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Empirical Review of Food Crop Technologies Adoption in Ethiopia: Meta Analysis

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Abstract

Adoption of improved climate smart food crop technologies is known to be the prerequisite for productivity improvement, assuring food security and enabling small scale farmers to widen income opportunities. However, due to different socioeconomic, demographic and institutional; factors the level of food crop technology adoption and utilization is not optimal. A meta-analysis is performed to review empirical estimates of Adoption factors of improved food crop technologies in Ethiopia. The objective of the study is to contribute to a better understanding of the factors that influence adoption of improved food crop technologies. A Critical review was done from data set of 150 significantly influential variables that merged in to 48 observations at different articles from 48 case studies. The synthesized data used in order to test if specific characteristics of the data and econometric specifications account for systematic differences in the adoption influencing factors. The data processed using Multinomial Logit model for estimating probability of food crop technology adoption choices that defined as higher, moderate and lower rate as dependant variable and study period, model type used, study district, sample size, data type and technology type introduced as explanatory variable. From these data and reviewed articles the results showed that using low adoption as bench mark, higher and moderate estimate of Adoption probability of food crop technology significantly affected by Sample size and technology type introduced. The synthesized information implies that larger sample size cannot be ultimate solution for accurate information and different technologies disseminated owned different value across small scale farmers that demands full packaged technologies and awareness creation. Using low adoption rate as base category (<40% adoption),the Results also showed that using the other than Probit model procedure indicate decrease in estimate of adoption probability that pointed out that model selection can play detrimental role in estimating the adoption probability, which also could result in wrong level of decision. The Meta analysis result also indicated that as number of sample size increase, the level of adoption decreases, which indicated existence of data management problem starting from data collection up to processing, which also could not be eased with increased sample size. Using low adoption as reference category, the result showed that Moderate adoption rate also significantly different across the study areas and affected by technology type and Model type applied. Other factors, including the study period and data type do not seem to significantly affect estimates of food crop technology adoption probability. The analysis result also confirmed that the mean size effect of food crop technology adoption estimate is function of training, extension service and credit access, oxen holding, TLU, labor force and income. This implied that through awareness creation, improving and credit, infrastructural development, livestock ownership and income earning opportunity improving, there is an opportunity for accelerating the speed of food crop technologies. The study result also justified that food crop technologies only focused on the specific technology type and quantity, not on how the technology implemented by farmers and how it scaled up, these assumed to be one of the most probable reason for low adoption of improved practices that resulted in low agricultural production and productivity the sector.

Keywords: Adoption • food crop • means size effect • Meta analysis • Multinomial logit

1. Introduction

Modern agricultural technology defined and summarized in different major categories such as application of optimum rate of fertilizer, irrigation, intensive tillage, monoculture, use of chemical for pest control, improved soil and water conservation, improved natural resource management agronomic practices, improved value addition, improved livestock rearing and feeding, improved harvesting and post-harvest handling practices [1].

As sited by [2] farm technology referred transformation of producers from using unproductive and endangered seed to productive variety, enabling farmers to reflect their role in

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demonstration and invent that enhances technology dissemination and shorten unnecessary resource wastage in the process. Thus, despite its prehistoric origins and hayseed caricature, farming is the source of Invention of all technology.

The study results confirmed that large efforts were made to increase agricultural productivity through technology dissemination in Ethiopia, but food insecurity remains a major challenge in the country. Improving smallholders´ productivity demands sustainable adoption of suitable and package-full agricultural technologies and practices. It also reported that the socio-economic factors plays detrimental role in agricultural technology transfer and dissemination; but little attention given for the role of social capital in technology adoption and its potential to create collective actions, reduce transaction costs, relax supply side constraints, and disseminate information [3].

The study results revealed that the benefit of agricultural technology realized in enhancing production and productivity can be justified when yield increasing technologies are widely been demonstrated, disseminated and used. The agricultural technology adoption decision of farm households has been found to be function of irrigation use, land ownership right, security, credit access, distance to the nearest market, plot distance from the home stead, off-farm participation and tropical livestock unit [4].The other result also implied that farmers who adopt technologies once are more likely to adopt the technologies due to its the profitability of agricultural technology adoption and agricultural extension services and technology adoption have a statistically significant and positive impact on nutrition and food security [4].

Agricultural technology development and adoption is an essential approach for increasing agricultural productivity, achieving food self-sufficiency and alleviating poverty and food in-security among smallholder farmers in Ethiopia. In Ethiopia, farmers have been adopting and using different agricultural technologies at different proportion in relation to difference in Socioeconomic, institutional and environmental factors; the adoption of technologies has not completely optimal yet. Therefore, it is needed to further promote agricultural new technologies by designing based on farmer's problem and demand. The article reviewed on the issue revealed that major explanatory variables significantly affect the adoption of agricultural new technologies by farmers comprised of age, education level, training and demonstration access, family size, tropical livestock unit, market distance, gender, farm size, improved infrastructure access, extension service provision and credit access [5].

Empirical studies results on adoption of agricultural technologies in Ethiopia were concentrating on the adoption of fertilizer and improved seed varieties. However, the adoption rate of technologies by farm household is complex and interlinked that based on the type of technology and the time of study, lagged variables, socioeconomic and institutional factors. The farm households were adopting more of chemical fertilizers than improved seeds and their adoption rate increases for more recent studies [6].

The study result shows that younger farmers, famers with larger land size, farmer living closer to market, and farmers who had closer contact with the extension system are more likely to adopt new technology in better manner and proportion and use it more. The result underscores the need for research and extension programs to be sensitive to the needs of farmers when developing and disseminating technologies that are relevant to their agro-ecologies [7].

The study results by Solomon et al. (2011) show that knowledge of existing varieties, perception about the attributes of improved varieties; household wealth (livestock and land) and availability of active labour force are major determinants for adoption of improved technologies. The finding also suggests that the adoption of improved agricultural technologies has a significant positive impact on farmers' integration into output market and the findings are consistent across the three models suggesting the robustness of the results [3].found that extension was the variable most significantly affecting with wheat and maize technology adoption, and extension services continue to play an important role in disseminating information on new varieties and how to manage them[8]. reported that economic factors such as income, wealth and debt family size, access to outside information, education and experience significantly known to influence on the adoption of pesticide technologies. The effect of socio-economic factors on adoption of fertilizer and pesticide technologies is greater in the area which has more access to outside information and off-farm activities than in more 'self-contained' area. The impact of the degree of risk aversion of farmers is found to be significant for fertilizer and pesticide technologies in only one area.

In General the transfer and utilization of improved agricultural technologies depends on social, economic, environmental, institutional and demographic factors that all known to impose detrimental role in the system. However the attention given to listed factors are uneven and related to these, the speed of technology transfer and utilization was at stagnant position. In addition to these the agricultural constraints not listed in the way to generate information and policy formulation. Hence, the Meta analyses study in food crop technology at country level aimed for generation information over the technology adoption factors and the mean size effect of socioeconomic, institutional and demographic factors over adoption rate of food technologies.

Methodology for Meta analysis of food crop technology adoption

Critical article Review and synthesizing on food crop technology adoption

Review in technology adoption of cereal crops in Ethiopia:-

The study report by revealed that when the farmers access fertilizer and seed their access to extension services seemed automatic and that production specialization together with wealth play a major role in explaining crop area under fertilizer and improved seed for cereal crop production [9]. Extension service, risk aversion behaviour, wealth and land fragmentation played detrimental role in adoption of fertilizer in cereal crop production.

Practical training has positive and significant effects on the likelihood of adopting improved varieties of barley; secondary level education has positive and significant effects on the likelihood of adopting improved varieties of barley and wheat. Hence, efforts to increase adoption of improved barley and wheat varieties would more likely be successful if accompanied with practical trainings and demonstrations [10]. indicated that for the strength of wheat production system, the existences of strong farmers-extension-research linkage among actors within the system has a vital importance in a way that to transfer skill, knowledge and provision of improved bread wheat varieties in efficient and effective manner is mandatory.

The empirical study result showed that the existence of supportive relationship between household head sex, field day participation, roads access, and district potentiality in enhancing the adoption of improved wheat varieties. The level of improved wheat varieties was also known to be inverse function of household head gender and road access to all weather roads. The level adoption of improved wheat varieties is defined as function of access to credit, active family force, market distance and district potentiality. The overall findings of the study emphasized household head sex, field day participation, access to all weather roads, access to credit, active family force, district and market distance as being key determinants on the intensity and adoption of use of improved wheat varieties.

The farmer's total wheat area, number of livestock, and the use of hired labour and credit significantly influenced the amount of fertilizer used. The age of the farmer, the use of credit, and several varietal characteristics preferred by farmers (disease and lodging resistance and baking quality) significantly influenced the area allocated to improved wheat varieties [10].

The use of local and low-yielding wheat varieties, incidence of diseases and pests, poor agronomic practices and declining soil fertility have been identified as major constraints to low wheat production and productivity in Ethiopia. Household level human capital, household asset endowment, farm level institutional factors and policy variables significantly affect the raw planting technology adoption of Teff production in Southern Ethiopia[11].

The study report revealed that household being headed by Illiterate head, family size (in man equivalent), Farm size, Annual off-farm income, Distance to nearest market and Training on row planting significantly influenced adoption and level of adoption of row planting. Moreover, adoption of row planting is significantly affected by Farming experience, No. of information sources and Distance to DA whereas level of adoption of row planting by livestock (TLU) and Number of oxen [3,4] found that row planting for Teff yields higher productivity at demonstration than at large scale area of production due to implementation problem in recombined agronomic practises.

The survey result revealed that farm size, household income, access to credit, contact with extension agents, participation in training, and field day were positively and significantly influenced whereas, age of household and market distance negatively influenced adoption and intensity of use of improved highland maize varieties production in the study area (Dawit and Abduselam, 2018).The study result revealed that difference in production district, labour force, membership to cooperatives, distance to FTC, and livestock holding significantly affected smallholders' intensity of adoption of DAP in maize production [12].

The survey result in eastern Ethiopia indicated that there are positive relationships between improved seed and fertiliser and between improved seed and soil conservation. There were also negative relationships between adoption of manure and fertiliser and between manure and improved seed. The estimation results indicated that the variables affecting farmers' decisions to adopt a technology differ between technologies. Educational level of the household, family size, off /non activities, livestock ownership, and distance to the market, plot ownership, slop of the plot and other variables also play significant roles, partly with differing signs across technologies.

The study result by [2,3] indicated that Adoption of hybrid maize varieties depends on ages, education level, farm size and land proportion allocated to specific crop, extension service, market distance and altitude of the district[4]. expressed that farmland size positively influences the adoption of improved OPVs of maize. On the other hand, the adoption decision of improved OPVs is negatively influenced by distance from the nearest grain market. The frequency of substantial yield stress encountered due to drought is an impediment to adoption of improved OPVs of maize and is of concern for mitigation through adoption of improved drought tolerant maize varieties [3] confirmed that adoption of the improved maize varieties among Maize producer households was found to be positively influenced by adult-literacy, family size, livestock wealth, access to output market and credit access for the new varieties. On the other hand, farmer associations, distance to main markets and fertilizer credit negatively influenced adoption. Indicated by study result revealed that variation in districts, family size, membership to cooperatives, distance to farmers training centre, and livestock holding significantly affected smallholders' intensity of adoption of DAP in maize production. On the other side, variation in district, farming experience, farm size, membership to cooperatives, dependency ratio, and annual income significantly determined intensity of adoption of Urea found that level of education and family size were found to significantly and positively influence die adoption decision of improved maize and chemical fertilizer. Different maize varieties have different productivity at due to different in potentiality across districts [13].

Factors affecting the adoption rate and intensity and utilization of the improved sorghum varieties across their suitable agro ecology summarized as extension service, access to improved varieties and its production packages, training in form of awareness creation and field day and access to market points for farmers.

Review of Root and tuber crop technology adoption

Although potato is considered to be one of the strategic crops for ensuring food security in Ethiopia, the adoption of high yielding and disease tolerant improved potato varieties is low. Higher education of the household head and the presence of a radio and/or television also have a positive effect on adoption. As to the scale of adoption, we found that only the percentage of owned land, tuber size (of ware potatoes), access to credit, stew quality, and presence of a mobile phone have an impact on ware potato farmers' decision on the amount of land to be used for growing Improved Varieties [14] confirmed that Variation in districts, access to irrigation, farm size, membership to cooperatives, and annual income of the households were found to significantly affect the adoption of potato technology package study result revealed that variation in districts, access to irrigation, frequency of extension contact, and livestock holding significantly affected intensity of adoption of both DAP and Urea in potato production.

Review on adoption of pulse crops

The study showed that the household head educational status, age, land size and household size affect consumption and production of pulse crops. The survey result by pointed out that practical training has positive and significant effects on the likelihood of adopting improved varieties of fababean. Hence, efforts to increase adoption of improved agronomic practices and varieties would more likely be successful if accompanied with practical trainings and access to improved knowledge.

Study result revealed that the decision to adopt improved fababean varieties is positively influenced by annual farm income and training obtained but negatively influenced by residents of the household heads. The study concludes that adoption decision was found to be a combination of economic, physical and institutional variables of the farmers.

The survey results show that knowledge of existing varieties, perception about the attributes of improved varieties, livestock and land ownership and availability of active family labour force play a significant role in enhancing the level of adoption of improved chickpea varieties. The report also confirmed that adoption of improved agricultural technologies has a significant positive impact on marketed surplus and the findings are consistence across the three models suggesting the robustness of the results. Integration into output market is also positively associated with household wealth and availability of active family labour force and negatively associated with age of household head and distance to main market [15].

The decision to adopt white haricot beans variety is known to positively supported by frequency of extension visits, land size allocated to haricot beans, agricultural income, price perception, training obtained and perception on fertility enhancement benefit of the crop, and negatively by distant to market, ownership of haricot beans farm land (ten and nutritional perception of the crop. The intensity of adoption of white beans is affected negatively by the number of dependents in the household, ownership of haricot beans land (tenure) and positively by non-farm income and contact with non-governmental organizations.

The survey result by [2,3] revealed that that speed of adoption of beans better at male headed households compared to female headed households and the size of cultivated land, proximity to extension office and remoteness to fertilizer market hastened adoption, while dependency ration and livestock ownership contributed to accelerated in the adoption probability.

The study result of various findings indicated that household head's attitude towards common bean production technology package, participation in extension event (participation in training and field visit) and access to credit were important variables which had positively and significantly influenced adoption and intensity of adoption of improved common bean production package. Whereas, perceived relative is advantage of technology attributes of the household head had shown negative relationship with adoption and intensity of adoption. Some farmers who previously adopted improved common bean varieties have discontinued planting the varieties mainly due to market problem and poor management practice.

The study report indicated that existence of the variation in adoption of improved varieties that implies difference in access to inputs and information about the improved varieties. At present input supply (especially seed) is limited or non-existent particularly in the remote chickpea producing areas (EARO, 2003).The study result showed that attendance on training of soybean production and use of soy food at home affects soybean adoption positively and significantly. However, age of the household head and distance to main market has negative and significant impact.

Review on adoption of artificial fertilizer

The survey results indicated existence of positive impact of extension and credit services, age, farm land size, education, livestock, off/non-farm income and gender in enhancing the adoption of inorganic fertilizer. Physical characteristics like distance from farmers' home to markets, roads, credit and input supply played a critical role in the adoption of inorganic fertilizers as proximity to information, sources of input and credit supply and markets save time and reduce transportation costs [16].

The study showed adoption of DAP fertilizer depends on location variables, farmer type, institutional factors and resource endowment. The study revealed that farmers residing in the SNNP cluster and Eastern and Western Oromiya apply significantly less DAP fertilizer to cereal crops as compared to farmers dwelling in Central Oromiya. On the contrary farmers in the Bahir Dar cluster apply significantly higher levels of DAP fertilizer as compared to farmers in central Oromiya. Model farmers are more likely to apply a higher amount of DAP fertilizer to cereal crops as compared to non-model farmers. Access to credit and cooperatives membership were the two institutional factors that were found to positively influence the level of DAP fertilized applied to cereal crops. The tropical livestock units and annual gross income significantly affected the adoption decision and level of DAP.

The study results showed that the decisions to use fertilizer and manure are negatively related to one another. Fertilizer is expensive in prices and inadequate in supply but less demanding of labour in its application. The parcel size has a positive effect on both land management practices. Access to credit is found to be significant in positively affecting the probability of using fertilizer. This implies that credit is very helpful in relieving capital constraints faced by farmers for using fertilizer and other purchased inputs. The use and intensity of adoption of fertilizer defined as function of age of the farmer, farmers' expectations of rainfall conditions and farmers' perception of the price of fertilizer [17].

Meta-analysis Research questions for food Crop technology adoption

i. what were the major food crop technologies had been transferred in agricultural sector in Ethiopia?

ii. Do differences exist in relation to proportion of technology adoption probability across study periods, data type used, region, model employed and samplsize used?

iii. Wich small scale farmer socio-economic, institutional and demographic factors that significantly influences mean size effect of probability of food crop technology adoption?

Discussion and Conclusion

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	246.888			
Final	114.214	132.673	12	.000

Table 1: Model Fitting Information.

The estimated LR 246.88 is highly statistically significant, its p value being practically zero. This points out that the model we have chosen gives a good fit.

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced	Chi-Square	Df	Sig.
Intercept	103.691a	.000	0	.
Sample size	147.899	44.208	2	.000
datatype1if cross-sectional	155.353	51.662	12	.000
Technology type 1 if improved varieties	140.507	36.816	2	.000
Region_new 1Oromiya	119.763b	16.072	2	.000
Study period 1 if after 2010	139.892	36.200	4	.000

Table 2: Likelihood Ratio Tests.

The table above confirmed that the independent variables included in the model significantly affected the dependant variable. Hence, it recommended for further analysis and interpretation of results based on results estimated. The mode fitness also checked and confirmed by estimates of cox and snell (.685)/Negelekerke (0.772) and McFadden (0.530)**.**

Model category	Frequency	Percent	Valid Percent	Cumulative Percent
Other models	64	55.65	55.65	55.65
Probit	51	44.45	44.3	100.0
Total	115	100	100.0	

Table 3: Model Used defined as 1 if Probit.

As it indicated in the table above majority of the papers reviewed used Probit model (44.3%) from which 12.17% articled used double hurdle probit, 6.09% used multivariate Probit and 26.09% used Probit. The proportion of critically reviewed papers that used Logit models was 20%, Tobit model was 31.30% and 4.35% used two limit Tobit model. This summarized table indicated that 55.7% of reviewed articles used Tobit and Logit models.

Study region	Frequency	Percent	Cumulative Percent
Amhara	18	15.65	15.65
Oromiya	74	64.35	80.00
SNNPR	21	18.26	98.26
Tigray	2	1.74	100.00
Total	115	100	

Table 4: Region where food crop adoption study carried out.

The table above indicated that the articles reviewed carried out un equally over the regions of the country that justified by finding 64.35% papers studied in Oromiya Region. In relation to production potentiality, existence of numerous learning and research institute, market proximity provoked the probability of the study to be carried out at single region.

Crop technology types	Frequency	Percent	Cumulative Percent
Improved varieties	82	71.30	71.30
Artificial fertilizer	14	12.17	83.48
Chemicals	4	3.48	86.96
Sowing method	15	13.05	100.00
Total	115	100	

Table 5: Food Crop technology type defined and adopted.

The table above showed that it was improved food crop varieties that majorly known as improved food crop technologies that thoroughly adopted and widely used in major food crop producers in the country. The result indicated that for sustainable dissemination and utilization of agricultural technologies, it demands integrated crop technology approach that entail combination of variety, fertilizer and other agronomic practices. The descriptive analysis summarized in the table above showed that the adoption of improved food crop varieties holds the lion share (71%) of total adoption of the farmers. The result implied that the known agricultural technologies usually used was improved food crop varieties and the remaining less than one third of farmers categorized by using the technologies such as artificial fertilizer, chemicals and sowing methods.

Adoption rate	Frequency	Percent	Cumulative Percent
High adoption	33	28.4	28.4
Moderate adoption	45	38.8	67.2
Low adoption	38	32.8	100.0
Total	116	100.0	

Table 6: Categories of food crop Adoption rate.

The proportion of farmers belongs to lower adoption rate of crop technologies took the leading position (33%) in proportion and that belongs to moderate adoption rate follows and finally the higher adoption rated farmers. The proportion of farmers categorized under moderate and higher adoption rate summed to be 67%.

Variables	Mean Size Effect	EXP(bn)/ Odds Ratio	Standard Error	t values
Age	0.002	1.00	0.003	0.632
Training	0.28	1.32	0.08	3.69***
Family size	0.20	1.23	2.21	0.09
Farm size	0.14	1.15	0.03	4.20***
Extension contact	0.151	1.16	0.050	3.033***
Market distance	-0.312	0.73	0.005	58.386***
Credit access	0.840	2.32	0.260	3.231***
TLU	0.002	1.00	0.014	0.120
Income	0.0002	1.00	0.000053	4.27***
Oxen Holding	0.14	1.15	0.04	3.67***
Irrigation access	0.313	1.37	0.076	4.16***
District	-0.278	0.76	0.061	4.553***
Gender	-0.637	0.53	0.397	-1.605
Road access	6.342	567.92	3.799	1.669
Cooperative membership	0.458	1.58	0.143	3.209***
Fertilizer level	0.773	2.17	0.227	3.401***

Table 6. Factors affecting Mean size effect of food crop technology adoptions in Ethiopia.

The variables are highly significant at 1 %(***) significant level

In Meta-analysis sixteen explanatory variables were used and out of which eleven significantly affected the Mean size effect of the technology adoption. The regression analysis justified that mean size effect of food crop technology adoption depends on training and credit access, farm size, extension contact, market distance, income earned from off-farm and farm and oxen holding, irrigation access, district potentiality, road access ,cooperative membership, fertilizer level used,. From explanatory variables used, market distance is negatively related with adoption rate of food crop technology.

Training Access: The parameter estimate was 0.28 that showed, holding other variables constant; having one unit of training provokes the likelihood of technology adoption by 32%. The Meta analysis result confirmed that through improving training access for food crop technologies, it is possible to enhance technology adoption. The Meta analysis result also in line that reported as Participation on field day is one of the means of teaching and learning process of improved technologies, it promoted technology dissemination through demonstration.

Farm size: The parameter estimate of the variable farm size estimated to be 0.2 that indicated increase farm size by one unit, increase the likelihood of adoption of food crop by 0.2 units, others variable fixed constant. The small scale farmer that acquainted with one more ha possessed more of 0.2 crop technology adoptions. This implies, since they can handover risks of the technology failure and success through diversification the small scale farmers acquainted with larger farm size higher in adoption probability of food crop technology. The finding is in line that reported adoption of improved highland maize varieties by farmers is influenced by farm size [18]. Also supported the study by summarizing the report as land owned provokes improved potato farming.

Market Distance: The parameter estimate referred distance from farmers' residence up to market point found to be -0.312.This showed that one if the farmers away from market point by 1km unit in comparison to other farmer, the adoption probability of the farmer increase by 0.312 units, holding other variables constant. The result points out that through improving access to market points, there is the probability of technology adoption for food crops in the country. The study result also supported by the finding reported as market distance inversely related and influenced by distance.

Credit access: The Meta analysis result indicated that credit access is one of important explanatory variables that significantly affect food crop technology adoption in the country. The calculated value of credit access was 2.32 implied that if the farmer able to access one more training in the improved practices of the technology, the likelihood of increment in adoption rate was by 32%.This is also in line with reported credit supply supports intensity and probability of the adoption of inorganic fertilizers[19].

Income Earned: The parameter estimate of income earned from agricultural and nonagricultural activities found to be 0.0002.This indicated that enabling the small scale farmers to get additional income support to adopt the farmer to adopt more likely. This is in inline where the model result revealed that household income positively and significantly influenced the adoption and intensity of use of improved highland maize varieties.

Oxen Holding: The parameter estimate referred oxen holding estimated to be 0.14. This Meta analysis result indicated that the small scale farmers that owned one more additional ox, increase the adoption likelihood by more of 0.14 proportion, holding other variables constant. As one of major draft power for crop farming, enabling the farmer to have more ox make to adopt in better probability. This also supported by that reported ownership of oxen positively affected with the likelihood and intensity of using improved varieties and inorganic fertilizer.

Irrigation access: The parameter estimate and its odds ratio for irrigation variable estimated to be 0.315 and 1.37.The analyzed output indicated that the likelihood increasing access to irrigation promotes food crop technology adoption. Holding other variables constant, accessing farmers one more irrigation access, increases the adoption probability by 37%.

District: The parameter estimate and odds ratio for district variable calculated to be -0.28 and 0.76.This implied that if the farmers forced to plant the food crops technology away from potential distinct, its likelihood of technology adoption decrease, holding other variables constant.

Cooperative membership: The parameter estimate for the variable cooperative membership for the farmers estimated to be 0.458.This indicated that enabling farmers to be cooperative membership by one unit accelerate the technology adoption of food crops by 58%, ceterisparibus.

Fertilizer level: The parameter estimate for the variable extent of fertilizer used calculated to be 0.77.This justified that increase the extent of level adopted by more of one unit, increase the level of food crop technology adoption by 17%,holding other variables constant [20].

Adoption rate	**Explanatory variables used**	**B**	**Std. Error**	**Wald**	**Df**	**Sig.**	**Exp(B)**	**95% Confidence Interval for Exp(B)**	
								Lower Bound	**Upper Bound**
High rate adoption of above 65%	Intercept	39.549	2817.109	.000	1	.989			
	Sample size	-.058	.014	16.178	1	.000	.944	.918	.971
	Data type 1 if cross-sectional and 0 other wise	-24.630	2817.105	.000	1	.993	2.011 E-011	.000	.b
		0c	.	.	0	.	.	.	.
	Technology type 1 if new1 improved varieties and 0 other wise	-7.733	1.972	15.372	1	.000	.000	9.171 E-006	.021
		0c	.	.	0	.	.	.	.
	Region 1 if Oromiya and 0 other wise	.866	1.274	.462	1	.497	2.377	.196	28.874
		0c	.	.	0	.	.	.	.
	Study period 1 if after 2010 and 0 other wise	-1.574	1.337	1.385	1	.239	.207	.015	2.850
		0c	.	.	0	.	.	.	.
	Model Used 1 if probit and other wise	-1.229	1.295	.901	1	.343	.293	.023	3.702
		0c	.	.	0	.	.	.	.
Mode rate adoption rate of between 40% to 65%	Intercept	58.020	3.032	366.295	1	.000			
	Sample size	-.030	.008	16.357	1	.000	.970	.956	.984
	Data type 1 if cross-sectional and 0 other wise	-46.069	.000	.	1	.	9.825 E-021	9.825 E-021	9.825 E-021
		0c	.	.	0	.	.	.	.
	Technology type 1 if improved f varieties and 0 other wise	-8.494	2.032	17.475	1	.000	.000	3.816 E-006	.011
		0c	.	.	0	.	.	.	.
	Region 1 if Oromiya and 0 other wise	3.908	1.332	8.608	1	.003	49.810	3.660	677.921
		0c	.	.	0	.	.	.	.
	Study period 1 if after 2010 and 0 other wise	-24.597	2817.104	.000	1	.993	2.078 E-011	.000	.b
		0c	.	.	0	.	.	.	.
	Model Used 1 if probit and other wise	-2.579	1.079	5.707	1	.017	.076	.009	.629
		0c	.	.	0	.	.	.	.

a. The reference category is: Low adoption rate of bellow 40%. b. This parameter is set to zero because it is redundant. The variables are significant at 99 %(***) and 95%(**) significance level .

Table 6. Multinomial Logit regression result for factors affecting probability estimate of food crop technology adoption in Ethiopia

As it is indicated in the table above, in the regression analysis, the estimate of adoption rate probability used as dependant variable and study period, region, model type used, sample size, food crop technology type and data type used as independent variable. The dependant variable adoption defined as high, adoption rate (for above 65% rate), moderate adoption rate (for adoption rate between 65% and 40%) and low adoption rate (for adoption rate bellow 40%).In the data analyzing estimating procedure the model used was Multinomial logit Model. In the Multinomial logit regressions analysis low adoption rate used as reference and the remaining higher and moderate adoption rated defined based on this. From these explanatory variables under higher adoption rate, food crop technology type and sample size found to affect significantly and negatively affected the adoption rate, using low adoption rate as bench mark. By using low adoption rate as reference point, the reviewed results implied that as sample size increase both higher and moderate the adoption rate decreases. In comparison to other food crop technologies (artificial fertilizer, sowing method and chemicals), adoption probability decrease as the farmers moved away from improved varieties technologies to other. This implies that improved variety given high value as technology than other practices. This is in contrary to other review by Chilot and Dawit (2016) finding that indicated almost all of the crop technology adoption studies concerned on improved seeds and chemical fertilizers.

The regressions also confirmed the existence of direct relation between region and technology type adopted, but three is inverse relation between moderate adoption probability technology types for improved varieties introduced, in relation to low adoption rate. This implies that in comparison to low adoption rate, the moderate adoption likelihood of farmers dwelling at Oromiya state better for improved varieties than other technology type (sowing method, chemical and fertilizer) in comparison to other regions dwellers (SNNP, Amhara and Tigray). This could be due to proximity to central markets, availability of numerous national and regional research and learning institutions that give due attention to one technology (improved variety) than others. It also showed that if the researcher gone away from using Probit model to other type, the adoption probability estimate increase, having low adoption rate as reference. This is in line with Gujarati (2012) that illustrated the Logit model estimate 1.81 higher than Probit estimate coefficients. The result pointed out that higher or lower adoption rate estimated may not be the true picture of the study results, rather due to data management problems that can result in wrong conclusion.

References

1. Rehman, Abdul, Luan Jingdong, Rafia Khatoon, and Imran Hussain. “Modern Agricultural Technology Adoption its Importance, Role and Usage for the Improvement of Agriculture.” American-Eurasian J Agric & Environ Sci 16 (2016): 284-288.
2. Schummer, A. “Ein Neues Mittel (“Plastoid”) und Verfahren Zur Herstellung Korrosionsanatomischer Präparate.” Anat Anz. 81 (1935): 177-201.
3. Taniguchi, Yoshiyuki, Yoshikuni Ohta and Shigeru Tajiri. “New Improved Method for Injection of Acrylic Resin.” Okajimas Folia Anat. Jpn. 24 (1952): 259-267.
4. Kus, J. “The History of Injection Methods in the Morphological Sciences.” Folia Morpholia. 27 (1969): 134-146.
5. Thompsett, DH. “Anatomical Techniques.”(2nd edn). Scotland: E & S Livingstone, Edinburgh, (1970).
6. Murakami, T. “Application of the Scanning Electron Microscope to the Study of the Fine Distribution of the Blood Vessels.” Arch Histol Jpn. 32 (1971): 445-454.
7. Murakami, T. “Pliable Metacrylate Casts of Blood Vessels: Use in a Scanning Electron Microscope Study of the Microcirculation in Rat Hypophysis.” Arch Histol Jpn. 38 (1975): 151-168.
8. Nopanitaya, Waykin, JG Aghajanian and LD Gray. “An Improved Plastic Mixture for Corrosion Casting of the Gastrointestinal Microvascular System.” Scan Electron Microsc. (1979): 751-755.
9. Murakami, Takuro, Tatsuya Itoshima, Kusukuma Hitomi, and Aiji Ohtsuka, et al. “A Monomeric Methyl and Hydroxypropyl Methacrylate Injection Medium and its Utility in Casting Blood Capillaries and Liver Bile Canaliculi for Scanning Electron Microscopy.” Arch Histol Jpn. 47 (1984): 223-237.
10. Aharinejad, SH, and A Lametschwandtner. “Principles and Fundamentals of Microvascular Corrosion Casting for SEM Studies.” In: Microvascular Corrosion Casting in Scanning Electron Microscopy. Springer (eds), Vienna, Austria. 6 (1992): 170-193.
11. Gannon, Bren J. “Preparation of Microvascular Corrosion Media: Procedure for Partial Polymerization of Methyl Methacrylate Using Ultraviolet Light.” Biomed. Res. (1981): 227-233.
12. Thomas, Krucker, Axel Lang, and Eric P Meyer. “New Polyurethane-Based Material for Vascular Corrosion Casting with Improved Physical and Imaging Characteristics.” Microsc Res Tech. 69 (2006): 138-147.
13. Eberlova, L, V Liska, H Mirka, and T Gregor, et al. “Porcine Liver Vascular Bed in Biodur E20 Corrosion Casts.” Folia Morphol. 75 (2016): 154-161.
14. Weiger, T, A Lametschwandtner and P Stockmayer. “Technical Parameters of Plastics (Mercox CL-2B and various methylmethacrylates) Used in Scanning Electron Microscopy of Vascular Corrosion Casts.” Scan Electron Microsc. (1986): 243-252.
15. Sims, PA, and RM Albrecht. “Improved Tissue Corrosion of Vascular Casts: A Quantitative Filtration Method Used to Compare Tissue Corrosion in Various Concentrations of Sodium and Potassium Hydroxide.” Scanning Microsc. 7 (1993): 637-642.
16. Miodonski, AJ, KC Hodde and C Bakker. “Rasterelektronenmikroskopie Von Plastik-Korrosions-Präparaten: Morphologische Unterschiede Zwischen Arterien Und Venen.” Berichte Elektronenmikroskopische Direktabbildung Von Oberflächen 9 (1976): 435-442.
17. Levesque, Murina J, Fredrick Cornhill, and Robert M Nerem. “Vascular Casting. A New Method for the Study of the Arterial Endothelium.” Atherosclerosis. 34 (1979): 457-467.
18. Nerem, Robert M, Murina J Levesque, and Fredrick Cornhill. “Vascular Endothelial Morphology as an Indicator of the Pattern of Blood Flow.” J Biomech Eng. 103 (1981): 172-176.
19. Gaudio, E, L Pannarale and G Marinozzi. “An S.E.M. Corrosion Cast Study on Pericyte Localization and Role in Microcirculation of Skeletal Muscle.” Angiology. 36 (1985): 458-464.
20. Hodde, KC, DA Steeber and RM Albrecht. “Advances in Corrosion Casting Methods.” Scanning Microsc. 4 (1990): 693-704.

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