Farmers' Rational Perception and Inefficient Response to the Drought
- A Case Study of Wheat Production in Adana and Konya Regions -

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1. Introduction

Impact of weather shocks such as drought on agricultural production is composed of not only the agronomical factors but also farmers' response action to them. Weather shocks firstly affect technological relationship between input and output. Farmer decides the amount of agricultural inputs in order to maximize their profits under this changed technological condition. If they don't recognize this condition correctly, however, or they are suffered from some constraints such as credit constraint, limited access to new technology, imperfect market of agricultural outputs and inputs, they cannot make the optimum decisions. In order to clarify the impact of weather shocks on agricultural production, we need to examine the following questions. First, how weather shocks affect the technological relationship between input and output? Second, Do farmers perceive correctly the changed technological conditions? Third, Do farmers change agricultural inputs optimally based on their correct response to weather shocks?

We have conducted the farm household surveys three times in Adana and Konya regions of Turkey from 2002 to 2004[1]. Farmers were affected by the drought shock in 2004, especially in Adana region. On the contrary, 2002 is said to be normal weather year. By comparing the farm household data of 2004 with these of 2002[2], we can examine the impact of drought on agricultural production. These farm data can be divided into the following four groups according to their attributions, that is, 1. Adana irrigated area 2. Adana non-irrigated area 3. Konya irrigated area 4. Konya non-irrigated area.

In this report, we will focus on wheat production. It is because wheat is the main product in all four areas on the aspect from land use for crop production. Furthermore, wheat production was affected most severely by the drought and high temperature shocks of 2004[3].

In section 2, the farmers' perception to drought shock will be shown. In section 3, the correctness of farmers' perception to drought will be checked by the analysis of wheat production function. In section 4, the differences between farmers' actual and optimal response actions to the drought will be examined by calculating the input efficiency under the wheat production of 2002 (normal condition) and 2004 (drought shock condition). Finally we will analyze the computed results and research issues in the future.

2 Farmers' Perception of Input Response to Drought

We added some new two questions about farmers' perception of weather shocks to our old questionnaire in 2004. First is in which month a weather shock such as drought and high temperature affects agricultural production most crucially? Second is whether agricultural inputs such as fertilizer, pesticide, and irrigation water will be increased or decreased in the case of weather shock. In this section, firstly, farmers' perception to drought

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[1] The farm survey was conducted one time in each year.

[2] Because the survey data of 2003 lacks the information to estimate production function, the data of this year was excluded from this analysis.

[3] This information was informed from farmers and also the officer of Agricultural Ministry in Adana region.

and high temperature shocks will be examined.

In Adana region, 75.5% of farmers answer that the drought during March - June damage the wheat production most strongly. In Konya region, 93.1% of farmers have the same answer. 85.7% of Adana's farmers answer that high temperature shock during March - June damages the wheat production most severely. 90.3% of Konya' farmers have the same answer. These periods are the season of pollination and fructification for wheat production. Normal temperature and enough water are required for good vegetation[4].

Table 1. Change of input use under drought

Unit:Household numb

	Decrease	Same	Increase	Total
Adana IR	8	7	0	15
Adana NIR	11	13	1	25
Konya IR	21	8	0	29
Konya NIR	24	3	0	27
Total	64	31	1	96

About irrigation

Unit:Household numb

	Decrease	Same	Increase	Total
Adana IR	0	6	9	15
Konya IR	0	2	27	29
Total	0	8	36	44

Source) Farm Survey in 2004
IR means irrigated area, NIR meand non irrigated area.
Counting was done for famers who answered that if drought happens during March to June, wheat production

Table 2 Change of input use under high temperature shock.

About fertilizer

Unit:Household number

	Decrease	Same	Increase	Total
Adana IR	8	4	0	12
Adana NIR	23	5	0	28
Konya IR	16	14	0	30
Konya NIR	18	8	0	26
Total	65	31	0	96

About irrigation

Unit:Household number

	Decrease	Same	Increase	Total
Adana IR	0	5	4	9
Konya IR	1	13	6	20
Total	1	18	10	29

Source) Farm Survey in 2004
IR means irrigated area, NIR meand non irrigated area.
Counting was done for famers who answered that if high temperature shock happens during March to June, wheat production is damaged most strongly.

Table 1 & 2 show the farmers' perception about increase and decrease of fertilizer and irrigation water in the case of the drought and high temperature shocks during March - June. Most of farmers answer that the use of fertilizer should be decreased in all four areas. If farmers would use fertilizer too much under the condition of drought and high temperature, it is said that roots of wheat were perished. In the next section, we test the rationality of this farmers' perception about the fertilizer decrease. Predictably, most of farmers of irrigated areas answer that the use of irrigation should be increased.

3. Rational Farmers' Perception about Fertilizer Use in the Case of Drought

In this section, we estimate the production function of wheat in order to 1. examine how drought and high temperature shocks affect the technological relationship between input and output in wheat production. 2. test the rationality of farmers' perception about fertilizer use under the weather shocks.

As mentioned above, the data used for estimating production function is the farm household data collected. The data of 2002 (normal year) and 2004 (drought year) are pooled to estimate production function in a lamp. It is noted that surveyed villages in 2002 and 2004 are not same. But we assume that the village surveyed in 2002 has the same technological condition as the village surveyed in 2004 has in each area. This assumption is supported by the following facts. Each area's actually surveyed yield is shown on Table 3. And we have the information from our interview about each area's standard wheat yield in normal year, that is, 518kg/da in Adana irrigated area, 368kg/da in Adana non irrigated area, 408kg/da in Konya irrigated area, and 216kg/da in Konya non irrigated area. Compared standard yield with surveyed yield of Table 3 respectively, we can not find big differences between each other. Our surveyed village has standard technological condition respectively, so that the same technological condition of each area can be assumed.

[4] If precipitation is too much in the season of pollination, wheat is also damaged. Tsujii et al. (2005) find the evidence using time series data of Adana region. So the distribution of precipitation during March to June is also important.

Table 3 Wheat production in 2002 and 2004

		Cultivate Area (da)	Yield (kg/da)	Fertilizer (kg/da)
Adana IR	2002	65.4	512.7	47.5
	2004	74.8	346.9	57.2
Adana NIR	2002	60.4	326.0	61.5
	2004	46.5	165.8	69.0
Konya IR	2002	35.1	398.5	34.3
	2004	105.7	409.2	42.2
Konya NIR	2002	79.8	236.9	28.6
	2004	97.8	185.9	21.6

Source) Farm survey in 2002 & 2004
IR means irrigated area and NIR means non irrigated area.

By using OLS (Ordinary Least Squares) estimation procedure, Cobb-Douglas production function of wheat of each area is computed. Firstly we adopted days of family labor, days of hired labor, pesticide input, and water use as independent variables. But significant results of estimation can not be obtained, because of multicolinearity and imperfection of collected data. After try and error procedure, we choose the following variables which are considered to explain farmers' response to weather shock most crucially.

Dependent variable is log of wheat production (LWHTPRDUCT). Independent variables are log of planted area of wheat (LWHTAREA), log of the fertilizer input to wheat (LFERTILIZER), and coefficient dummy variable of the fertilizer input (LFERTILIZER_CDM). Coefficient dummy takes zero in normal year and takes log of fertilizer input in drought year. This variable reflects the impact of drought and high temperature shocks on technological relationship between input and output.

Table 4 shows the result of estimation. The production elasticity of land of irrigated areas is higher than that of non irrigated areas. This means that the productivity of land of irrigated areas is higher than that of non irrigated areas. In contrast, the production elasticity of fertilizer of non-irrigated areas is higher than that of irrigated areas. The sign conditions of coefficient dummy variable (LFERTILIZER _CDM) of all for areas are minus. This means that the productivity of fertilizer declines in drought year. Insufficient significance of coefficients dummy of Konya shows the fact that the impact of drought in 2004 was more severe in Adana than in Konya.

Table 4 Results of the estimation of production function

Adana	IR Area			NIR Area		
	Coefficient	t-value		Coefficient	t-value	
LWHTAREA	1.028	20.21	***	0.676	4.92	***
LFERTILIZER	0.071	2.46	**	0.355	2.88	**
LFERTILIZER_CDM	-0.057	-5.24	***	-0.091	-8.22	***
CONSTANT	5.613	24.05	***	4.162	8.22	***
No. of observation	33			65		
Adj. R-squared	0.943			0.905		
BPG test statistics	0.31			0.45		

Konya	IR Area			NIR Area		
	Coefficient	t-value		Coefficient	t-value	
LWHTAREA	1.021	27.74	***	0.615	6.12	***
LFERTILIZER	0.028	1.20		0.276	4.77	***
LFERTILIZER_CDM	-0.005	-0.60		-0.029	-1.27	
CONSTANT	5.721	45.69	***	5.010	13.71	***
No. of observation	54			36		
Adj. R-squared	0.975			0.802		
BPG test statistics	0.05			0.09		

** Significant at 5% level. *** Significant at 1% level.
BPG (Breush-Pagan-Godfrey) test statistics test heteroskedasticity of multiple regression.

As mentioned in section 2, most of farmers answer that they will reduce input of fertilizer in the case of drought. Estimation results support the rationality of farmers' this perception, because farmers should reduce input of fertilizer in the case of decline of fertilizer productivity in order to maximize their profit.

4. Farmers' Inefficient Response Action to the Drought

In this section, firstly we will find the optimal level of fertilizer input. According to the production economics theory, profit can be maximized at the point that marginal productivity of the input is equal to the price ratio between the input (fertilizer) and output (wheat), supposing other inputs are given. This point, therefore, can be defined as optimum level. These data can be calculated by the estimated production elasticities and the collected price data in farm survey. By comparing the optimum level of input with actual level, we can check whether farmers input fertilizer at the optimum level or not. Especially, by comparison between the optimum and the actual level of input in the case of drought, we can examine whether farmers can response optimally to the drought or not.

The marginal productivity at the optimum input level is supposed to be the average price ratio. Marginal productivity at the actual input level is

Table 5 Optimal and actual input of fertilizer to wheat

		Marginal Productivity		Fertilizer input (kg/da)	
		Optimal	Actual	Optimal	Actual
Adana IR	2002	1.3569	0.8466	27.5	47.5
	2004	1.0066	0.0953	4.7	57.2
Adana NIR	2002	0.9591	1.6006	165.6	61.5
	2004	0.9882	0.6740	34.7	69.0
Konya IR	2002	1.0589	0.7792	10.4	34.3
	2004	1.1360	0.1559	8.3	42.2
Konya NIR	2002	1.1368	2.4612	74.3	28.6
	2004	1.3858	1.7773	33.9	21.6

IR means irrigated area, NIR meand non irrigated area.

evaluated based on average planted size of wheat and average input of fertilizer. Optimum input level of fertilizer can be calculated by the average planted size and the optimal marginal productivity that was calculated above. Each variables are calculated on each area of each year respectively.

Table 5 shows the result of calculation. Compared to normal year (2002), the optimum input levels of fertilizer have decreased in drought year (2004) in all areas. The actual input levels of fertilizer, however, increased in drought year in three areas except for Konya non-irrigated. In Konya non -irrigated area, farmers have not reduced fertilizer use so much, even though they did not increase fertilizer.

These facts imply the important characteristics of farmers' action in Adana and Konya, that is, farmers could not respond optimally to the drought shock of 2004. Even though they have the rational perceptions that fertilizer should be reduced in the case of drought, they do not obey their perception. They are apt to input fertilizer more than optimum level. They are apt to response to the drought shock inefficiently. This inefficiency can be explained as follows[5].

1) Customary behavior of farmers

In spite of enlightened knowledge about drought shock, farmers do not want to change his every day's customary behavior.

2) Remained fertilizer for second crop

Just after harvesting first crop wheat, farmers must start to sow second crop maize in irrigated area. The remained fertilizer in the soil, that is originally input for wheat, is said to be effective in growing maize. Farmers dislike reducing the fertilizer input, even though they are affected by drought.

3) Self consumption use

Wheat is grown for not only sale but also self consumption in non irrigated area. Farmers cannot decrease the amount of wheat production for their subsistence. Even though they know that fertilizer input must be reduced to profit maximization, they cannot reduce fertilizer and reduce their wheat production.

In addition to this kind of inefficiency, it must be noticed that the actual input of fertilizer is more than the optimal input in irrigated areas and the actual is lower than the optimal in Konya non-irrigated areas. These facts show that farmers input fertilizer excessively in irrigated areas and insufficiently in non-irrigated areas. We can find another inefficiency of farmers' behavior.

5. Conclusion

This report shows Turkish farmers' inefficient response action to weather shocks in spite of their rational perceptions. Even though they know that fertilizer should be reduced in the case of drought, they are apt to input fertilizer more than optimum level.

Climate change will influence agriculture firstly on the base of agronomical points. But agricultural activities are conducted by farmers. Through their inefficient behavior to weather shocks, climate change could be amplified to influence land, water resources.

This report presented some descriptive explanations for farmers' inefficiency under drought shock. In future we examine these explanation using theoretical model and quantitative analyses.

[5] Risk theory may solve these issues in non irrigated areas. Because risk theory shows that farmers reduce use of inputs under risk (Please see Sadoulet and de Janvry (1995) for the review of risk theory.). However, the analyses of farmer's behavior under risk treat how farmers under risk behave in normal years, and not in the year the risk happened actually. Also the theory of farmer's behavior under risk generally assumes that the farmer must decide the use of inputs before they know the risk happens or not(Lamb (2003) examined the relationship between fertilizer use and off-farm labor markets, using risk theory. He also treat farmers must decide the use of fertilizer before farmers know whether the risk happens or not.). However, in research areas, farmers use fertilizer in spring season. So, the assumption that farmers cannot know whether the risk happens or not before they decide the use of fertilizer is too strict.

6. References

Lamb, Russell L., 2003: "Fertilizer Use, Risk, and Off-Farm Labor Markets in the Semi-Arid Tropics of India," *American Journal of Agricultural Economics*, Vol. 85, Iss. 2, pp. 359-371.

Sadoulet, E. and A. de Janvry, 1995: *Quantitative Development Policy Analysis*, Baltimore and London: The Johns Hopkins University Press.

Tsujii, H., M. Kusadokoro, T. Maru, U. Gűltekin, and K. Taşdan, 2005, "Current Research Status of the Socio-Economic Team of the ICCAP and One Analysis of the Impacts of Weather to Wheat Production in Adana and Konya" in Research Team for the ICCAP Project, Research Institute for Humanity eds. *Proceedings of the International Workshop for the Research Project on the Impact of Climate Change on Agricultural Production System in Arid Areas(ICCAP)*, Research Institute for Humanity, pp.27-34.