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Extent of modern agriculture input adoption in Kolla and Woina-dega Agro-climate zone in Alamata, Ethiopia

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Abstract
Agricultural productivity of smallholder farm household was low and declining. One of the key reasons attributed to the poor performance of smallholder farmers were low use of modern agricultural technologies. This is due to multiple and interwoven problems in socio-economic, cultural, institutional and agro-ecological setting of a particular area. Therefore, the objective of this research is mainly to assess the extent of modern agricultural technologies adoption.
The study was conducted in Alamata woreda Northern Ethiopia. Multistage sampling technique was employed to identify the sample households. From 174 sample households, 111 adopters and 63 non-adopters were identified randomly. The data were collected using questionnaire, focus group discussions and key informant interviews. Quantitative data were analyzed using descriptive statistical technique whereas qualitative data was analyzed by narration. The results were presented in the form of tables and statement.
The finding reveals that, adoption of modern agricultural technologies varies in different agro-climate zones. In addition, smallholder farm household extent of adoption differs on agro climatic zone and socio-economic characteristics of the households. Unsuitability of the input, high cost of the inputs, untimely available of the inputs, unconvinced household and lack of cash were listed as influential variable for non-adoption decisions.
It needs to work more on agricultural extension and research in the woreda in order to identify the reasons why some of the technologies were not adopted and vice versa as well as identifying appropriate agricultural technologies for the woreda in general and for each agro-climatic zone in particular.

Keywords: Adoption, Agro-climate, Ethiopia, Extent

1. Introduction
Agriculture remains the backbone of the economy in most African countries and is the key to both social and economic development (Breth, 1997) [5]. Nevertheless, despite the efforts and investments made by the governments and donor agencies in agricultural sector, household farm productivity has remained low and declined beyond the subsistence level.
At present, many scholars in Ethiopia are discussing the issue as to why agricultural sector remained backward and failed to generate surplus production; and most of them argue that one of the causes of stagnation in agricultural production is the low level use of modern agricultural technologies (Awetahgne, 1975 [2]; Befekadu and Berhanu, 2000) [4]. Over the past years various attempts have been made to raise agricultural productivity by extending new technologies to smallholder farmers through various extension and research outreach programs. Although these programs have spatial biases and limited coverage, they ensured the increase in major cereal crop productivity through improved technology adoptions and extension communication in that impact area (Befekadu and Berhanu, 2000[4]; Dejene, 1996) [7]. However, due to multiple and inter related problems like inappropriate input and output policies, poorly designed research extension linkage, ill-advised use of inputs, lack of access to credit, agro-climatic conditions, variability of rain fall and soil degradation also accounted for its low extent of adoption. Hence, identification of these factors contributing to low adoption level is needed to come up with possible options that would improve the level of agricultural technology adoption, thereby, improving smallholder's agricultural productivity in particular and economic development in general.

Statement of the Problem

Africa is in the midst of generalized agricultural crisis, the most visible symptom of which is the continent's inability to feed itself. The crisis is mainly attributed to low level of agricultural technology innovation, diffusion and adoption of process. Ethiopian agriculture is dominated by small farm household which produces 97 percent of the total agricultural output (CSA, 2003) [6]. However, the majority still continue to depend on the traditional techniques of farming. Major reasons attributed to the poor performance of Ethiopian agriculture emanate from inherent natural environment deficiencies, human induced problems and use of traditional techniques of farming (Arega, 2002[1]; Befekadu and Berhanu, 2000) [4]. In addition, many of the literature indicated that Ethiopia has very poor and low level of modern agricultural technology innovation, dissemination and adoption even compared to African standards (Howard *et al*., 1995) [10]. This was because adoption behavior differs temporally and across socio-economic groups. Certain groups adopt some new technologies while others reject depending on the nature of the technologies, the socio-economic, agro-climatic and institutional characteristics of a particular area, which naturally have important influence on small farm households' decision to adopt or reject new agricultural technologies.

Most of the literature on adoption of modern agricultural technologies dealt with particular locations (Itana, 1985) [11]. In addition, most of the studies in Eastern Africa and in Ethiopia focused on areas where adoption levels were known to be high (Arega, 2002[]; Awetahegne, 1975 [2]; Doss, 2003[8]; and Itana, 1985) [111]. Thus, most of the studies use socio-economic and cultural variables as the major determinants in analyzing adoption decision of modern agricultural technology inputs. However, many studies of agricultural technology adoption disregard in examining the extent of adoption modern agricultural inputs in space and time. Moreover, very little is known about the types of agricultural technologies adopted by the farmers in relation with agro-climatic zone. Hence, the contention of the researcher is to assess the extent of modern agricultural input adoption in Ethiopia. In addition, the researcher wants to see whether extent of adoption of modern agricultural inputs is different or the same in across agro-climate zone.

Obviously, this will provide further information for the planners and policy makers in order to formulate appropriate policy aimed at improving smallholder farm household's extent of adoption different inputs in general and type of inputs in a specific agro-climate zone study area.

Research Objectives

The aim of the study is to assess the extent of modern agriculture inputs adoption in Alamata Woreda. And to identify the type of modern agricultural inputs adopted across agro-climate zone.

Research Questions

What is the extent modern agricultural inputs adoption in Alamata Woreda? And what types of inputs are adopted in which agro-climate zone.

Research Methodology

This research used both primary and secondary data sources. The primary sources mainly used to analyze the variables that determine extent of modern agricultural technology adoption. Furthermore, the secondary data obtained from the consultation of different documents used to enrich the research with evidences.

Multistage sampling technique was used to identify sample households. From different woreda's of Ethiopia, Alamata woreda was purposely selected as the study site on the basis of the researcher's acquaintance with the area and its relative importance and accessibility. In the woreda there were ten (10) PAs before 2008 but now there are (13) PAs. However, the boundaries of these newly emerged PAs are not clearly demarcated as well as the number of households who live in these PAs are not clearly known. Therefore, for the purpose of this research it was considered more convenient to use the former division of PAs. The study site was stratified into two strata based on agro-climatic zones; assuming the variability in climatic conditions. Merewa and Tsetsera PAs were purposely selected since they were the only PAs from woina-dega agro-climatic zone. And Selam-Bekalsi and Garjalle were randomly selected from kolla agro-climatic zone. The sampling frame determined to be 174 households based on time and financial constraints. The total sample size of the study was proportionally distributed to each PA based on their size of households. Finally, those households were randomly selected from the list of households Merewa (58), Tsetsera (43), Selam-Bekalsi (36) and Garjalle (37) totally 174 household, of which 111 adopters and 63 non-adopters.

Structured questionnaire, focus group discussion and key interview of elderly people were used as data collection tools. The questionnaire was consisting of broad categories on the demographic, socio-economic, institutional and agro-ecological characteristics of the households and the area. The main target of the interview was the household head. In addition, focus group discussion was also used to collecting data on extent of modern agricultural input adoption. In regard to this, 5 members of the discussant were selected from each sample PA with a total of 20 members discussing in one group. Moreover, interviews with agricultural extension department, DAs and with elderly peoples were designed and conducted, with the intention that such information is complementary and cross checking to other sources.

Methods of data processing and analysis

Organization, coding, data cleaning and data entering were data processing activities used in the study. Both quantitative and qualitative approaches were used to analyze extent of modern agricultural input adoption.

The quantitative data was analyzed using computer software such as SPSS 15.0 for Window and the results were presented in simple descriptive statistics (mean, standard deviation, coefficient of variation, percentage and range). Moreover, qualitative data were analyzed by narration and description of the information obtained through focus group discussion and key informants.

Results and Discussions

Socio-economic characteristics

The socio-economic characteristics of the sample households can be described in simple descriptive statistics based on peasant associations (Table 1). As per the table, the average land holding size of the sample household is 0.79 ha. The land holding size among peasant associations ranges from 0.93 ha, which is the highest in Selam-Bekalsi PA, to the lowest in Merewa PA, i.e. 0.72 ha. There are two basic reasons that account for such small size land holding. These were growing population pressure and dissected by steep slopes and drained by small intermittent streams (particularly in Merewa and Tsetsera).

Table 1: Descriptive Statistics on Socio-economic Characteristics of the Household by Peasant Associations

Name of PA	Total land holding size in ha				Educational level in completed grades			Number of ox owned		
	≤ 0.25	1.00-1.50	≥2.00	Mean	Illiterate	Read write	1-8 grade	≤1	2	≥3
Selam-Bekalsi	11 (30.5)	15 (41.7)	10 (27.8)	0.93	15 (41.7)	5 (13.9)	16 (44.4)	14 (38.9)	16 (44.9)	6 (16.7)
Garjalle	9 (24.3)	26 (70.2)	2 (5.4)	0.81	14 (37.8)	7 (18.9)	16 (43.6)	12 (32.4)	20 (54.1)	5 (13.5)
Tsetsera	19 (44.2)	18 (41.8)	6 (13.9)	0.77	15 (34.9)	10 (23.3)	18 (41.9)	23 (53.3)	11 (25.6)	9 (20.9)
Merewa	23 (39.6)	30 (51.3)	5 (8.6)	0.72	27 (46.6)	11 (19)	20 (34.5)	33 (56.9)	19 (32.8)	6 (10.3)
Total mean LHS for sample households in the woreda 0.79 ha										

Note: *Numbers in bracket are percentage*

In regard to the characteristics of household head level of education, more than 50 per cent of the sample households of each peasant association belong to illiterate and read and write categories, for individual PAs about 55.6, 56.7, 58.2 and 65.6 per cents were found in Selam-Bekalsi, Garjalli, Tsetsera and Merewa, respectively. The proportion of household head who received formal education is the highest for Selam-Bekalsi and the lowest for Merewa. All in all, result indicates that household head educational level was low. This could be mainly due to the fact that education is a recent phenomenon in rural areas of Ethiopia in general and in Alamata in particular.

The third variable used for describing socio-economic characteristics of peasant association was number of oxen owned by the household. The percentage of the household who have less than or equal to one ox is 38.9, 32.4, 53.3 and 56.9 per cent in Selam-Bekalsi, Garjelle, Tsetsera and Merewa, respectively. Thus, it indicated that, more than half of the total farm households have at least a pair of ox in the woreda. To sum up, the land holding size is small as compared to the national average of one ha (Befekadu and Berhanu, 2000) [4]. In addition, less than 50 percent of the household head completed 1-8 grades. Moreover, more than 50 percent of the household owned a pair of ox or more.

Characteristics of Adopters and Non-Adopters

Table 2 presents the characteristics of teff and wheat cultivators using modern and local factors of production by socio-economic and demographic variables and the amount of modern agricultural inputs applied. It can be observed from Table 2 that, the average farm size of teff cultivators was 0.81 ha while that of wheat cultivators was 0.77 ha with almost same coefficient of variations 55 and 57 per cent, respectively. Therefore, teff and wheat cultivators have land holding size less than a hectare. However, the average application of fertilizer on wheat and teff fields was 26.4 kg/ha and 8.6 kg/ha with CV of 124 and 241 percent, respectively. This indicates varied distributional patterns of uses of fertilizers by the household cultivating wheat and teff.

Table 2: Descriptive Statistics of Wheat and Teff Cultivators and Amount of Agricultural inputs Applied per Hectare

Variables	Wheat N= 78			Teff N=96		
	Mean	SD	CV%	Mean	SD	CV%
Age of household head	48.82	13.21	27.05	40.81	13.60	32.00
Household size	4.85	1.63	33.61	4.83	1.70	35.20
Total land holding size in ha	0.77	0.44	57.14	0.81	0.45	55.56
Fertilizer applied kg/ha	26.78	33.25	124.16	8.59	20.78	241.91
Improved teff or wheat seeds applied kg/ha	17.89	24.84	138.85	25.13	24.03	95.62
Herbicide applied lit/ha	0	0	0	0.46	0.86	186.96
Local teff or wheat seeds kg/ha	26.15	28.78	110.06	20.08	26.83	133.62

Average application of fertilizer on wheat was more than three times that of teff. However, the application of fertilizer by the households on both fields were below the recommended rate of 120 kg/ha (AWOoARD, 2009) [3]. The low rate of application of inputs was due to high cost of inputs and unfavorable conditions of agro-climate zone. Considering the application of improved seeds by wheat and teff cultivators were found to be 17.89 kg/ha and 25.13 kg/ha, respectively. Furthermore, in the study area application of herbicide was low. These were because weeds are considered as an important source of feed for livestock, contributing to curbing out the shortage of pasture. As a result, smallholder farmers were very much reluctant to use herbicides. Therefore, the implication is that in the study area, smallholder farm households use human labor to avoid herbs or weeds from their fields rather than using herbicides, so as to use the weeds for animal feed.

Type of Modern Agricultural Inputs Adopted by Wheat and Teff Cultivars

Table 3 provides the description of households by type of agricultural technologies used for cultivation of teff and wheat. It is observed that, about 10.34 percent of the adopters used fertilizer on local wheat seeds but not on local teff seeds during the reference period, i.e. 2000 E.C.

Table 3: Distribution of Adopters and Non-adopters of Wheat and Teff Cultivators by type of Modern Agricultural Inputs

Modern agricultural technology type	Adopters N=111						Non-adopters N=63					
	Wheat		Teff		Total		Wheat		Teff		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Fertilizer on local seeds	18	10.34	0	0	18	10.34						
Fertilizer with improved teff or wheat seeds	22	12.64	9	5.17	31	17.81						
Fertilizer, improved teff or wheat seeds with herbicides	0	0	5	2.87	5	2.87						
Improved teff or wheat seeds only	10	5.74	29	16.67	39	22.41						
Improved teff or wheat seeds with herbicides	0	0	18	10.34	18	10.34						
Only local teff or wheat seeds							28	16.09	35	20.11	63	36.2

The numbers of respondents who use fertilizer together with improved wheat seeds are relatively greater than that of fertilizer and improved teff seed users as indicated in the same table, i.e. 12.6 and 5.2 percent, respectively. As presented in Table 3, the finding exhibited that, the proportion of households who used improved wheat seed were low as compared to teff. As mentioned by the key informants, the low proportion of wheat improved seed users were attributed mainly to its critical shortage. Furthermore, the percentage of teff cultivator who used fertilizer with improved teff seed was low (5.17). The low proportion of adopters of this combination of modern agricultural technology can be explained mainly due to shortage of rainfall which was not good for the application of fertilizer, specifically in kolla agro-climate. In addition, the result shows that 16 and 20 per cent of the total sample households were non-adopters of modern agricultural inputs for cultivation of wheat and teff in the woreda, respectively.

Adoption of Modern Agricultural Inputs across Agro-climate Zones

Table 4 provides the distribution of adopters and non-adopters by agro-climatic zones. As indicated in Table 4, about 10 percent of adopters in woina-dega agro-climate apply fertilizer on local wheat seeds. Households in kolla agro-climatic zone did not apply fertilizer on local teff and wheat seeds during the reference cropping season. The users of improved teff seed were high in kolla as compared to woina-dega, i.e. 11.5 and 5.2 per cent, respectively. This high variation across agro-climatic zone was due to delay of rainfall in kola agro-climate zone. Delay of rainfall forced small farm households to adopt improved teff seeds since this seed needs short period of time to give production. In addition, teff performs better than other cereals under moisture stress condition especially when the main rainy season stops early. In line with this, Hailu and Seifu, (2001) [9] reported that the farmer's preference to sow improved teff seeds if there is delay in rainfall. Moreover, farmers were very much interested in the use of improved teff varieties; according to the focus group discussions the main reason they attributed was it gives better grain yield than local teff seed varieties. In addition, consumers' prefer for these improved varieties due to the white color of the flour and elasticity of the "*injera*" as a result of which it fetches higher prices. In the reference season herbicide was not applied on wheat fields in both agro-climates. But, 13.21 percent of the total respondents were applying herbicides with combination of fertilizer and improved teff seeds or with improved teff seeds. Moreover, higher percentage of the household was applying fertilizer with improved wheat seed than with improved teff seed about 12 and 5, respectively. Generally, proportion of respondents who use combination of two or more agricultural inputs in the woreda was low, 16.7 and 14.4 per cents in woina-dega and kolla, respectively. Thus, this can be argued as some of the modern agricultural technologies were not compatible to agro-climatic zones. Moreover, most of the respondents used human labor to avoid herbs or weeds than using herbicides since the weeds is used as animal forage. Furthermore, the use of fertilizer in kolla was not worth mentioning as compared to woina-dega because most of the respondents believed that the soil of the areas is fertile enough. On the other hand, 36 percent of the total sample household did not adopt even one of the agricultural technologies provided in both agro-climatic zones.

Therefore, high percentage of the household was adopting modern agricultural technologies in the production of teff and wheat. But, the percentage of households who adopt the technologies was different for different agricultural technologies based on the characteristics of the technologies and the agro-climatic zone where the technologies were applied.

Table 4: Distribution of Adopters and Non-adopters of Modern Agricultural Technologies by Agro-climatic zone

Type of modern agricultural technology	Woina-Dega								Kolla							
	Adopters				Non-adopters				Adopters				Non-adopters			
	Wheat		Teff		Wheat		Teff		Wheat		Teff		Wheat		Teff	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Fertilizer with local teff or wheat seed	18	10.34	0	0	-	-	-	-	0	0	0	0	-	-	-	-
Fertilizer with improved teff or wheat seed	21	12.07	5	2.87	-	-	-	-	1	0.57	4	2.29	-	-	-	-
Improved teff or wheat seed only	7	4.02	9	5.17	-	-	-	-	3	1.72	20	11.49	-	-	-	-
Improved teff or wheat seed, with fertilizer and herbicides	0	0	0	0	-	-	-	-	0	0	5	2.87	-	-	-	-
Improved teff or wheat seed with herbicides	0	0	3	1.72	-	-	-	-	0	0	15	8.62	-	-	-	-
Local teff or wheat seed only	-	-	-	-	28	16.09	10	5.75	-	-	-	-	0	0	25	14.36

Extent of use of Modern Agricultural Technologies

The level or extent of modern agricultural technology adoption by small farm households varies with the type of technology they adopted. According to Table 5, it is observed that, for all types of technologies the proportion of respondents who never used either of the technologies were highest, i.e. 60, 35, 36 and 62 percent for fertilizer, improved wheat seed, improved teff seed and herbicides, respectively. Moreover, the proportion of respondents who tried but discontinued using the inputs were the highest for herbicides (19.5%) followed by fertilizer (9.2%). Table 5 also shows that, 28 percent of the total respondents applied fertilizers on wheat and teff crops since 1998 E.C. cropping season out of which about 74 percent of the respondents who used fertilizers were for wheat production. This large proportion of households' use of fertilizer for wheat production were attributed to the prevalence of wheat cultivation in the highlands of the woreda (Merewa and Tsetsera PAs) which suffer from continuous degradation of soil, hence require frequent application of fertilizer to maintain soil fertility.

Table 5: Extent of Modern Agricultural Inputs Adoption before two years

Type of technology	Never used		Still using		Tried but discontinued		Discontinued but now restarted		Total	
	No	%	No	%	No	%	No	%	No	%
Fertilizer	105	60.34	50	28.74	16	9.20	3	1.70	174	100
Improved wheat seed	28	35.89	32	41.03	4	5.12	14	17.95	78	100
Improved teff seed	35	36.45	61	63.54	0	0	0	0	96	100
Herbicides	108	62.07	23	13.22	34	19.50	9	5.20	174	100

Moreover, according to the group discussants most of the households have less than 0.5 ha of farming land as a result to increase yield per hectare they are using fertilizers on wheat crop since it was the main crop produced in 2000 E.C. cropping season. Furthermore, application of fertilizer in kolla was very low as compared to woina-dega because not only fertilizer needs more water but also relatively greater fertility of the soil. As indicated in Table 5, 63 percent of teff cultivators were still continuously using improved teff seed varieties since 1998 E.C. crop season for the production of teff.

It is often argued that at times of delay or shortage of rain fall in kolla zone smallholder farm households used improved teff seed varieties primarily because of its early maturity nature to cope with in the zone. Moreover, about 41 percent from the total wheat cultivators used improved wheat seeds in the production of wheat during 2000 E.C. cropping season. Extent of adoption of modern agricultural inputs was also different some of the respondents did not use either of these modern agricultural inputs or tried but discontinued because of varied reasons.

From 63 non-adopters of sample households, 326 responses were received concerning the reasons for not using the modern inputs. This clearly indicates the multiple answers from the households concerned. Out of the maximum responses 28.53% pointed to the non-suitability of the inputs specially fertilizers and herbicides for the area. It was followed by the reasons of high cost of the inputs and untimely available of the inputs which accounts for 18.17% and 8.10%, respectively. Next in order of importance were high cost (18.71), households were not convinced (17.79) and lack of cash (13.50). Over and above 3.37% of the responses argued that local seeds were better.

In regards to reasons concerning individual inputs 45.71 % of the responses timely availability of improved teff seeds, where other 20 % opined that they were not convinced. Regarding improved wheat seeds, the above mentioned two causes shared 35.71 and 25.00%, respectively. Concerning fertilizers the main reasons were high cost (31.40%), unsuitability for the area and being unconvinced (23.97 % each), lack of cash (20.66 %). As depicted, in Table 6, the majority of the households were faced problems of adopting these agricultural technologies. Untimely available of improved teff and wheat seeds, unsuitability and high cost of fertilizer, unconvinced use of herbicides were the most important prevailing factors for increasing extent of adoption of these agricultural inputs in the woreda.

Table 6: Reasons for Non-adoption and Discontinued of Adoption of Modern Agricultural Inputs

Type of agricultural technologies	Not convinced		Untimely available		High cost		Lack of cash		Not suitable for the area		Local seeds are better		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Improved teff seed	7	20.00	16	45.71	3	8.57	3	8.57	0	0	6	17.14	35	100
Improved wheat seed	7	25.00	10	35.71	3	10.71	3	10.71	0	0	5	17.86	28	100
Fertilizer	29	23.97	0	0	38	31.40	25	20.66	29	23.97	0	0	121	100
Herbicides	15	10.56	33	23.24	17	11.97	13	9.15	64	45.07	0	0	142	100
Multiple responses	58	17.79	59	18.10	61	18.71	44	13.50	93	28.53	11	3.37	326	100

Conclusion and Recommendation

Conclusion

Ethiopia is one of the developing countries that depend heavily on agricultural activities. Agriculture contributes 45 percent of the GDP and absorbing 95 percent of the total labor force of the country in rural areas but, the overall agricultural growth is very low. The low level of adoption of modern agricultural inputs were mainly attributed to unconvinced households, unsuitability of inputs for specific agro-climate zone, high cost of inputs and untimely availability of inputs.

The descriptive statistics on socio-economic characteristics showed that households with better farm resource base, farming land, pair of ox; better attainment of household head level of education, relatively younger household head and household head with better availability of labor supply, tends to adopt modern agricultural technologies.

The finding indicates varied distributional patterns of uses of fertilizers by the household cultivating wheat and teff. Average application of fertilizer on wheat was more than three times than that of teff. However, the application of fertilizer by the sample households on both fields were below

the recommended rate of 120 kg/ha. In addition, in the study area the application of herbicide was low; this was due to reluctant nature of the household to use herbicides. Furthermore, combination of one or more modern inputs, i.e. fertilizer, improved wheat seed and herbicide was not applied by wheat cultivators. The proportion of sample households who use fertilizer with improved wheat is better than households who use fertilizer with improved teff seed.

Moreover, farmers were very much interested in the use of improved teff varieties mainly due to grain yield and consumers' preference as a result of which it fetches higher prices. Proportion of respondents who use combination of two or more agricultural inputs in the woreda was low. In addition, the use of fertilizer in kolla was not worth mentioning as compared to woina-dega because most of the respondents believed that the soil of the areas is fertile enough. Therefore, high percentage of the household was adopting modern agricultural technologies in the production of teff and wheat. But, the percentage of households who adopt the technologies was different for different agricultural technologies based on the characteristics of the technologies and the agro-climatic zone where the technologies were applied.

Extent of adoption of modern agricultural inputs was also different some of the respondents did not use either of these modern agricultural inputs or tried but discontinued because of varied reasons. Non-suitability of the inputs especially fertilizers and herbicides for the area were important factor for non-adoption of modern agricultural inputs. In addition, high cost of the inputs, untimely available of the inputs, households were not convinced and lack of cash were listed as influential variable for non-adoption decisions. Application of fertilizer in kolla was very low as compared to woina-dega because not only fertilizer needs more water but also relatively greater fertility of the soil. Untimely available of improved teff and wheat seeds, unsuitability and high cost of fertilizer, unsuitability of the area for use of herbicides were the most important overriding factors for increasing extent of adoption of these agricultural inputs in the woreda. Hence, the finding of this study contributes a lot to the knowledge of extent of adoption and the overriding factors for the variation across different agro-climate zone.

Recommendation

It needs to work more on agricultural extension and research in the woreda in order to identify the reasons why some of the technologies were not adopted and vice versa as well as identifying appropriate agricultural technologies for the woreda in general and for each agro-climatic zone in particular.

It is necessary to encourage smallholder farm households to adopt at least one of those modern agricultural inputs, which are in fact more suitable, so as to increase grain productivities in the short run. Hence, it is vital to expand and strengthen agricultural extension service through; introducing incentives to extension agents, increasing the number of extension workers, expanding extension service within optimum distance from the household and defining the tasks of extension agents.

Further studies need to explore extent of adoption and their impacts on smallholder farm household's crop productivity. Generally, since most of the agricultural production comes from the small farm households and small farm households make up the largest segment of the rural population, promoting small farm households adoption of modern agricultural inputs in sustainable condition would bring the greatest overall benefits in terms increasing agricultural productivities.

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