Chapter 14 Measuring The Effect of the Change in Climate Condition on Input Use in Agriculture in Konya, Turkey.

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Abstract

This study was conducted to determine effect of climate change (temperature and rainfall) on the amount of ınput uses such as fertilizer, pesticide, animal manure, family labour, paid labour and machine by selected farmer's.The minumum usable sample of farm enterprises were determined as 124 based on stratified sampling technique. The data were collected from six willages in Çumra and Sarayönü districts in Konya. Input applications as farmer preference under the increasing temperature and rainfall were compared with its under the decreasing temperature and rainfall situations. The binary logistic regression was applied to determine the influence of each selected agricultural practise on the probability that the change of temperature and rainfall conditions.

The results showed that when the temperature rises, the percantage of farmers who decrease the amount of chemicals (fertilizer and pesticide), the amount of paid labour increase. When the rainfall rises, the percantage of farmers who increase the amount of chemicals and the amount of family labour decrease. The other factors weren't significantly important at the level of probability or beter as 0.05.

Introductıon

It seems obvious that any significant change in climate on a global scale should impact local agriculture, and consequently affect the world's food supply. Considerable the study has gone into questions of just how farming might be affected by climate change in different regions, and by how much; and whether the net result may be harmful or beneficial, and to whom. As a result of study several uncertainties contrats occur for current projections. One relates to the degree of temperature increase and its geographic distribution, the other pertains to the concomitant changes likely to occur in the precipitation patterns that determine the water supply to crops, and to the evaporative demand imposed on crops by the temperaturer climate (Rosenzweig and Hillel, 2005).

The economic and social implications of global climate change, due to increases in atmospheric trace gas concentrations, are presently the subject of intense national and international political debate. In order to formulate policies to address this issue, the costs and benefits of the impacts of potential climate change recommended to be identified (Kane and at all.1992).

The economic effects of climate change on agriculture is particularly important since agriculture is among the more climate sensitive sectors. However, the assesments on economic impact of climate change on agriculture are few. Notable exceptions include Adams et al. (1988, 1990) and Arthur (1988). Adams incorporates climate change into a spatial equilibrium model to determine its effects on U.S. agricultural supply and demand. Arthur uses a linear programming model to calculate the effect of climate change on net revenues in Canadian agricultural sector. Also Arthur used an input/output model to estimate production effects in other sectors of the Canadian provincial economy. For Turkey, the study which was conducted was about the effect of climate change on wheat production.It is prepared by Tsuji at. all (2006). The result of made econometric analyses was showed that the farmers in Turkey responded to increase their wheat yield to the higher last year's real farm gate wheat price. Wheat yield in Turkey responded positively changes to the higher cumulative temperature and rainfall. Especially this result showed that Turkey wheat yield declines when april temperature become higher than 15 degree centigrade. This reflected heat damage to wheat in Turkey. Hence, the climate change decreases wheat yield.

Another study was conducted by Oguz at. all in Konya and Adana provinces in Turkey. The results of the study showed that the farmers in Konya changed crops production pattern relatively concern on rainfall quantity in March-May. At the same time the farmers in Adana changed crop production pattern by taking into consideration climate change such as global temperature and rainfall decrease in Adana too. The climate change impact on crop pattern was more significant in Konya than its in Adana since soil fertility is higher, ang irrigation area is larger in Adana.

In this study binary logistic regression was used to determine the impact of climate change on the farmers behaviours about ınput use. Therefore, the change of the farmers behaviour will show that probability of which climatic condition happen.

Materials and Methods

Population and Sample

Target population for this study was defined as Konya farm operators in the Cumra and Sarayonu districts. From these two locations, six villages were selected based on agricultural potential, geographic location, population intensity, and posibilities of representing socio-economic characteristics of rural life in the region. From each village a list of farm operators showing their farm sizes was obtained from the District Agricultural Office. List of six selected villages for each district made the accessible population of the study. Yamane's (2001) stratified sample size determination formula was used to identify the sample size. The equation for this formula is:

$$n = \frac{N \sum (N_h S_h)^2}{N^2 D^2 + \sum N_h S^2_h} \quad (1)$$

$$D = \frac{e^2}{t^2} \quad (2)$$

Where
n = sample size,
N = accessible population,
Nh = number of farms in a stratum,
Sh = standard deviation within a stratum,
D^2 = desired variance,
E = accepted error from the mean
t = t value corresponding the accepted confidence interval

Accepting 5 percent error from the mean (e) and 95 percent confidence interval (t = 1.645), the sample size was calculated as 124 (farm operators). This number were randomly selected.

Developing a Farm Level Sustainability Indicator

In order to compare farmers behaviour about input use in the two different climatic conditions-the changing of temperature and rainfall- and the effects of climate changes on agricultural production systems were examined by the researches. These changes were the numbers of farmer who decreased or levelled-off the amount of fertilizers, pesticide, animal manure, family labour, paid labour rather than family labour and machine.

Data Collection

The 6 farm level practices about input use indicators were properly worthed with two choices. If the amount of each practices decreases, the answer is "decreasing" and "no" otherwise. These were the independent variables of the study. Respondents were also asked whether or not they change of behaviour about input use and this was treated as the dependent variable of the study. Panel of experts established validity for the data colection instrument. It was also pre-tested and slight changes were made for establishing reliability. Data were collected in March and April 2006. SPSS – Version 10.0 (Statistical Package for the social sciences) was used for data analyses.

Analytical Procedures

The study used the chi-square contingency test for independence to determine whether significant differences existed between decreasing of temperature and increasing of temperature; increasing of rainfall and decreasing of rainfall in terms of the selected 6 factors which is about that farmers use the inputs in agriculture like the amount of fertilizer, pesticide, animal manure, family labour, paid labour and machine.

$$X^2 = \sum \frac{(n_i - E_i)}{E_i} \quad (3)$$

Where,
n_i = are the observed frequencies in the k categories and
E_i = represent the expected frequencies (Freund and Wilson, 1993)

For each factor (temperature and rainfall) 6 Chi-square tests were conducted to determine whether each of the agricultural practices selected was independent of changing climate condition (temperature and rainfall). "Although this test can describe relationships between or among variables, it cannot measure the combined influence of a group of explanatory variables on a specific dependent variable" (McLean – Meyinse 1997). Therefore, to analyse the influence of each explanatory variable on the dependent variable, which is a dichotomous variable, the binary logistic regression was used as a method (Maddala 1983; Grene 2000). Two different binary logistic regressions were applied for dependent variables such as temperature increase (y=1), or decrease (y=0). The dependent variable which was rainfall was coded if the rainfall increase (y=1), or decrease (y=0). The logit model is written:

$$\Pr ob(y=1) = \frac{e^{x\beta}}{1} \quad (4)$$

where;
Prob (y=1) is the probability pof 1,
E is the base of natural logarithm,
F(xβ) is the standart logistic distribution function, and
X is the explanatory variable vector, which include the selected agriculture practises

These were also collected as dichotomous variables with 1= the farmers decrease in the amount of input, and 0= otherwise. Six explanatory variables as showen below were used in this study (Table 1).

Table 1. Having used explanatory variables in the equations

Explanatory variables
Using chemical fertilizers (DUMCF) Decreasing (1) Leveling-off (0)
Using chemical pesticides (DUMCP) Decreasing (1) Leveling-off (0)
Using animal mannure (DUMAP) Decreasing (1) Leveling-off (0)
Using family labour(DUMFL) Decreasing (1) Leveling-off (0)
Using paid labour (DUMPL) Decreasing (1) Leveling-off (0)
Using farm machinery (DUMFM) Decreasing (1) Leveling-off (0)

The odds ratios for the explanatory variables were calculated considering the fallowing formula;

$$odds = \frac{P}{1-P} \qquad (5)$$

It indicates for a single explanatory variable that when holding all other variable constants, farmers who decrease the amount of input use is more or less likely to farmers who levell off the amount of input use regarding to the sign of their coefficient.

Findings

Results of the study are presented by the objectives. One of the study objective was to determine the descriptive statistics by the different climatic conditions. It was showed in Table 2.

Table 2. Descriptive Statistics of explanatory variables by the different climatic conditions (the number of farmers)

Factors	Decreasing of temparature	Increasing of temparature	Increasing of rainfall	Decreasing of rainfall
	N	N	N	N
Using Chemical Fertilizer				
Levelling-off (0)	37	13	1	44
Decreasing (1)	21	39	11	17
Increasing (2)	4	10	50	1
Using chemical pesticides				
Levelling-off (0)	30	13	1	35
Decreasing (1)	32	47	24	27
Increasing (2)	0	2	37	0
Using animal mannure				
Levelling-off (0)	26	17	5	28
Decreasing (1)	35	44	45	34
Increasing (2)	1	1	12	0
Using family labour				
Levelling-off (0)	8	19	2	9
Decreasing (1)	31	38	24	40
Increasing (2)	23	5	36	13
Using paid labour				
Levelling-off (0)	8	20	0	7
Decreasing (1)	33	41	30	43
Increasing (2)	21	1	32	12
Using farm machinery				
Levelling-off (0)	6	20	1	4
Decreasing (1)	29	37	23	31
Increasing (2)	27	5	38	27

The second objective of the study was to determine if the using of each selected factors differs between behaving farmers in the increasing and decreasing temperature situations. Chi-square test of independence procedure was used to accomplish this objective and the results were showed in Table 3. From the table, 5 of total factors were found significant at the level of 0,01 probability or better. One factor wasn't found significant at the level of 0,05 probability.

While thirty-four percent of the farmers decrease in amount of using chemical fertilizers in the situation of the increasing of temperature, about sixty percent of farmers level-off their amount of using chemical fertilizer in the situation of the increasing of temperature. These findings show that in the situation of the increasing of temperature, farmers have more tendency of levelling-off in amount of using chemical fertilizers.

About seventy-six percent of the farmers decrease in amount of using chemical pesticides in the situation of the decreasing of temperature, about fourty-eight percent of farmers level-off their amount of using chemical fertilizer in the situation of the increasing of temperature. These findings show that in the situation of the decreasing of temperature, farmers have more tendency of decreasing in using of chemical pesticides.

When the relationship between temperature and using of animal manure examine, it wasn't significant in the level of 0,05 probability. While the percentage of farmers who decrease in amount of using animal manure in the decreasing temperature situation is 70,97 %, the remended (20,97%) wasn't change their behaviour.

The relationship between the temperature and using of family labour was found as significantly in the level of 0,01 probability by using Chi-square anlyses. However, when the temperature increase, the farmers have more tendency of decreasing in using of family labour.

The relationship between the temperature and paid labour was found as significantly at the level of 0,01 probability with Chi-square anlyses. So that when the temperature increase, the farmers have more tendency of decreasing in using of paid labour.

The last significant factor was the using of machine. The result of Chi-square analyses was found as significant at the level of 0,01 probability. The percentage of farmers who decrease in using of machine when the temperature rises was 46,77%. It can be said that the percentage of decreasing in machine use was more significant than the other situations, the temperature rises.

Table 3. Differences between the number of farmers decreasing the amount of input use and levelling off in the two different rainfall condition

Factors	Increasing of tempearture		Decreasing of temperature		χ^2	P
	N	%	N	%		
Using Chemical Fertilizer						
Levelling-off (0)	37	59,68	13	20,97		
Decreasing (1)	21	33,87	39	62,90		
Increasing (2)	4	6,45	10	16,13	19,491	0,000
Using chemical pesticides						
Levelling-off (0)	30	48,39	13	20,97		
Decreasing (1)	32	51,61	47	75,81		
Increasing (2)	0	0,00	2	3,23	11,569	0,003
Using animal mannure						
Levelling-off (0)	26	41,94	17	27,42		
Decreasing (1)	35	56,45	44	70,97		
Increasing (2)	1	1,61	1	1,61	2,909	0,234
Using family labour						
Levelling-off (0)	8	12,90	19	30,65		
Decreasing (1)	31	50,00	38	61,29		
Increasing (2)	23	37,10	5	8,06	16,763	0,000
Using paid labour						
Levelling-off (0)	8	12,90	20	32,26		
Decreasing (1)	33	53,23	41	66,13		
Increasing (2)	21	33,87	1	1,61	24,190	0,000
Using farm machinery						
Levelling-off (0)	6	9,68	20	32,26		
Decreasing (1)	29	46,77	37	59,68		
Increasing (2)	27	43,55	5	8,06	23,633	0,000

When we examine the relationship rainfall and the input use, it was found that the relationship among 5 factors with rainfall were significant at the level of 99% confidence interval. Only the factor of machine use wasn't significant at he level of 95% confidence interval. But it was significant at the level of 0.10 probability level (Table 4). When both temperature increase and rainfall decrease, the amount of using fertilizer decreases. Also planting time of wheat extended from first week of September to last week of October through first week of November in the rainfall area. Harwested time changed from middle of July to first week of August in last decade. When the amount of rainfall decrease, the percantage of farmers who use animal manure, family labour paid labour and farm machinery have more tendency to decrease in amount of them. But when the amount of rainfall increase, ıt most of the farmers tend to increase the amount of using chemical fertilizer and chemical pesticide.

Table 4. Differences between the number of farmers decreasing the amount of input use and levelling off in the two different rainfall condition

Factors	Increasing of rainfall		Decreasing of rainfall		χ^2	P
	N	%	N	%		
Using Chemical Fertilizer						
Levelling-off (0)	1	1,61	44	70,97		
Decreasing (1)	11	17,74	17	27,42		
Increasing (2)	50	80,65	1	1,61	89,453	0,000
Using chemical pesticides						
Levelling-off (0)	1	1,61	35	56,45		
Decreasing (1)	24	38,71	27	43,55		
Increasing (2)	37	59,68	0	0,00	69,288	0,000
Using animal mannure						
Levelling-off (0)	5	8,06	28	45,16		
Decreasing (1)	45	72,58	34	54,84		
Increasing (2)	12	19,35	0	0,00	29,562	0,000
Using family labour						
Levelling-off (0)	2	3,23	9	14,52		
Decreasing (1)	24	38,71	40	64,52		
Increasing (2)	36	58,06	13	20,97	19,250	0,000
Using paid labour						
Levelling-off (0)	0	0,00	7	11,29		
Decreasing (1)	30	48,39	43	69,35		
Increasing (2)	32	51,61	12	19,35	18,406	0,000
Using farm machinery						
Levelling-off (0)	1	1,61	4	6,45		
Decreasing (1)	23	37,10	31	50,00		
Increasing (2)	38	61,29	27	43,55	4,847	0,089

Logistic regression analysis was used to estimate the probability of respondents the farmers behaviour with the temperature and rain change. Because of that the effect of the temperature and the rain change on the behaviour of farmer about input use examined in two different equation.

First of all when we look at the effect of the temperature change on farmer behaviour, the full model was significant, X^2=48,295, p<0,01. The model had a -2Log Likelihood statistic of 123,605, a Cox and Snell R Square of 0,32, and Nagelkere R Square of 0,43. It was able to correctly classify 93,5% of temperature decrease and 58,1% of temperature increase, for an overall success rate of 75,8%.

The logistic binomial model estimation for whether or not change of temperature was presented in Table 5, which includes the explanatory variables, coefficients, standart error, the Wald X^2, p values and odd ratios

Of 6 explanatory variables 3 had significant effects at the level of 0.05 probability. These are the using of chemical fertilizers, chemical pesticide and paid labour. All of the significant variables had the expected signs. The odds ratios for the significant variables can be interpreted as the fallowing. Holding all other variables constant, the percantage of farmers who decreasing in the amount of using chemical fertilizer was 10,01 times more likely than the percantage of farmers who levelling off the amount of using chemical fertilizer in the situation of increasing temperature. Farmers who decreasing in the amount of using chemical pesticide was 20,84 times, farmers who increasing of using paid labour are 0,05 times less likely to the percantage of farmers who levelling off using them in the situation of increasing temperature.

Table 5. Logistic binomial model estimation for increasing temperature and decreasing temperature

Factors	Coefficient	Standart Error	Wald X2	P Value	Odds-ratio
DUMCF	2,304***	0,762	9,131	0,003	10,0142
DUMCP	3,037**	1,529	3,947	0,047	20,8426
DUMAM	-1,678	1,339	1,571	0,210	0,1867
DUMFL	-0,318	1,161	0,075	0,784	0,7276
DUMPL	-3,043*	1,283	5,622	0,018	0,0477
DUMFM	-0,399	1,179	0,114	0,735	0,671
Constant	-0,480	0,268	3,219	0,073	0,6188

*** 0,01, **0,05, *0,10

First of all, when we look at the effect of the rainfall change on farmer behaviour, the full model was significant, X^2=106,98, p<0,01. The model had a -2Log Likelihood statistic of 64,92, a Cox and Snell R Square of 0,58, and Nagelkere R Square of 0,77. It was able to classify correctly 77,40% of temperature decrease and 96,80% of temperature increase, for an overall success rate of 87,108%.

The logistic binomial model estimation for whether or not change of rainfall is presented in Table 4, which includes the explanatory variables, coefficients, standart error, the Wald X^2, p values and odd ratios.

When we look at the model about rainfall, we use same 6 factors again in this model. In this model the amount of using chemical fertilizers, family labour and chemical pesticide were found that they were significant at 99% and 95% significant level, respectively. So that, The decreasing of the number of farmer who decrease the amount of chemical fertilizer (dummy=1) closes p probability value to the number of zero "0" that means of decreasing of the rainfall because the coefficient of chemical fertilizer is negatif value. So that diminishing of the number of farmer who decrease in using of chemical fertilizer means that the amount of rainfall lessen. This situation was valid for chemical pesticide. However, the effect of using of family labour was different from the others. Because its coefficient is pozitif value. So that decreasing of the farmers who diminish the amount of family labour means that the amount of rainfall increases. Because if the dummy is equal to 1 (decreasing of family labour) closes p probability value to number of one "1". It means that the amount of rainfall increases. The odds ratios for the significant variables can be interpreted as the fallowing. Holding all other variables constant, the percantage of farmers who decreasing of proper use chemical fertilizer are 0,02 times less and farmers who decreasing of proper use chemical pesticide are 0,05 times likely to the percantage of farmers who levelling off the amount of using chemical fertilizer and pesticide respectively in the situation of decreasing rainfall. Farmers who increasing of proper use family labour are 62,16 times more likely to the percantage of farmers who levelling off using them in the situation of decreasing rainfall.

Table 6. Logistic binomial model estimation for increasing rainfall and decreasing rainfall

Factors	Coefficient	Standart Error	Wald X2	P Value	Odds-ratio
DUMCF	-3,662***	1,187	9,52	0,002	0,026
DUMCP	-2,971**	1,399	4,511	0,034	0,051
DUMAM	-2,477	1,852	1,79	0,181	0,084
DUMFL	4,13***	1,601	6,65	0,010	62,159
DUMPL	-12,154	74,579	0,027	0,871	0,000
DUMFM	7,512	58,583	0,016	0,898	1829,595
Constant	0,629	0,338	3,467	0,063	1,875

*** 0,01, **0,05, *0,10

Results

As a results of the study, the impact of the climate change on farmers behaviours was found significant decreasing amount of chemicals(fertilizier and pesticide) and increasing the amount of paid labour when the temperature rised.

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