Advance Report of the Socio-economic Sub-group of the ICCAP Project

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1. Introduction

In this paper we like to present the current status and some research results of the socio-economic group in the ICCAP project regarding the impacts of pseudo-warming to cropping pattern, land use and water use in Adana and Konya.

2. The Four Components of the ICCAP's Socio-economic and Institutional Study and the Current Status

2.1 The Four Components and Their Relationship

There are four components in the ICCAP's Socio-economic and Institutional Study.

(1) An economic analysis of the farm survey data regarding the interactions among farmers' perception of and responses to climatic changes, technological changes, and policy and institutional changes and their impacts to farmers' economy and agricultural sustainability.

Rearchers in charge: Hiroshi Tsujii, Y. Asami, Kusadokoro, Maru, Onur Erkan, Ms. Cennet Oguz, Kenan, Ms. Basen, Karayaci, Kan, Avci, Ufuk Gultekin, Kemaletin Tasdan, Baran, Ms. Naciye

(2) An input-output analysis on the interrelations among rural industrial structure, agricultural productivities, and climatic change.

Researcher in charge: M. Kgatsume

(3) The new institutional economics analyses of the use of commons such as water and soil by farmers, and pastoralists.

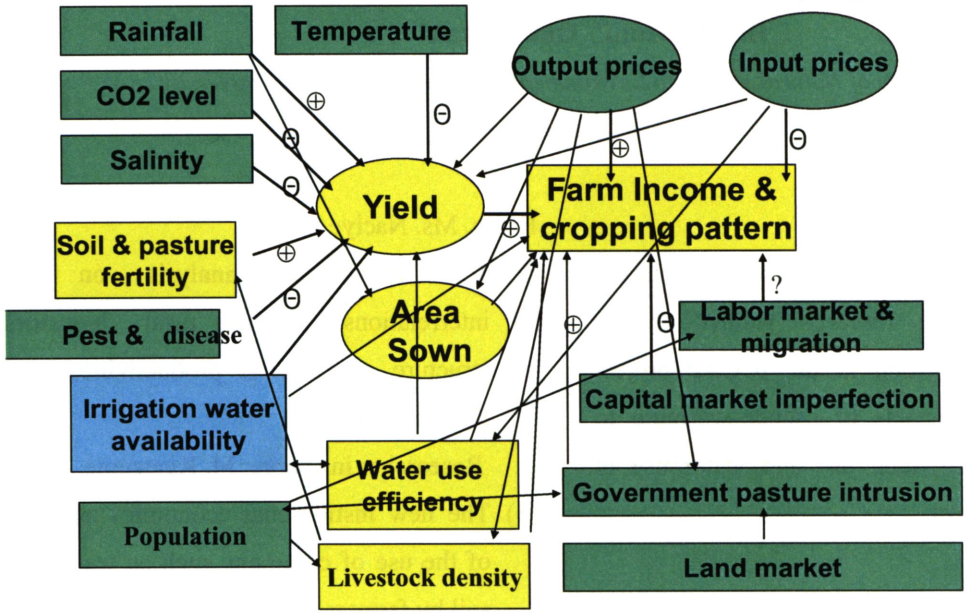
Researchers in charge: Y. Asami, Umetsu, and Tsujii.

(4) An econometric and agro-climatological study of the interactions among production of wheat, barley and other major crops, weather variables, prices of wheat and other major crops, and climatic change in Konya and Adana.

Researchers in charge: H. Tsujii, and Ufuk Gultekin.

These four components are related as shown by the following diagram.

The Variable Relation Structure for Socio-economic Sub-group



2.2 Current Status of the Socio-economic Research and its Four Components

2.2.1 Overall status

Two methodological memos for the ICCAP socio-economic research project were written by H. Tsujii in 2003 and 2004. Farm surveys were conducted in Adana and Konya by Japanese and Turkish graduate students in 2002, 2003, and 2004. Additional farm survey was conducted in Adana early 2006, and is being conducted in Konya in March and April 2006. The collected data from earlier farm surveys were input and analyzed. Turkish Socio-economic sub-group in cooperation with Tsujii has done farm survey in Adana and Konya regarding farmers' perception of climatic change and their responses to the perception in 2005. As Japan side has done similar farm survey during last three years, both side try to analyze the collected data and to integrate the result now. Three master theses using the results of the farm surveys were written by the Japanese students in February 2003, and another master thesis was written in February 2004. Dr. Erkan, Gulteklin, and Tasdan have visited Kyoto University for short periods during last three years. An English interim report of the socio-economic team was published and distributed in February 2005. Dr. Gultekin visited Japan for 6 months in order to work for Dr. Tsujii's econometric work in 2005. Through these research steps we have discussed our research objectives and research methodology, and have arrived at the current status of somewhat integrated research objectives and methodology.

2.2.2 An economic analysis of the farm survey data regarding the interactions among farmers' perception of and responses to climatic changes, technological changes, and policy and institutional changes and the impacts of climatic change to farmers' behavior.

Several approaching methodologies for economic analysis of the interactions among farmers' perception of and their responses to climatic changes, technological changes and policy and institutional changes have been sought in the research projects of Hiroshi Tsujii conducted in Nigeria, Tanzania, Indonesia, and Japan using the farm questionnaire similar to the one used in Turkey. English papers by Tsujii and others have been published and were accepted in international journals.

Early this year Kusadokoro, Maru, Erkan, Gultekin, Tsujii and others have conducted farm survey in the following villages in Adana.

Irrigated Villages

- Geçitli (Yüreğir District; 26Households)
- Gerdan (Seyhan District; 25Households)

Rain-fed Villages

- Yeniyayla and Cihadiye (Yüreğir District; 28Households)
- Boztahta (Aladağ District; 27Households)

Tsujii, Cennet, Erkan, Kenan and others conducted farm survey of about 30 farms in Cesimilesevile(rainfed) and Arikoren(irrigated) in Konya, and we plan to conduct farm survey of about 70 more farms in these villages and in Yaglibayat this year soon.

I shall summarize the following Kusadokoro and Maru's papers as follows: Based on the information collected from this survey, from earlier surveys of ours, and other sources Kusadokoro concluded as follows:

1. The dominance of cotton and wheat in Adana before 1975 had been changed, and wheat has become the dominant crop by the decline of cotton price and increasing shortage of cotton harvesting labor.
2. Thus in the rain-fed area of Adana wheat and cotton rotation had ceased and wheat monoculture was established and the inherent soil fertility has decreased. This decline has been compensated by modern inputs.
3. After 1990 in the rain-fed area of Adana shortage of grazing grass caused mainly by overgrazing and partially by illegal conversion of the government pasture land to crop land by farmers led wheat and barley rotation be adopted by the farmers there in which barley was fed to animals. This has enforced crop and livestock integration and the wheat and barley rotation contributed to soil fertility maintenance.
4. In the irrigated area in Adana, maize and citrus have become important as the factories for sweetening and citrus juice were established, and new maize varieties were introduced after cotton production had disappeared. Single cropping of wheat , maize, and other field crops became popular and was adopted by large owner farmers because they prefer better soil fertility

conservation by half year fallow of the single cropping.

5. The double cropping of wheat and maize has become popular among tenant farmers in the irrigated area of Adana. This system is soil fertility depleting, but tenant farmers are not much concerned about this problem, and preferred this system because it has higher land productivity than the single cropping.
6. Citrus is planted widely in Adana. Since it is a perennial crop, tenant farmers cannot plant this crop as tenancy of irrigated land is annually contracted in Adana.
7. Vegetables, especially watermelon is very popular among tenants and small farmers in the irrigated area of Adana, because tenants can evade continuous cropping problem of vegetables by changing the rented land every year, and the vegetables have the highest land productivity among the crops discussed here.

Maru analyzed the relationship between global warming and feeding types, growth stages of livestock, milk yield, and growth of livestock in Adana.

2.2.3 Impact of climatic change to agricultural and national economy by the IO Analysis

In this research, the following analyses were carried out during 2004 and 2005.

(1). Generation of Agriculture based IO table in 3 time point (1985, 1990, 1996)

(2). Prediction of time series IO coefficients and output shares by RAS method and the Markov Transition Probability Matrix.

(3). Simulation on the effects of weather change on productivities.

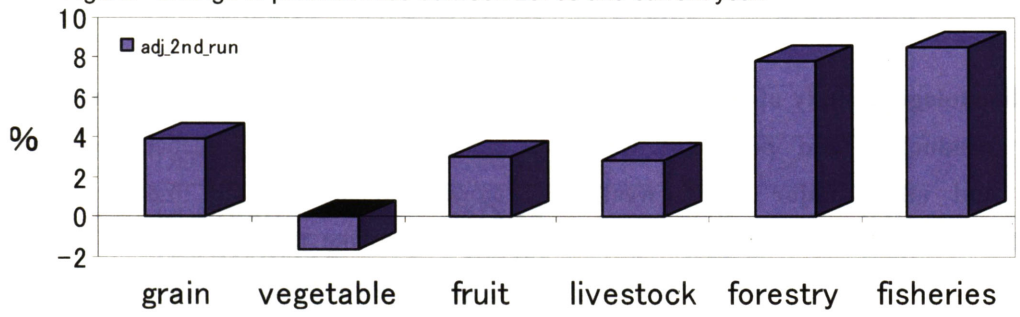
(4). Simulation on the effects of climatic change on productivities.

(5). Simulation on the effects of the EU accession on production amount.

(1) to (3) were done in 2004. More or less good estimation result between the time series IO coefficients and weather variables were obtained.

Then changes in the productivities of major agricultural sectors in Turkey from now to 2070 are calculated using the predicted changes in the May rainfall and temperature in Konya and in May temperature and December rainfall in Adana from now to 2070 in Dr. Kimura's RCM calculatuion. The result of this simulation is shown in the next figure.

Figure. Change of productivities between 2070s and current year.



This figure shows that the productivity of forestry and fishery sectors increases most, while it of grain, fruits, and livestock sectors increases moderately as global warming will occur. This is may be because the products of last three sectors are produced under more protected condition than it in the forestry sector. The predicted increase of grain sector productivity in this study does not necessarily contradict with Tsujii & Gultekin's prediction in the Econ group study of decrease in wheat and barley production, because productivity and production are different concepts. The predicted decrease in the vegetable sector productivity can not be explained at the present time.

Then the effects of Turkey's accession to the EU are estimated for 2073, by estimating and using the Markov transition probability matrix based on 85 and 96 agricultural IO matrices, and adjusting production amount shares according to the EU's help to Turkey during pre-accession period and fishing quota following the ICCAT. Much sharper increases in the product shares for fruit and vegetable sectors, and much sharper decreases in the product shares for gtrain and livestock sectors comparing with the non-accession scenario were estimated for the period from now to 2073.

2.2.4 The new institutional economics analyses of the roles of the water users' associations (WUAs).

A survey of the water users'associations in Adana was done by Umetsu in 2003. Partly based on this survey, a numerical optimization analysis of crop combination in Adana by maximizing the expected value of the total gross revenue of the crops grown minus covariance matrix of crops' revenue multiplied by risk aversion parameter of the farmers was done by Umetsu in 2005. Several hypothetical risk aversion levels of the farmers, and hypothetical irrigation water deficiency levels related with global warming were assumed, and hypothetical numerical calculation was conducted. Naturally it was found that risk aversion levels affected optimal crop combination. Irrigation water abundance was also found to be an important characteristic of Adana agriculture.

2.2.5 An econometric and

agro-climatological study of the interactions among production and prices of wheat, barley and other major crops, weather variables, and climatic change in Konya and Adana.

In this study we present a result of our econometric analysis of the effects of heat damage, drought, and output prices to wheat and barley production, and the evaluation of the impacts of pseudo-warming to these crops in Adana and Konya for 2070 based on the estimated yield and area sown functions for wheat and barley in these areas and on the RCM climatic projection by Dr. Kimura. In the near future, we shall estimate models for other important crops in Adana and Konya, considering the interdependences between these crops, and analyze the impacts of global warming to the farmers' behavior concerning cropping pattern, land use and water use.

This study follows the methodology used in the past econometric studies of H. Tsujii on the similar topic conducted for Japan and Thailand. Here we just show in the following figures the results of our econometric study of wheat for Adana, and Konya only. The period of analysis is for 1951 to 1998, and the linear function is used for the analysis. The variable description for the wheat yield function for Adana is shown in Table 1 just below.

Table 1. Description of the Variables for the Wheat Yield Function for Adana

NPC	:	Nominal Price Change
DDMA(t)10	:	Drought Effect in May in year (t) (1 if rainfall <= 10%, 0, otherwise)
DHDAA(t)16.2	:	Heat damage in April in year (t) (1 if temperature >= 16.2 °C, 0, otherwise)
DHDMA(t)23.5	:	Heat damage in May in year (t) (1 if temperature >= 23.5 °C, 0, otherwise)

Table 2. The Estimated Wheat Yield Function for Adana

	R^2= 0.261	AR^2= 0.186	DW= 0.758
Variables	**Coefficient**	**t-value**	**Significant**
CONSTANT	2417.33	6.84	0.00
NPC	11.60	3.41	0.00
DDMA(t)10	-286.29	-0.61	0.54
DHDAA(t)16.2	-179.24	-0.52	0.61
DHDMA(t)23.5	-409.09	-0.55	0.59

Table 3. Description of the Variables for the Wheat Yield Function for Konya

NPC	:	Nominal Price Change
CROCT(t-1)MAY(t)	:	Cumulative monthly rainfall from October in year (t-1) to May in year (t)
DDAK(t)20	:	Drought Effect in April in year (t) (1 if rainfall <= 20%, 0, otherwise)
DHDAK(t)12.8	:	Heat damage in April in year (t) (1 if temperature >= 12.8 °C, 0, otherwise)
DHDMK(t)16.3	:	Heat damage in May in year (t) (1 if temperature >= 16.3 °C, 0, otherwise)
DHDJK(t)20.7	:	Heat damage in June in year (t) (1 if temperature >= 20.7 °C, 0, otherwise)

Table 4. The Estimated Wheat Yield Function for Konya

	R^2= 0.526	AR^2= 0.449	DW= 1.185
Variables	**Coefficient**	**t-value**	**Significant**
CONSTANT	1085.76	4.24	0.00
NPC	5.63	3.53	0.00
CROCT(t-1)MAY(t)	1.98	2.46	0.02
DDAK(t)20	-263.68	-1.38	0.18
DHDAK(t)12.8	-164.48	-1.09	0.28
DHDMK(t)16.3	-210.83	-1.83	0.08
DHDJK(t)20.7	-279.61	-2.08	0.04

Table 5. Description of the Variables for Wheat Area Sown in Adana

NPC(t-1)/(t-2)	Nominal farm gate price Change from year (t-1) to year (t-2)
CRSEP(t-1)OCT(t-1)	Cumulative monthly rainfall from September in year (t-1) to October in year (t-1)

Table 6. The Estimated Wheat Area Sown Function for Adana

	R^2= 0.467	AR^2= 0.441	DW= 1.058
Variables	**Coefficient**	**t-value**	**Significant**
CONSTANT	199932.10	10.19	0.00
NPC(t-1)/(t-2)	1531.91	5.24	0.00
CRSEP(t-1)OCT(t-1)	535.42	2.12	0.04

Table 7. Description of the Variables for Wheat Area Sown in Konya

RPWB(t-1)	Relative farm gate price between wheat and barley in year (t-1)
CRJUN(t-1)SEP(t-1)	Cumulative monthly rainfall from June in year (t-1) to September in year (t-1)

Table 8. The Estimated Wheat Area Sown Function for Konya

	R^2= 0.134	AR^2= 0.092	DW= 0.453
Variables	**Coefficient**	**t-value**	**Significant**
CONSTANT	623466.10	4.28	0.00
RPWB(t-1)	277925.50	2.52	0.02
CRJUN(t-1)SEP(t-1)	507.84	1.12	0.27

The estimated parameters were generally significant and had theoretically expected signs in both Adana and Konya. Heat damage and drought effect to yield of wheat were found for both Adana and Konya. The heat damage were found in April and May in both provinces, and in June only in Konya.

Comparing the estimated heat damage coefficients, wheat yield in Adana was affected more by heat damage than in Konya. We think warmer climate in Adana than Konya is the reason for this difference.

heat damage to wheat yield in Adana was identified to be very significant when monthly average temperature became higher than 16.2 degrees centigrade in April and 23.5 degrees centigrade in May. Heat damage in Konya was identified to be very significant when monthly average temperature became higher than 12.8 degrees centigrade in April, 16.3 degrees centigrade in May, and 20.7 degrees centigrade in June. Drought effect to wheat yield was identified in different months and at different levels, in May and less than 10% of the sample average monthly rainfall in Adana, and in April and less than 20% of the sample average monthly rainfall in Konya. The positive effects of nominal wheat price change to its yield was very significant statistically, and the effect in Adana was about twice as large as the effect in Konya. The positive effect of past cumulative rainfall was fount to be very significant only in Adana, and the period was from October previous year to May in current year. This may be caused by the fact that annual rainfall in Adana is about three times more than it in Konya, and most rainfall occurs from October to May in Adana, while monthly rainfall is more evenly distribute in Konya than in Adana.

Estimation of barley yield and area sown functions for Adana and Konya was also conducted. Then, the model biases in Dr. Kimura's revised pseudo-warming second run N2 RCM prediction were revised. Then revised RCM projection data was used to predict area sown, yield, and production of wheat and barley in Adana and Konya for 2070 when global warming will occur.

The results are shown in the following table.

Table 17. Future Estimation on Barley And Wheat *

BARLEY

ADANA YIELD	Coefficient		2070-2079	1959-2002	%	
CONSTANT	2128.75	1	2128.75			
NPC	1.95	32.8	63.96			
DDDecember(t)23	-423.78	1	-423.78			
DHDApril(t)18,9	-135.45	1	-135.45			
DHDMay(t)23,4	-375.13	0	0.00			
			1,633	**2,328**	**- 29.8**	decrease

ADANA AREA SOWN	Coefficient		2070-2079	1959-2002	%	
CONSTANT	-9912.3	1	-9912.30			
Real PriceBARLEY(t-1)	0.13	241048.00	31336.24			
CRJAN(t-1)OCT(t-1)	15.44	338.0787	5219.93			
			26,644	**14,779**	**80.3**	increase

KONYA YIELD	Coefficient		2070-2079	1959-2002	%	
CONSTANT	858.22	1	858.22			
NPC	4.69	32.8	153.83			
CROCT(t-1)JUN(t)	3.43	214.8864	737.06			
DDMay(t)17	-579.05	1	-579.05			
DHDApril(t)137	-505.21	0	0.00			
DHDMay(t)163	-309.10	0	0.00			
			1,170	**2,178**	**- 46.3**	decrease

KONYA AREA SOWN	Coefficient		2070-2079	1959-2002	%	
CONSTANT	208247.40	1	208247.40			
RelativePriceBW(t-1)	290201.00	0.79	229258.79			
CROCT(t-2)SEP(t-1)	105.62	297.4769	31419.51			
			468,926	**587,142**	**- 20.1**	decrease

WHEAT

ADANA YIELD	Coefficient		2070-2079	1959-2002	%	
CONSTANT	2417.33	1	2417.33			
NPC	11.6	31.2	361.92			
DDMay(t)10	-286.29	1	-286.29			
DHDApril(t)162	-179.24	1	-179.24			
DHDMay(t)235	-409.09	0	0			
			2,314	**3,274**	**- 29.3**	decrease

ADANA AREA SOWN	Coefficient		2070-2079	1959-2002	%	
CONSTANT	199932.10	1	199932.10			
NPC	1531.91	31.2	47795.59			
CRSEP(t-1)OCT(t-1)	535.42	43.7	23386.87			
			271,115	**357,941**	**- 24.3**	decrease

KONYA YIELD	Coefficient		2070-2079	1959-2002	%	
CONSTANT	1085.76	1	1085.76			
NPC	5.63	31.2	175.66			
CROCT(t-1)MAY(t)	1.98	215	424.98			
DDApril(t)20	-263.68	1	-263.68			
DHDApril(t)128	-164.48	0	0.00			
DHDMay(t)163	-210.83	0	0.00			
DHDJune(t)207	-279.61	1	-279.61			
			1,143	**1,903**	**- 39.9**	decrease

KONYA AREA SOWN	Coefficient		2070-2079	1959-2002	%	
CONSTANT	623466.10	1	623466.10			
RelativePriceWB(t-1)	277925.50	1.3	361303.15			
CRJUN(t-1)SEP(t-1)	507.84	56.56	28722.00			
			1,013,491	**934,822**	**8.4**	increase

* In the equation, average price (1935-2002) was used for all price estimation

It was found that wheat yield will decrease by 29.3% from the average yield of 1959-2002 to 2070 in Adana and by 39.9% in Konya. The predicted decrease in wheat area sown in Adana was 24.3%, but wheat area sown in Konya was predicted to increase by 8.4%. Consequently, the total wheat production in Adana was predicted to decrease drastically by 54% in 2070. But in Konya wheat production in 2070 was predicted to decrease less by 32% in 2070. Our prediction seems to show that the global warming decreased Adana wheat production more than Konya because of greater heat damage in Adana than Konya.

For barley, yield in Adana was predicted to decrease by 29.8%, and by 46.3% in Konya. Barley area sown was predicted to increase by 80.3% in Adana, and to decrease by 20.1% in Konya. This difference in predicted area sown is caused by slight increase in the predicted rainfall in Adana, and considerable decrease in the predicted Konya rainfall. Consequently, barley production in Adana was predicted to increase by 50% by 2070, but in Konya it was predicted to decrease by 66%.

From this quantitative study we can conclude that heat damage and drought effects identified to wheat and barley production in Adana and Konya from our econometric study using past monthly weather data, output price data, and production data have very strong negative effects to future wheat and barley production in these provinces under global warming situation assuming the current technology will hold.

Regional differences in predicted monthly temperature and rainfall for year 2070 also affect very much the predicted differences in wheat and barley production between these provinces.

ACKNOWLEDGEMENTS

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