Valid N (listwise)	261				

Source : Survey Result, 2021

4.1.1. Sex of household respondents

Gender was analyzed by checking the number of male and female headed households. The sample population of farmer respondents considered during the survey was 261. Out of the total households interviewed 90% were male while 10% were female respondents.

4.1.2. Age of the household respondents

The survey on this major demographic factor, measured in years, provided a clue on working ages of households. The mean age of

the sample household heads was 45.75years with the minimum and maximum age of 24 and 82 years, respectively.

4.1.3. Family size

The mean family size of the total sample households was 6.37 persons ranging from 2 to 13 with standard deviation of 12.53 and this might help them for a better participation in agricultural production because of labour availability .According to survey result the average number of active age group between 15 years and 64 years from the sample respondents was 4, family size less than 15 years was 2.45 on average whereas above 64 years was 0.21. This might show that there was availability of labour for agricultural production in the study area.

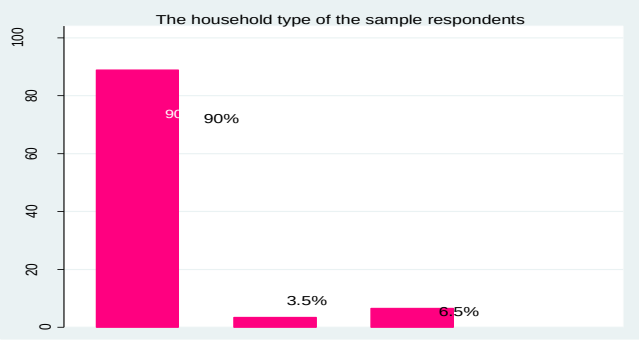

Fig. 1 Household type

The above fig. indicates that about 90% of sample respondents were male headed or monogamous, 3.5% was male headed or polygamous whereas 6.5% was female headed household type.

2.1.1. Education level of the respondents

In the study area according to sample respondents the mean grade level achieved by respondents was about grade 5.1. The minimum grade achieved was grade 1 and the maximum was grade 12.

In both theoretical and practical situations, education level plays an important role in ensuring household access to basic needs such as food, shelter and clothing. Skills and education might enhance the working efficiency resulting into more income and food security.

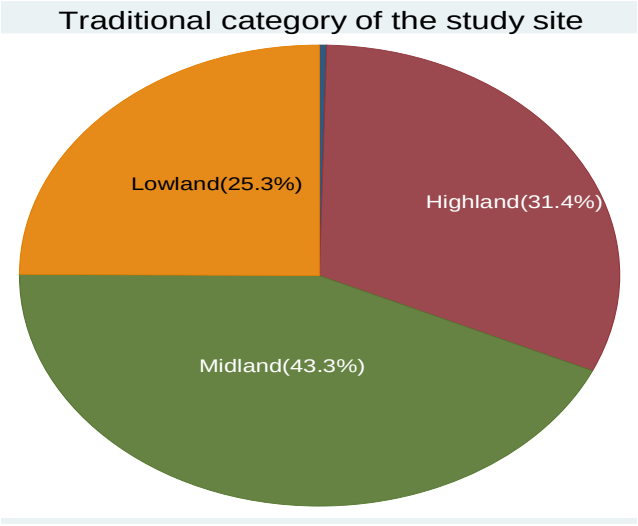

Fig. 2 Agro-ecological zones of the study areas

From the above figure the traditional category of the study area was about 43.3% midland, 31.4% highland whereas 25.3% was lowland. This indicates that the midland agro-ecology was dominant in the study area.

4.2. Access to Land Resources

Table 2 . Land ownership and use particulars for the cropping seasons (2009/10 E.C)

Land ownership and use in ha (mean/standard deviation)	**Zone**	
	Wolaita & Kembeta Tembaro	
	The current	**10 years ago**
Total land owned	0.485 (0.45)	0.52(0.5)
Land covered by annual crops	0.26 (0.27)	0.27(0.29)
Land covered by perennial crops	0.093(.098)	0.092(0.1025)
Land shared-in	0.1225(0.22)	0.091(0.23)
Land shared out	0.06(0.16)	0.04(.098)
Land allocated for grazing/browsing	0.103 (.168)	0.34(2.76)
Land allocated for multipurpose trees	0.065 (0.113)	0.28(2.67)

Source: Survey result, 2021

Land ownership	**Test Value** = 2.08(Mean of total land owned in Timad 10 years ago					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Total land owned in 2009/10 in timad	-1.239	255	.217	-.13938	-.3610	.0822

Source: Survey Result, 2021

The total land size of sampled farmers varies from 0.0325ha to 2.25 ha and the average farm size for sampled farmers is found to be 0.485 ha with standard deviation of 0.45. As indicated in the above table the average land ownership of the sample respondent 10 years ago has been 0.52 ha whereas currently the average land ownership which was reduced to 0.485ha. However, there was no any mean significant difference between the total land ownership of current and 10years ago in the study area.

Table 3. Total land owned in different agro –ecology

Variable	Highland/ Midland(195)		Lowland(61)		Total(256)		t- value
Total land owned in Timad	Mean	SD	Mean	SD	Mean	SD	(-4.9949)***
	1.58	1.48	3.09	1.8	2.2	1.94	

Source, Survey Result, 2021 NS= Non significant

As depicted in the above (table 3) the total land ownership between the highland or midland farmers and lowland farmers has negative and significant mean difference at less than 1% significance level. This might indicate that the total land ownership of farmers in the lowland larger than that of midland or highland farmers. This is due to the fact that as farmers move from lowland to midland or highland, the size of total land holding of the farmers become decreased.

With regards to land ownership almost all sampled households have been obtained land certificate for their own lands in the study area. According to sample respondents about 84.3% of the respondents know the existence of local by-law regarding land administration in their locality while 11.5% those who didn't have information on the existence of local by-law land administration and only 4.2% of the respondents didn't know about local land administration by -law. However, the survey result indicates that the local by-law regarding the land administration in their locality has bean started on average 17 years ago.

According to FGD Land ownership has been only through inheritance from family**.** Due to this land holding is becoming decreasing from time to time as result of high population growth as well as the land administration system does not permit land exchange through purchase/sold. However**,** there is trend of contract farming, in terms of renting and share cropping**.** Land is allocated into different crops based on two common production seasons called Belg &Meher.

4.3. Trends and Dynamics of Technology Use Practice

The farmers' attitudinal change to ward agricultural technology use for the last 10 years is better because the farmer informed that the technology can increase the production and productivity. The trend of technology use is being increased as compared to the last 10 years. According to KI, the intervention of WADU for the last several years has made good opportunity for the farmer to use the agricultural technology and attitudinal change of the farmer in Wolaita.

There is no any problem that hinder the attitudinal change of the farmer toward agricultural technology in the area. Because the farmers are well awared of about the advantages of agricultural technologies that can increase the production and productivity. Due to this there is no cultural. Social and other problems that can hinder the attidunal change of the farmer in the study area.

With regard to the adoption level of agricultural technology and practices. The use of row planting, improved seed and fertilizer has been highly adopted by the farmers due to high contribution toward productivity.

The main communication channels used for agricultural technology transfer in the study area were sending official letter from the woreda to DAs, phone, feedback, command post, meeting at kebele,. Development team (limat budin) is one of the communication channels that mobilizes the farmers and made linkage between the kebele and farmers in agricultural technology transfer. The improved agricultural technology information is also disseminated through the above mentioned method .The effective communication channels are command post approach using mobile however, meeting approach is also taken as the second good approach which helps to get the target population physically.

The main extension approach used in the study area were using demonstration site, school, meeting, individual model farmer, billboard input price post, radio and FTC. Among those FTC approach is more preferred.

The extension system in the study area is better to provide different agricultural technologies such as improved inputs, fertilizer use rate, row planting, seed rate per ha. However, there is challenges of timely provision of improved inputs and pesticides. Pesticides are provided by private which affected the farmer to purchase inputs and leads to incurre high price on farmers. It is better to provide this pesticides through government. The FTC approach is effective in transferring technologies and demonstrates improved agricultural technologies and training. The farmer get information about improved agricultural technologies through DAs. However, access to improved agricultural technologies are poor.

According to FGD the main challenges to agricultural extension system with respect to technology use were high price of inputs, none agro-ecological based input provision and no timely provision of improved seed.

4.4. Gender Dynamism In Technology Use

With regard gender dynamism in agricultural technology use, male was highly participated in dissemination of extension services as well as during awareness creation on the improved varieties and breeds as compared to that of previous. In the gender role male is mainly participated in crop production while females also participate during weeding activity. The post- harvest handling and crop product marketing activities performed by both male and female with male dominance. The FGD indicated that cattle marketing is mainly by male whereas females sell the livestock products in the market but the decision to sell their live cattle has been made by male and female together.

4.5. Crop Production Practice

Table 4. The major crops grown and production practice

Major crops grown	Wolaita and Kembata Tembaro			
	Mean area allocation timad	**Main production season**	**Intercropping crops**	**Crop rotation**
Maize	1.25	Belg	s.potato, faba bean,haricot bean etc	Maize,taro,haricot bean, teff etc
Teff	0.68	Meher		Haricot bean
Wheat	0.79	Meher		Potato,haricotbean,taro,maize
Faba bean	0.58	Meher		Potato, maize,wheat
Potato	0.4	Belg		wheat
Enset	0.37	Belg		potato
Barely	0.6	Meher& irrig.		s.potato, potato, wheat
Soyabean				
Common bean	0.35	Belg, meher & irrig.	maize	Wheat,sweet potato
Taro	0.13	Belg	Maize,haricot bean etc	maize
S. potato	0.13	Meher& irrig.		
Potato	0.426	Belg		

Source: Survey result, 2021

The major crops grown in Wolaita and Kembata Tembaro were maize, teff, wheat, barely, faba bean, potato, enset, sweet potato, potato, taro common bean soyabean, yam tomato cabbage, onion, garlic , head cabbage etc. in both belg and meher production season based on the crop type. The crop production practice in Wolaita and Kembata Tembaro was almost similar farming system as indicated on the above tabeles. According to the sample respondents their livelihood was mainly based on mixed farming system which is both crop production and livestock production with the share of 75% and 25%, respectively. The majority of sample respondents' social position was simply farmers and some of the respondents were model farmers Intercropping, alley cropping and crop rotation of maize with common bean were the common practices in the areas. Except enset all crops were produced by crop rotation. The FGD indicated that there was traditional agriculture 10 years ago but now the use of new technologies like row planting, use of improved (seed) varieties, use of chemicals and/or inorganic fertilizers etc has been started . The way it began is not surprising which was adopted through awareness creation, practical training and through experience in their majorly growing crops like; wheat, faba bean, teff, enset (major food crop), and maize so on. However, fruits (Banana, Avocado) and vegetables (carrot, head cabbage, tomato, onion and garlic) were grown by using irrigation. Even if no crop has exceptional importance, wheat is produced for income generation. The production trend varies with type of crop. Maize, common bean, barley, sweet potato, taro, enset, yam, head cabbage, onion, and banana production decreased since the last five years while rest of the crops' production increased . The reason for the decline of production was mainly price escalation of inputs, vertebrate pests, storage pests, insect pests (fall army warm on maize) and shortage of improved seed .

However, the major challenges in the production of crops are, increasing of input prices specially fertilizer price per year, crop diseases (wheat, faba .bean, head cabbage, irish potato, EBW etc), pests, soil fertility loss, seed quality problem, untimely provision of inputs mainly chemicals, seed and supplying of inputs take place without the consideration of agro ecology and soil type. According to FGD the yield loss of different crops were due to disease occurrence.

4.6. The Crop Technology and Input Use Practices In the Cropping Season of 2009/010 E.C

Table 5. Input use practice

Agricultural inputs used	**Ave. amount of input used per hh in kg**		**Source of inputs**
	Mean	St.dev.	
DAP	25.4	35.69	Agricultural extension
UREA	40.9kg	32.97	>>
NPS	45.89	72.73	>>

Herbicides	0.73cc	1.064	Agricultural ext. & private
Fungicide	0.56cc	1.032	>>
Insecticide	0.43cc	0.73	>>

Source: Survey result, 2021

According to the sample respondents the agricultural inputs that has been used in the study area were Urea, DAP, blended fertilizer(NPS) ,NPSB and improved seed. However, some farmers have been also using herbicides, fungicides and insecticides as a chemical application on their crops in the study area. The sample respondents indicated that about 84% of the respondents didn't use organic fertilizer like compost whereas only 16% use mainly for their f major staple food crops and vegetables. The use of those inputs have been improved the status of soil fertility and land management for better crop production and productivity.

With regards to dynamism in input use practice over the years, the FGD indicated that there is a change in use of different inputs; (i.e. improved seeds, organic and in organic fertilizer, chemicals) over different crops. Farmers use improved seeds for (maize,wheat, teff, faba bean, common bean, barley etc). However, the inflating price of agricultural inputs were the main challenges in crop production.

Table 6. Crop technology use practices

Major crop type	Frequency of plowing	Planting method(freq. in %)			aware of improved variety of(%)		Use of improved variety (%)		Type of improved variety .
	Mean	Broadcast	Row	Both	Yes	No	Yes	No	
Maize	4	7	93	0	95.7	4.3	96	4	BH540,shone, BH 140, Pioner
Teff	4	40	55	5	93.3	6.7	93.3	6.7	Fantahun, Cr37
wheat	4	5	90	5	87	13	74	26	Denda, Kakaba, Ogolcha ,Onee
Barley	3	40	60	0	83.4	16.6	83.4	16.6	
Haricot bean	3	25	60		75	25	75	25	Nasir
Taro	3.5	0	100	0	100	0	60	40	Boloso-1
S.potato	3	0	100	-					Hawasa
Potato	3.6	0	100						Belete, Jaleni
									Gudina

Source: Survey result, 2021

As depicted from the above table about 93% of sample respondents were use row planting for maize while only 7% use broadcast planting methods. With regard to teff about 55% of the respondents use row planting whereas 40% use broadcast and only 5% use both broadcast and row planting. In wheat production the majority (90%) use row planting, 5% use broadcast and 5% use both broadcast and row planting. This might indicate that the farmers mainly use row planting method for the major crop production and utilization of other technologies in order to enhance production and productivity. As indicated in the above table the majority of the sample respondents have awareness and utilization of different improved crop variety through agricultural extension system. As indicated in the above (table 6) except for Enset , major crops are sown/planted using row planting method with the integrated application of inorganic fertilizers (NPS/NPSB and Urea) and spacing. The organic fertilizer, compost for maize around home stead and vermicomposting for vegetable production at Warza locho being practiced. Concerning the improved crop varieties of Maize (BH-540, BH-140, Shone, Pioner), wheat (Damphe, Denda, Kakaba, Ogolcha & onee), Teff (Fantahun, DZ-Cr-37), common bean (Nasir), sweet potato (Hawassa-83) and potato (Gudeni and Jalene and Belete) , taro(Boloso-1)were used. The average yield (q/ha) obtained from improved varieties of maize, wheat, teff, fababean, field pea, common bean, sweet potato, potato were 40, 24, 8, 16, 80 and 60, respectively. The local varieties of Faba bean, Field pea purchased from market, gave average yield of 12, 8 and 20 quintals per hectare, respectively.

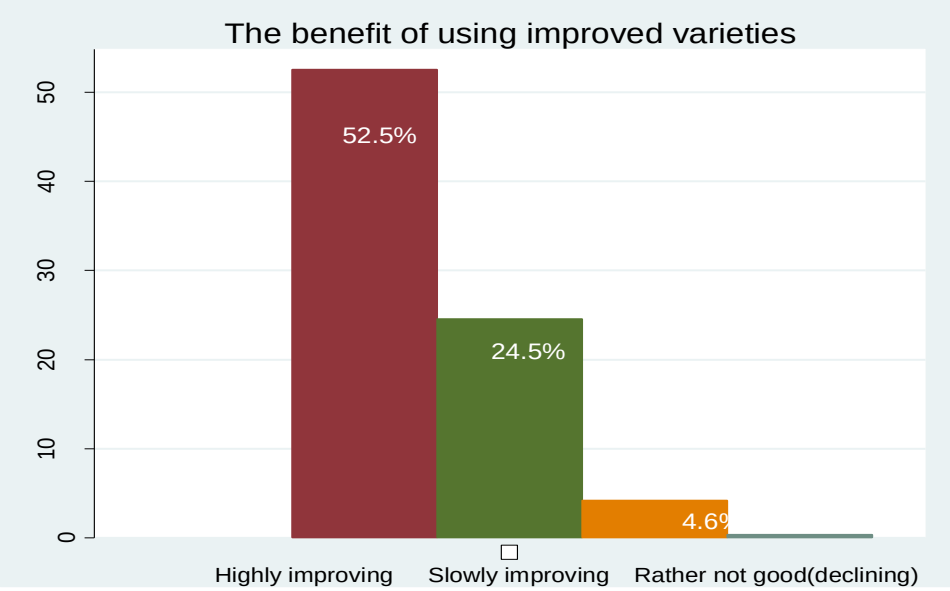

Fig.3 Benefit of using improved varieties

From the above figure about 52.5% of the sample respondents indicated that the benefited from using improved varieties have been highly improving whereas 24.5% those said slowly improving. However, only 4.6% of the sample respondents the benefit of improved varieties rather not good or declining

Table 7. Agronomic practices employed

Major crops	**Planting method**	**Inorganic fertilizer Rate kg/ha**		**Organic Fertilizer**	**Pesticides used and frequency**			**Hand weeding frequency**	**Tillage frequency**
		NPS/NPSB	Urea		Fungicide	Herbicide	insecticide		
Maize	Row	100	100	Compost			1	2	3-5
Wheat	Row	100	100			1		2	3-5
Teff	Row	100	50			1		2	3-5
Common Bean	Row	100	50					1	3-5
Barley	Row	100	100		1	1		1	3-5
Sweetpotato	Row		150				1	1	3-5
Enset	Broad casting*	-	-	FYM	-			3	2
Irish Potato	Row	100	150					2	3-5
Tomato	Row	150	150		1-2			2-4	1-2
Cabbage	Row	200	200					2-4	1
Garlic	Row	200	200	FYM				2-4	1-3

*FYM=farm yard manure

As the above table indicates the majority of the farmers use row planting methods for grain crops with the tillage frequency ranges 3 to 5 whereas for some vegetable crops the tillage frequency ranges between 1 to 3.

Table 8. The use of improved varieties and agro-ecology

Variables	**Using of improved variety (Yes/No)**		**Chi-square value**	**t-value**
1.Agro-ecology	Yes(238)	No(23)	261	(1.8973)NS
Highland/midland(0)	176(73.9)	20(86.9)	196(75.1)	
Lowland(1)	62(26.1)	3 (13.1)	65(24.9)	
2. Family size				

3. Extension services	Yes(238)	No(23)	261	
Yes	192(80)	16(69)	218(84)	(1.8356)*
No	36(15)	7(31	43(16)	(5.0480)*

Source, Survey Result, 2021, NS = Non Significant

As depicted on the table 11 above, the use of improved crop varieties has no any significant effect on the smallholder farmers due being in different agro-ecology. This might indicate that those farmers who living in different agro- ecology didn't prevent from using different crop technologies to enhance production and productivity. Thus, The provision of improved crop technologies to the farmers based on different agro-ecologies are highly needed in order to boost the yield because those farmers who live in different agro-ecological zones. According to survey result family size has positive and significant mean difference at 10% on the use of improved varieties. This might indicate that the availability of labour is one of the opportunity for better utilization of improved crop technologies.

The survey result indicates that the extension services were positive and significant effects on the using of improved crop technologies at 10% significance leve.

5. CONCULUSIONS AND RECOMMENDATIONS

This study has been mainly aimed at analyzing the crop production system and characterization in Wolaita and Kembeta Tambaro Zone. The general objective was is to explore the changes of crop production systems over time and identify the factors that contributed for the change across the different agro-ecologies. The descriptive statistics, chi-square and t-test as well as triangulation have been used to analyze the collected data in the study area. Both primary and secondary sources were used to generate data. The information that has been collected from those methods were supplemented by conducting FGD and KI interview in the study area. A total of 261 sample household head have been randomly selected and interviewed using structured questionnaire.

The total land size of sampled farmers varies from 0.0325ha to 2.25 ha and the average farm size for sampled farmers is found to be 0.485 ha and which was not significantly different as compared to land ownership 10 years ago. Hence, high quality improved technologies that can enhance the agricultural production and productivity needed to be utilized in order to meet the growing population since there was no chances to expand the farm size.

The major challenges in the production of crops are, increasing of input prices specially fertilizer price per year, crop diseases (wheat, faba .bean, head cabbage, irish potato, EBW etc), pests, soil fertility loss, seed quality problem, untimely provision of inputs mainly chemicals, seed and supplying of inputs take place without the consideration of agro ecology and soil type. The extension system needed to provide and avail with affordable price agro-chemicals such as insecticide on maize to manage insect, fungicides on vegetables to control disease and herbicides on wheat, teff and barley to manage common weeds as well as fertilizers and improved quality seed .

The organic fertilizer is very important to enrich the soil nutrients for better agricultural yield. However, the majority of sample respondents didn't use organic fertilizer and highly encouraged the farmers to use the organic fertilizer in order to improve sustainably the soil fertility status and enhance the crop yield. The use of improved varieties has been highly improving the yield of crops and contribute to the livelihood improvement of the farmers. Hence, there should be strong extension services in the provision of improved crop technologies for better crop yield.

Regarding public institution, the distance between the farmers' house and the woreda town market was far apart to market their agricultural products easily with better price since the agricultural products are highly perishable. Thus, availing the market access for the agricultural products and strengthening public institutions were very relevant for good services provision to the farmers.

A crop farming system in the Wolaita and Kembata Tembaro zone is almost similar which practice mixed farming system with dominant share of crop production, and livestock production as the livelihood means for households. However, over 10 years there was several potential factors that contributed for farming system dynamism. Therefore, those dynamic potential factors in the farming system should be treated with improved agricultural technologies to enhance agricultural production and productivity.

Agricultural extension approach is very critical tool and needed to address farm households with improved agricultural technology such as improved livestock breed, improved forage and improved NRM practices.

Finally, the concerned body including GO and NGO needed to intervene based on this survey findings in order to address all issues that has been discussed in the crop production system for better improvement in the livelihood of the farmers.

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