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Original Article

Farmers' Perception and Adaptation to Climate Change: Multinomial Logistic Model Evidence

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Abstract - *This research examines farmers' perception and adaptation to climate change in Fayoum governorate, Egypt. A survey was collected in January 2019 where seventy-four farmers were interviewed. Results revealed that farmers perceived an increase in temperature and a lack of rainfall. Increased farm costs are considered the first negative impact of climate change. The results of the multinomial logistic model revealed that there is a significant effect of education level, age, and farm location of water source on the adaptation method to climate change. Government should provide farmers with extension services, moreover, ensuring credit facilities to enhance farmers' access to credit, which will increase their capacity to adapt to climate change.*

Keywords - *Perception, Adaptation, Climate change, Multinomial logistic model*

I. INTRODUCTION

Agriculture is considered a major sector in Egypt's economy, it contributes up to 14.5 percent of GDP and 28 percent of all jobs (USAID, 2019). Furthermore, the agriculture sector has strong forward and backward linkages that provide essential intermediate inputs to the most important manufacturing activities in Egypt. The sector is dominated by small-scale farms which use traditional practices in production that make farms at risk due to climate vulnerability. Climate Change is expected to cause serious environmental, economic, and social impacts on Egypt. Agriculture in Egypt will be negatively affected by climate change, where it exists in an arid environment that mainly depends on the water of the Nile River. It is expected that the increase in temperature will lead to a decrease in the agricultural productivity of some crops and farm animals. Moreover, it will contribute to an increase in evaporation, water consumption, social and economic impacts such as labor migration from marginal and coastal areas (Abo Hadid, 2009). Fayoum governorate is mainly considered an agrarian Governorate, it has recently been observed a decrease in many food crops productivity due to a recent high temperature and lack of water supply which procured a bunch of losses for farmers and compelled some of them to leave the farming profession. Adaptation is the process of adjustment to actual or expected climate and its effects (IPCC, 2014). As for Egypt, there are limited studies about farmers' perceptions and adaptation to climate change. This study examines how farmers perceive climate change and how they adapt their farming in response to perceived changes in climate. Moreover, it investigates factors influencing the choice of adaptation methods and identifies the main barriers that limit adaptation to climate change.

II. MATERIALS AND METHODS

A. *STUDY AREA DESCRIPTION*

The study was carried out in Al-Hagar village which is located in Itsa district, Fayoum Governorate, Egypt. It is mainly considered an agrarian area where the most common crops are Wheat, Maize, Clover, and horticultural crops. The village as well as the area around is recently experiencing a climate vulnerability due to high temperature and low rainfall received compared to previous years which resulted in significant losses in crops and cattle and forced many farms to grow one season as a result of water scarcity lately.

B. *SAMPLING AND SAMPLE SIZE*

A survey was collected in January 2019 where 74 farmers were randomly selected from farmers' records of the Association of Agrarian Reform at the village. A structured questionnaire was used to investigate whether farmers had noticed long-term changes in temperature and rainfall over the past 20 years and the negative impacts of those changes. Moreover, questions about sensitivity and risk of negative changes of climate on farms and agricultural activities, and questions about adaptation and the barriers to adaptation to climate change were also asked.

C. *DATA ANALYSIS*

Descriptive statistics were applied to describe socioeconomic characteristics of the farmers' perception about climate change, methods, and problems of adaptation. The dependent variable in this study is the adaptation method that farmers take to adapt to climate change, while the explanatory variables include: household characteristics (Age, household size, years of farming experience, education level, livestock ownership, and farm location from water source).

A multinomial logistic model was applied to analyze factors that determine adaptation techniques. The independent variables can be either dichotomous (i.e., binary) or continuous (i.e., interval or ratio in scale). Multinomial logistic regression is a simple extension of binary logistic regression that allows for more than two categories of the dependent or outcome variable (Starkweather and Moske, 2011).

The empirical multinomial logistic model for this study is specified as (Sofoluwe. et al, 2011):

Y i = f (X1, X2,..., X6)

Where yi, the dependent variable is polychotomous and it is the method of adaptation chosen by the farmer; (yi) is defined as 1 for no adaptation, 2 for Plant trees for shading, 3 for Crop rotation, 4 for Cultivate one season, 5 for Mixing irrigation water, 6 for Cultivation of heat resistant varieties, and 7 for the move to another place of cultivation. Xs are the explanatory variables, where:

X1 = Age, X2 = Household size, X3= Years of farming experience, X4= Education level, X5= Livestock ownership, and X6= Farm location from the water source.

III. RESULTS AND DISCUSSION

A. Socioeconomic characteristics of Farmers

Results showed that 100% of the farmers interviewed were males due to the fact that males control the land tenure in that area and who usually work on the farm. 51% of farmers' age range of 31-50 years; 41% are 50 years or more while only 8% of the farmers were in the age of 30 or fewer years. 30% of the farmers interviewed had obtained high school education; 36% had no formal education and they are illiterate; 18% had obtained basic education and they write and read; while only 16% had obtained a bachelor's degree. 66.2% of the Farmers indicated livestock ownership. 44% of the farmers have a household size between 5-6 persons; while 34% have 4 persons or less and 22% have a household size of 7 persons or more. 51% of the farmers interviewed had between 21-40 years of experience in farming; 34% had 20 years of experience or less, and only 15% of them had 41 years of farming experience or more. The location of Farm from water source was an end for 55% of the farmers, while 26% of their farms are located in the middle and 19% of their farms located at the first water source.

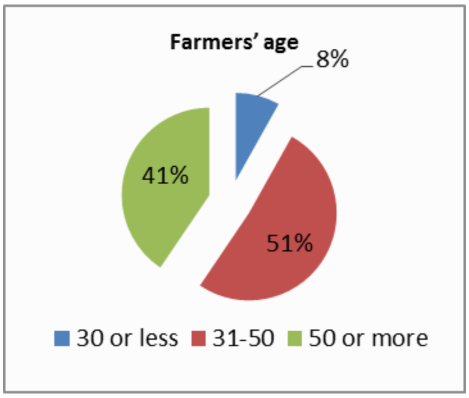


Fig. 1

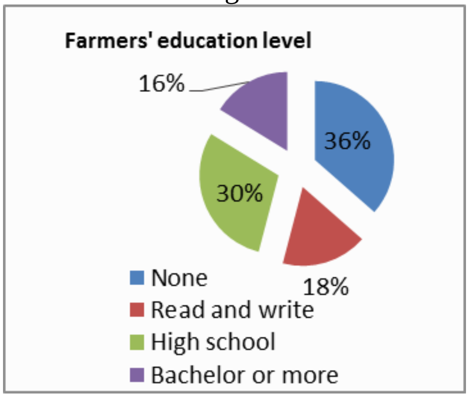


Fig. 2

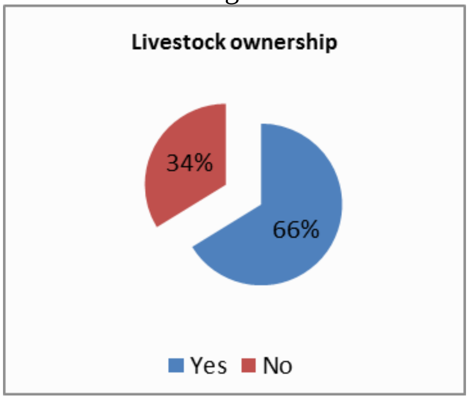
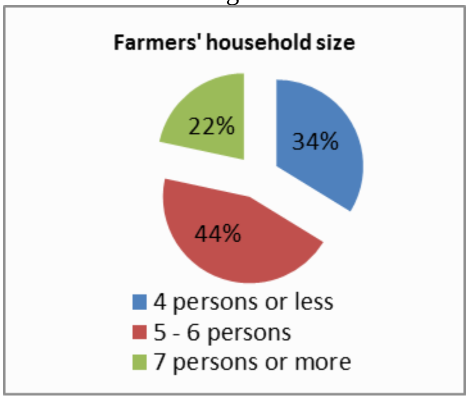


Fig. 3



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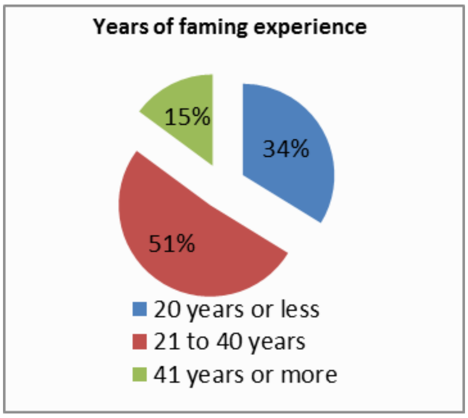

Fig. 5

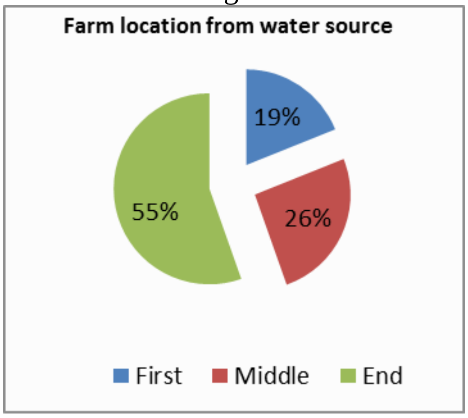

Fig. 6

Fig. (1-6). Socioeconomic characteristics of Farmers

B. Farmers' perception of climate change

Results revealed that 91.9% of the farmers interviewed observed long-term changes in climate change (Temperature and rainfall) over the past 20 years, while only 8.1% indicated no changes were observed, this result is in line with the findings of (Mertz et al., 2009), (Gbetibouo, 2009) and (Fosu-Mensah et al., 2012). As for the modification of agricultural methods to adapt to climate change, 56.8% of the farmers modify their agriculture using various methods while the rest of the farmers don't. Out of 74 farmers interviewed, 94.6% indicated that there are no positive impacts of climate change, while 5.4% of them indicated that there are some positive impacts of climate change whereas high temperature helps to increase the productivity of some crops such as corn and zucchini in their farms. Results showed that the whole farmers interviewed don't receive any support (mainly the extension services) from any source such as government, agricultural association, or private sector to adapt to the negative impacts of climate change. Personal experience and TV were found the main source of farmers' information about climate change and its impact on agriculture with a percentage of 86.4% of total respondents.

Table 1. Farmers' perception of climate change

Sample description		Frequency	Percent
Observation of long-term changes in climate change (temperature and rainfall) over the past 20 years	Yes	68	91.9
	No	6	8.1
	Total	74	100
Modification of agricultural methods to adapt to climate change	Yes	42	56.8
	No	32	43.2
	Total	74	100
Observation of any positive effects of climate change over the past 20 years	Yes	4	5.4
	No	70	94.6
	Total	74	100
Receiving support to adapt to the negative impacts of climate change	Yes	0	0
	No	74	100
	Total	74	100
Sources of information on climate change	TV	24	32.4
	Personal experience	24	32.4
	TV & Personal experience	16	21.6
	TV & neighbors	6	8.1
	TV & relatives	2	2.7
	TV & neighbors & relatives	1	1.4
	Neighbors	1	1.4
	Total	74	100

Source: field data, 2019

The results of Chi-square ($\chi 2$) showed that the calculated output value of adaptation to climate change among education levels is 8.03, it is significant at the 5% level of normality, that means among farmers interviewed, there is a significant effect of education level on the adaptation to climate change, in other words, the higher the education level, the greater the adaptation to climate change.

Table 2. Adaptation to climate change among education levels

adaptation to climate change	Education				Total
	None	Read and write	High school	Bachelor or more	
Adapt to climate change	13	8	10	11	42
No adaptation	14	5	12	1	32
Total	27	13	22	12	74
$\chi 2$ Value= 8.03*, P % value= 0.04					

*Values are significant at $P < 0.05$

Source: calculated using field data, 2019

Astable (3) indicates, farmers interviewed indicated that they perceived an increase in temperature in the first place with a percentage of 94.9%, while lack of rainfall comes in second place with 94.4%, followed by a decrease in irrigation water with 93.1%, decrease in temperature comes in fifth place with 77.3%, and increase in rainfall comes last with 50%.

C. *Negative impacts of climate change*

Astable (4) Shows, farmers interviewed were asked to rank the type of negative impact of climate change according to the degree of occurrence. Increased in farm costs is considered the first negative impact of climate change which ranked by farmers with a percentage of 97.2%, spread of pests and diseases comes in second place with 96.8%, while the death of cattle come in third place with 96.7%, and decrease in the share of irrigation water comes in fourth place with 94.8%. The disappearance of fish in watercourses comes in fifth place with 93.9, while migration from rural to urban comes in sixth place with 91.8%, etc.

Astable (5) shows the sensitivity of farms to different negative impacts of climate change was investigated. Farmers interviewed were asked to rank the type of negative impact of climate change according to the degree of sensitivity of their farms to it. Farmers indicated that their farms are first sensitive to an increase in temperature with a percentage of 97.3% while changing planting dates comes in second place with 77.7%, drought with 69.42%, and decrease in rainfall comes last with 65.3%.

Astable (6) indicates a danger on their farms from different negative impacts of climate change was investigated too. Farmers indicated that their farms are first at danger as a result of an increase in temperature with a percentage of 98.2%, while changing planting dates comes in second place with 76.6%, drought with 69.7%, and decrease in rainfall comes last with 65.7%.

Table 3. Type of climate change observed

Type of Climate Change	Degree of change						Total marks	Weighted percentage% = Total marks/(N*3) *100	Rank
	Very large		Medium		Small				
	F	%	F	%	F	%			
Increase in temperature	62	84.9	11	15.1	0	0	208	94.9	1
Decrease in temperature	24	45.3	22	41.5	7	13.2	123	77.3	4
Decrease in rainfall	59	89.4	3	5.6	4	7.5	187	94.4	2
Increase in rainfall	2	16.7	2	16.7	8	66.6	18	50	5
Decrease in irrigation water	56	82.3	10	14.7	2	3	190	93.1	3

*N= number of respondents answered each statement, (Very large=3, Medium=2, Small=1)

Source: field data, 2019

Table 4. Degree of occurrence of negative impacts of climate change

Type of negative impact of climate change	Degree of occurrence						Total marks	Weighted percentage% = Total marks/(N*3) *100	Rank
	Very large		Medium		Small				
	F	%	F	%	F	%			
Changing planting dates	33	47.8	32	46.4	4	5.8	167	80.7	7
Increased drought and crop loss	36	54.5	18	27.3	12	18.2	156	78.8	8
Spread of pests and diseases	66	89.4	7	5.6	0	0	212	96.8	2
The disappearance of the green cover	18	30	31	51.7	11	18.3	127	70.5	10

Decrease in the share of irrigation water	46	82.3	18	14.7	4	3	190	94.8	4
The disappearance of some plant species	27	41.5	33	50.7	5	7.8	152	77.9	9
Disappearance of fish in water	59	83	11	15.5	1	1.5	200	93.9	5
Death of cattle	65	90.3	7	9.7	0	0	209	96.7	3
Migration from rural to urban	59	80.8	10	13.7	4	5.5	201	91.8	6
Increase in farm costs	68	94	2	3	2	3	210	97.2	1

*N= number of respondents answered each statement, (Very large=3, Medium=2, Small=1)
Source: field data, 2019

Table 5. Degree of sensitivity of negative changes due to climate change

Negative impacts of Climate Change	Sensitivity degree						Total marks	Weighted percentage% = Total marks/(N*3)*100	Rank
	Very large		Medium		Small				
	F	%	F	%	F	%			
Increase in temperature	68	91.9	6	8.1	0	0.0	216	97.3	1
decrease in rainfall	26	36	17	23.7	29	40.3	141	65.3	4
Drought	31	47.7	8	12.3	26	40	135	69.4	3
Changing planting dates	29	42	34	49.3	6	8.7	161	77.7	2

*N= number of respondents answered each statement, (Very large=3, Medium=2, Small=1)
Source: field data, 2019

Table 6. Degree of the danger of negative changes due to climate change

Negative impacts of Climate Change	Degree of danger						Total marks	Weighted percentage% = Total marks/(N*3) *100	Rank
	Very large		Medium		Small				
	F	%	F	%	F	%			
Increase in temperature	70	94.6	4	5.4	0	0	218	98.2	1
Decrease in rainfall	26	36	18	25	28	39	142	65.7	4
Drought	31	47.7	9	12.3	25	40	136	69.7	3
Changing planting dates	27	42	37	49.3	6	8.7	161	76.6	2

*N= number of respondents answered each statement, (Very large=3, Medium=2, Small=1)
Source: field data, 2019

D. Barriers of adaptation to climate change

Reasons for not applying agricultural methods that adapt to climate change were investigated. Farmers were asked to rank the reasons for not applying agricultural methods that adapt to climate change, as table (7) shows, lack of funding is the main reason for not applying all methods such as moving to another place for agriculture, conservation, and maintenance of soil applications with a percentage of 90.6% respectively, followed by plant trees for shading with a percentage of 87.5%, and change from agriculture to animal husbandry with a percentage of 84.4%. Lack of information is considered a second reason for farmers to not apply crop rotation with a percentage of 53.1%, the availability of funding observed in this study as the main barrier for adaptation to climate change through using different agricultural methods, is in line with the findings of (Gbetibouo, 2009), (Deressa et al., 2009) and (Fosu-Mensah et al., 2012) in a study of Limpopo River Basin of South Africa, Ethiopia and Sekyedumase district in Ghana, respectively.

Table 7. Reasons for not applying agricultural methods that adapt to climate change

Methods	Reason					
	Lack of funding		Lack of information		Lack of manpower	
	F	%	F	%	F	%
Plant trees for shading	28	87.5	4	12.5		
Move to another place	29	90.6	3	9.4		

for agriculture						
Conservation and maintenance of soil applications	29	90.6	3	9.4		
Crop rotation	15	46.9	17	53.1		
Change from agriculture to animal husbandry	27	84.4	3	9.4	2	6.3
Insurance	21	65.6	11	34.4		
Land lease	23	71.9	8	25.0	1	3.1
Cultivate heat resistant varieties	22	68.8	10	31.3		

Source: field data, 2019

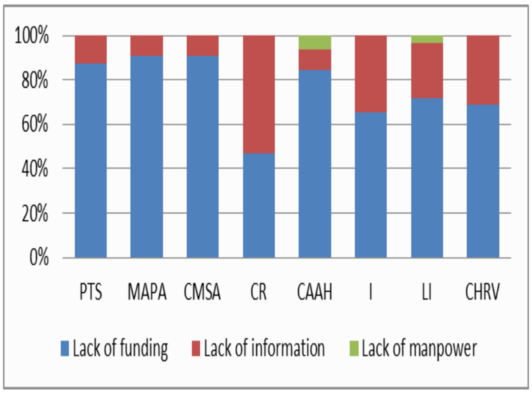

Fig. 7 Reasons for not applying agricultural methods that adapt to climate change

Note: PTS= Plant trees for shading, MAPA= Move to another place for agriculture, CMSA= Conservation and maintenance of soil applications, CR= Crop rotation, CAAH= Change from agriculture to animal husbandry, I= Insurance, LL= Land lease, CHRV= Cultivate heat resistant varieties.

Source: field data, 2019

Astable (8) shows, obstacles of adaption to climate change were investigated too, the results revealed that the absence of extension services is the first obstacle for farmers to adapt to climate change with a percentage of 88.8%, while lack of information comes in second place with 79.9%, these results are in line with the findings of (Gbetibouo, 2009), (Deressa et al., 2009) and (Fosu-Mensah et al., 2012), who indicated in other words that access to extension services has a positive and significant impact on the adaptation to climate change through education on climate change and advice on how to relieve its impact on crops. Farmers interviewed in this study indicated that they don't receive any support (table 1), mainly the extension services, to adapt to the negative impacts of climate.

Lack of funding is considered the third obstacle for farmers with 78%, and the educational level of farmers with a percentage of 59.46%. Age of farmers and resistance to change came in the fifth place with 39.77%, followed by a long time to see results with 37.26%, while some practices that don't conform to social norms come in last place with 16.22%.

Farmers interviewed were asked to rank the most urgent services to adapt to climate change, as the table (9) shows, water supply and irrigation development comes in the first place as the most urgent services for climate change adaptation with a percentage of 91.08%, followed by providing information on climate change with 64.59%, providing agricultural mechanization with 62.16%. While the provision of lending services comes in fourth place with 40.27% and health services came last with 36.49%.

A. *Results of the multinomial logistic model*

Astable (10) indicates, a multinomial logistic model was applied to analyze the socio-economic factors that determine adaptation techniques. the dependent variable is polychotomous and it is the method of adaptation chosen by the farmer; the dependent variable is defined as 1 for no adaptation, 2 for Plant trees for shading, 3 for Crop rotation, 4 for Cultivate one season, 5 for Mixing irrigation water, 6 for Cultivation of heat resistant varieties, and 7 for the move to another place of cultivation. The explanatory variables include socio-economic factors based on available data that include (Age, household size, years of farming experience, education level, livestock ownership, and farm location from water source).

The following methods of adaptation showed significant results with some explanatory variables, while the rest which was mentioned as dependent variables didn't show any significance so it is not displayed. Also, all explanatory variables (both significant and not statistically significant) are displayed in the first method (Plant trees for shading), while for the rest methods, the explanatory variables that showed significant statistical results with the dependent variable were only shown due to the length of the results. In this study, household size, number of years working in Agriculture, and livestock ownership, did not have a significant influence on adaptation methods to climate change.

Table 8. Obstacles of adaption to climate change

Obstacles	Rank														Total marks	Weighted percentage% = (Total marks/518 (74*7))*100	Rank
	first		second		third		forth		fifth		sixth		seventh				
	F	%	F	%	F	%	F	%	F	%	F	%	F	%			
Educational level	2	2.7	4	5.4	13	17.6	42	56.8	11	14.9	2	2.7			308	59.5	4
Lack of information	19	25.7	16	21.6	32	43.2	4	5.4	3	4.1					414	79.9	2
Absence of extension services	27	36.5	37	50	9	12.2	1	1.4							460	88.8	1
Lack of funding	26	35.1	13	17.6	16	21.6	13	17.6	2	2.7	2	2.7	2	2.7	404	78	3
Long time to see results					1	1.4	5	6.8	33	44.6	34	45.9	1	1.4	193	37.3	6
Age and resistance to change			3	4.1	2	2.7	9	12.2	24	32.4	34	45.9	2	2.7	206	39.8	5
Some practices don’t conform to social norms					1	1.4			2	2.7	2	2.7	69	93.2	84	16.2	7

Note: total mark (frequency*mark), mark from 7 to 1, 7=ranked first, 1=ranked last.
Source: field data, 2019

Table 9. the Most Urgent Services for Climate Change Adaptation

Service	Rank										Total marks	Weighted percentage% = (Total marks/370(74*5))*100	Rank
	first		second		third		forth		fifth				
	F	%	F	%	F	%	F	%	F	%			
Water supply and irrigation development	54	73	8	10.8	11	14.9	1	1.4			337	91.1	1
Providing information on climate change	6	8.1	28	37.8	21	28.4	15	20.3	4	5.4	239	64.59	2
Provision of lending services	1	1.4	9	12.2	12	16.2	20	27	32	43.2	149	40.27	4
Providing agricultural mechanization	1	1.4	23	31.1	37	50	9	12.2	4	5.4	230	62.16	3
Health Services	2	2.7	6	8.1	3	4.1	29	39.2	34	45.9	135	36.49	5

Note: total mark (frequency*mark), mark= from 5 to 1, 5=ranked first, 1=ranked last.
Source: field data, 2019

Table 10. Results of the multinomial logistic model

dependant		B	Std. Error	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
Plant trees for shading	Intercept	-1.76-	3.47	.61			
	age	-.11-	.094	.24	.895	.744	1.08
	Household size	-.026-	.29	.93	.974	.552	1.72
	Years of farming experience	.125	.087	.15	1.133	.956	1.34
	[education=bachelor or more]	**3.41***	**1.59**	**.032**	**30.28**	**1.346**	**680.92**
	[education=high school]	1.44	1.19	.23	4.21	.412	43.04
	[education=basic]	-.75-	1.58	.64	.473	.021	10.54
	[education=none]	0^b	.	.	.	.	.
	[Livestock ownership=yes]	2.11	1.25	.09	8.27	.715	95.56
	[Livestock ownership=no]	0^b	.	.	.	.	.
	[farm location=first]	.11	1.25	.93	1.117	.097	12.92
	[farm location=middle]	-19.6-	9433.65	.998	3.06E-9	.000	.
	[farm location=end]	0^b	.	.	.	.	.
Crop rotation	Intercept	5.02	3.76	.182			
	age	**-.260-***	**.128**	**.042**	**.771**	**.600**	**.990**
Cultivate one season	Intercept	4.02	2.41	.096			
	[farm location=first]	-1.65-	1.05	.117	.192	.024	1.51
	[farm location=middle]	**-3.13-****	**1.28**	**.014**	**.044**	**.004**	**.534**

	[farm location=end]	0[b]	.	.	.	.	.
Cultivate heat resistant varieties	Intercept	-5.6-	2.94	.057			
	[education=bachelor or more]	**4.46***	**1.95**	**.022**	**86.85**	**1.887**	**3996.9**
	[education=high school]	2.37	1.52	.117	10.73	.550	209.31
	[education=basic]	1.83	1.47	.213	6.21	.351	110.04
	[education=none]	0[b]	.	.	.	.	.

a. The reference category is no adaptation.
b. This parameter is set to zero because it is redundant.
** and * are significant levels at 1and 5% probabilities, respectively.
Prob> chi2 = 0.009
Log Likelihood= 240
Pseudo R2= (Cox and Snell= 0.586, Nagelkerke= 0.602, McFadden= 0.244)
Source: field data, 2019

A. Plant trees for shading

Holding age, household size, number of years working in Agriculture, farm location from the water source, and livestock ownership, the odds for a farmer with higher education (bachelor degree or more) of being planting trees for shading as a method to adapt to climate change rather than those who take no adaptation are 30.28 times (2928% higher than) the odds for a farmer with lower education. In other words, the relative log odds of being planting trees for shading as a method to adapt to climate change versus no adaptation will increase by 3.4 if moving from the lowest level of education (education= none) to the highest level (education= bachelor or more). The result is in line with many studies that showed a positive relationship and influence of education level of farmers on the adoption of new techniques and technologies (Igoden et al. 1990; Lin 1991; Deressa et al. 2009) furthermore using agricultural methods that adapt to negative impacts of climate change (Maddison, 2006).

B. Crop rotation

Holding education level, household size, number of years working in Agriculture, farm location from the water source, and livestock ownership, a one year decrease in farmers' age multiplies the odds of crop rotation to adapt to climate change rather than those who take no adaptation by 0.77, increases them by 23%. In other words, a one-year increase in farmers' age is associated with a 0.26 decrease in the relative log odds of being doing crop rotation versus no adaptation.

C. Cultivating one season

Holding age, household size, number of years working in Agriculture, education, and livestock ownership, the odds for a farmer in the middle for water source of cultivating one season as a method to adapt to climate change rather than those who take no adaptation are 0.044 times (96.5% higher than) the odds for a farmer located at the end of the water source. In other words, moving farmers who are located in the middle of the water source to the first water source leads to a decrease of being cultivating one season as a method to adapt to climate change by 3.13 versus those who take no adaptation.

D. Cultivate heat resistant varieties

Holding age, household size, number of years working in Agriculture, farm location from the water source, and livestock ownership, the odds for a farmer with higher education (bachelor degree or more) of being cultivating heat resistant varieties as a method to adapt to climate change rather than those who take no adaptation are 86.8 times (8583% higher than) the odds for a farmer with lower education. In other words, the relative log odds of being cultivating heat-resistant varieties as a method to adapt to climate change versus no adaptation will increase by 4.46 if moving from the lowest level of education (eduction= none) to the highest level (education= bachelor or more). The result is in line with (Igoden et al., 1990; Lin, 1991; Deressa et al., 2009 and Maddison, 2006).

IV. CONCLUSION

This study examines farmers' perception of climate change and how they adapt their farming in response to perceived changes. Moreover, it investigates factors influencing the choice of adaptation methods and identifies the main barriers that limit adaptation to climate change. The results of the study revealed that the majority of farmers interviewed perceived changes in temperature and rainfall, they perceived an increase in temperature in the first place and a lack of rainfall in the second place, 56.8% of the farmers modify their agriculture using various methods to adapt to negative impacts of climate change. Increased farm costs are considered the first negative impact of climate change ranked by farmers, while lack of funding is the main reason for not applying all methods that adapt to climate change impacts. The absence of extension services is the first obstacle for farmers to adapt to climate change followed by a lack of information. Water supply and irrigation development is the most urgent service for farmers for adaptation to climate change followed by providing information on climate change. There is a significant effect of education level, age, and farm location from the water source on the adaptation method to climate change, while household size, number of years working in Agriculture, and livestock ownership, didn't have a significant influence on the adaptation methods to climate change. Accordingly, the government should provide farmers with the necessary support such as providing information on climate change and its impact on agricultural production through extension services, moreover, ensuring credit facilities to enhance farmers' access to credit, which will increase their capability to modify their agricultural methods in response to climate change.

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