Understanding of Cropping System in Adana Province

-From the Perspective of Farmers' Characteristics-

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1. Introduction

Until the early of 1970s', cotton was the product, which was most frequently selected by farmers in both of irrigated area and rain-fed area in Adana province. However, cotton production has sharply decreased since the late of 1970s', because of decrease of the product price and shortage of the labor force for picking up (Please see Fig. 1). The decrease of cotton had a great impact on the crop pattern, or rotation in both of irrigated area and rain-fed area, but the impacts were different between the two areas[1].

The purpose of this report is, first, to clarify the factors that affected the crop pattern, or rotation, which was formed after the decrease of cotton production, second, to show the outlook of cropping system in the near future in Adana province, considering with climate change[2].

This report is described based on the information that was collected from farm survey in Adana province. It will be shown that various factors, including land property, livestock activity, introduction of new technology, and market condition of products, have played important role for the form of present cropping system. However, we will make a point that for the purpose of depicting the outlook of cropping system in Adana province, it is needed to focus on characteristics of farmers out of the various factors. That is, in irrigated area, the condition of land property of farmers and the condition of livestock activity of farmers in rain-fed area.

2. Present crop pattern and rotation in Adana province

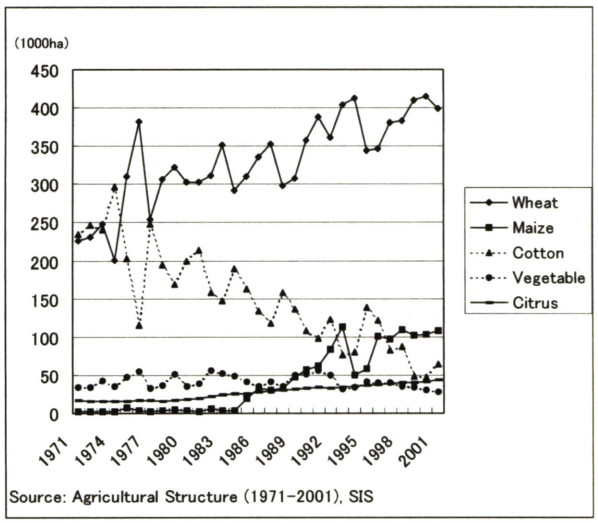

Fig. 1 Planted area of major crops in Adana province

1) Rain-fed area

Till 1980s', one crop rotation, that cotton is planted one year on the plot on which wheat was planted in the previous year was common in rain-fed area[3]. Cotton production had played two roles in this crop rotation system, one is for main cash income source of farmers, and the other is for keeping soil fertility of the land and the yield of wheat. However, this rotation system had been disrupted as the decrease of profitability of cotton, and continuous cropping system of wheat has been prevailed.

Cash income of farmers was not so affected by the decrease of cotton, because the mechanization of wheat production had become widespread and the innovation of seed variety of wheat had been achieved in 1980s'. So, it would be more appropriate to say that the farmers in rain-fed area had willingly increased planted area of wheat and frequency of planting wheat on the same plot, induced by the increase of profitability of wheat, than they had forced to leave from cotton production by the absolute

[1] The term "crop pattern" can be defined as combination of crops selected by a farmer in a certain cropping season. In contrast, "crop rotation" can be defined as arrangement of crops on a certain plot during some years.

[2] "Cropping system" used in this report contains both meaning of "crop pattern" and "crop rotation".

[3] The years that one crop is planted continuously was different between farmers. But, it was general that wheat and cotton was planted one after the other.

decrease of profitability of cotton. However, it must be noted that the scheme for keeping soil fertility and yield of wheat was lost by the disruption of crop rotation system of wheat and cotton, although farm income was not so affected by this. Also, it may be pointed that improvement of seed variety and modern inputs allowed the rise of yield of wheat after 1980s', though soil fertility was decreased[4].

There was another factor that affected the crop pattern, or rotation in rain-fed area about the same time. From 1950s' to 1980s', Most of governmental pasture land had been illegally converted to cultivated land (Asami, 2005), and the farmers who managed livestock activity had met the shortage of green feeding stuff. These farmers planted barley on some part of their managed crop land to cover the shortage of green feeding stuff[5]. Thus, the crop rotation system, which was composed by wheat and barley, was built up among the livestock farmers.

The establishment of this crop rotation system had two important meanings for the agriculture of rain-fed area in Adana province. First, the integration of crop and livestock activity was strengthened[6]. Second, barley served for the crop to keep soil fertility and yield of wheat as substitute for cotton.

In summary, two types of cropping system were established in rain-fed area after the decrease of cotton production. One is continuous cropping of wheat, and the other is crop rotation of wheat and barley. A decision of a farmer for the choice of crop system from the two options depends on whether the farmer keeps livestock or not. Also, the area allocated to barley and the frequency barley is planted on a certain plot depends on the number of livestock kept by the farmer and the size of his managed land. This means that the degree, soil fertility is sustained by the rotation system, is also affected by the number of livestock and the size of managed land size. These facts show that we must focus on the livestock activity and farm size to understand the cropping system in rain-fed area.

2) Irrigated area

After cotton production fell into a decline, cropping pattern and rotation in irrigated area changed drastically. Some crops have expanded the productions since 1980s'. The representative crops of these crops are maize and citrus. Vegetables, especially watermelon, are also important to understand the cropping system in irrigated area as we shall see later, though the planted area for vegetables has not changed so much.

Two factors are cited as the main reasons that maize production has increased sharply from 1980s'. First, the improvement of seed variety allowed rise of yield and double cropping with wheat[7]. Second, foundations of factories producing sweetening increased demand for maize and stabilized the farm-gate price. At the same time, citrus production has increased steadily from 1980s'. It may be due to the increase of demand caused by establishment of factories producing fruit juice and the progress of inland transportation[8].

The factors mentioned here explain why production of these crops has increased in irrigated area since 1980s'. However, they are not enough to understand the cropping system in irrigated area. There are many types of crops from which the farmers in irrigated area can choose, and their decisions of planting crops are actually wide ranging. Because of this, for the purpose of understanding the cropping system in irrigated area, it is needed to understand how individual farmers decide planting crops from various options.

In irrigated area, it can be said that rough options of crops from which farmers can choose are single cropping of wheat, maize and other field crops, double cropping of wheat with maize, vegetables (especially watermelon), and citrus[9]. From here, it is discussed about farmers' decision of crops from the four options mentioned above. How farmers decide the number of crops planted in a year, or how farmers decide the degree of continuous cropping are also important questions. However, in irrigated area, these issues are too complex to solve in here. In this report, we focus on the farmer's decision of the main crop from the four options in one year. Rented-in land and farm size

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[4] Some farmers in rain-fed area pointed that soil fertility was decreased after continuous cropping of wheat started. Also, there were farmers, who said the role of cotton for keeping soil fertility was more important than the role for generating income.

[5] In rain-fed area, most of farmers carried on livestock activity with cropping activity, but there were some farmers specializing livestock activity in some villages. These specialized livestock farmers started to rent in crop land and plant barley on the land.

[6] The detail of this issue is not discussed here, because this issue is beyond the scope of this report.

[7] There are also some crops which can be planted after wheat as second crop. These are groundnut, soybean, sesame, and cotton.

[8] I could not get information about technical innovation of citrus production in farm survey. However it will be appropriate to think that there were some technical innovations that increased the yield and reduced the production cost.

[9] Farmers can choose other field crops as single cropping and also as second crop after wheat. However, I will focus on wheat and maize to simplify the discussion.

are picked up here as the key factors to understand the decision of the main crop by individual farmers and the cropping system in irrigated area.

Before going to the effect of these factors on the cropping system, it may be worth to describe the characteristics of land market and land property in irrigated area. Till 1960s', some few big farmers owned most of land in irrigated area and hired a great number of agricultural workers. However, as mechanization of agriculture prevailing, these big farmers left from own agricultural management, and rented out their land to their agricultural workers (Keyder, 1989). Furthermore, Turkey has the tradition of division of succession that the land owned by individual is inherited equally to all his or her suns and daughters, when he or she died. This tradition caused the problem of segmentalization of land and shrinking of farm size. Some of these small farmers created by the tradition of inheritance went to city to get non-agricultural jobs and rented out their land to relatives or friends, who carried on their own farming. Because of these reasons, land market in irrigated area is very active; more than 50% of all managed land is rented-in land according to the farm survey data. Inequality of land distribution is also high.

From here, it is explained how rented-in land and farm size affect the decision of planting crops by individual farmers.

(a) Single cropping of maize or wheat

Most of the processes of production of field crops are mechanized and the labour productivity is highest in the four crops picked up in this report (Please see Table 1). Also, This system has advantage for soil fertility, that farmers can fallow their land for a half of cropping season. Because of these reasons, big farmers and land-owning farmers, who have incentive to keep soil fertility, tend to choose single cropping.

(b) Double cropping of wheat with maize

Double cropping of wheat and maize utilizes land almost of all year. Because of this, double cropping system cannot be continued than two or three years from the aspect of conservation of soil fertility. However, in the case of rented-in land, farmers don't need to consider this problem. Moreover, land productivity is more important for tenant farmers than labour productivity, because they must pay rent for land in cash to land owner based on the size they rented in. The land productivity of second cropping is higher than that of single cropping, though the labour productivity is lower (Please see Table 1). Because of these reasons, tenant farmers, who depend their farming on rented-in land tend to choose double cropping.

Table 1 Land productivity and labour productivity of each crop

Unit: 1000TL[1)]

		Single Cropping	Double Cropping	Vegetables	Citrus
Land Productivity[2)]	Average[4)]	129,817	150,715	301,570	198,475
	Number of farmers	60	26	26	20
	Standard Deviation	73,070	64,526	245,443	226,548
Labour Productivity[3)]	Average[4)]	125,257	96,653	10,759	37,112
	Number of farmers	18	17	6	7
	Standard Deviation	105,506	82,327	12,171	39,431

Sources: For land productivuty, farm survey in Adana province in 2002 and 2004.
For labour productivity, farm survey in 2004
1) 1US$ = 1,500,000TL (2002)
2) Land productivity = (Gross income - Seed cost - Fertilizer cost - Pesticide cost - Irrigation cost) / Planted area (10a)
3) Labour productivity = (Gross income - Seed cost - Fertilizer cost - Pesticide cost - Irrigation cost) / Labour days
4) Productivity was standarized by CPI index to 2002

(c) Citrus

It needs some years until citrus produces income after planted. For farmers willing to plant citrus, it is needed to acquire other income sources besides citrus at least until it produces income. Because of this, citrus is difficult to plant for small farmers, who cannot allocate some part of managed land to the other crops. Also, right to use of land must be assured in long time to safely plant citrus. However, in irrigated area of Adana, one-year contract is typical for contract of renting land, and it is difficult for farmers to get assurance of using rented-in land in long time from their land owners. So, tenant farmers cannot easily plant citrus, even if they want to do so.

(d) Vegetables

Most of vegetables, especially watermelon, are deprive a great deal of nutrition from soil, and also have the serious problem of replant failure. For example, after planting watermelon one time, this crop cannot be planted at least five or six years on the same plot. However, this difficulty doesn't become problematic for rented-in land, because farmers can change their rented-in land every year. Furthermore, vegetables are attractive for small farmers due to the high land productivity. So, small or tenant farmers tend to plant

vegetables. By the way, vegetables need many labour forces in the process of production, and mark the lowest labour productivity in the crops compared on Table 1. It is difficult to plant vegetables for the farmers doing other off-farm activities, or managing big farming. In other words, vegetables are not attractive crops for them.

Above discussion can be summarized as follows. 1. Single cropping is attractive for big land-owning farmers. 2. Double cropping is attractive for big tenant farmers. 3. Citrus is attractive for land-owning farmers. 4. Vegetables are attractive for small farmers, especially small tenant farmers.

3. Outlook of cropping system

In this section, the outlook of cropping system in Adana province is shown based on the present cropping systems described in section 2.

1) Rain-fed area

As mentioned in section 2, the present cropping system in rain-fed area is composed from continuous cropping of wheat and crop rotation of wheat and barley. However, the continuous cropping of wheat is recently changing according to the introduction of a new crop, sunflower. Like maize and citrus in irrigated area, the establishment of factory producing food oil is the background of progress of sunflower. However, the facts that farmers planting only wheat have willing to plant some crops for keeping soil fertility, and that sunflower is a good crop for this purpose also explain this recent change of cropping system. So, in the near feature, continuous cropping of wheat will decrease, and crop rotation of wheat and sunflower may take over from it.

The direction of crop rotation of wheat and barley is ambiguous. First, it is expected that the yield of wheat and barley will decrease under climate change according to the statistical analysis conducted by Prof. Tsujii and Dr. Gültekin. Because of this, relative change of yield of wheat to barley must be known to decide the direction of the crop rotation of wheat and barley in the future. But, this is subtle and difficult question. Furthermore, the area and frequency planted barley are decided depending on the number of livestock. Then, the effect of climate change on the productivity of livestock is critical for the outlook of the crop rotation system of wheat and barley.

In summary, it is appropriate to conclude that the present continuous cropping of wheat will decrease and that crop rotation of wheat and barley will increase among the class of farmers, where their farm managements don't depend on livestock activity so much. However, the future of about the crop rotation of wheat and barley cannot be described correctly so far.

2) Irrigated area

Maize is not so strong against too high temperature in summer season. So, it can be said that maize is susceptible to warming temperature. Until recently, maize as single cropping had been planted on April or May. However, some farmers started to put ahead the day of planting to February or March, because of recent high temperature in summer season. In the case of single cropping, warming temperature is not the serious problem, because farmers can easily put ahead the day of planting as some farmers already doing. But, in the case of double cropping, farmers cannot put ahead the day of planting due to the existence of wheat as first crop. There is a possibility that the double cropping come to not available for the farmers in irrigated area in the future. At least, the productivity of double cropping will decrease under warming temperature, even if it was possible for farmers to choose double cropping.

In the case that the productivity of double cropping decreased, the farmers who selected double cropping will meet the decision between vegetables and single cropping as a substitute for double cropping. Farmers can move to single cropping from double cropping without any difficulties, because there is no serious technical difference between single cropping and double cropping. However, single cropping may not be acceptable option for some tenant farmers, who don't manage enough land and need to get high land productivity. These farmers may choose vegetables, though they will meet some difficulties related to the technical difference between field crops and vegetables, and the need of labour force.

The harvesting machine of cotton was introduced in irrigated area of Adana province two or three years ago. This technical innovation has the possibility to improve the profitability of cotton in irrigated area. Also, cotton has advantage, that cotton is stronger against high temperature than maize. So, cotton production may increase again, especially among big farmers, who have difficulty to plant vegetables and citrus.

Generally, it is expected that the productivity of citrus will increase under global warming (Adams and et al., 1999). So, it may be also expected that citrus production

will increase in irrigated area. But, this expectation will not be realized by two constraints. Firstly, the supply of citrus is in excess of the demand in Turkey, and because of this, the price of citrus is decreasing recently. Unless policy helps the expansion of demand for citrus, for example export to EU countries, the production of citrus will not increase, even if the yield increased by the effect of warming temperature. The problem of rented-in land is the second constraint. As mentioned in section 2, tenant farmers cannot plant citrus, because of the lack of assurance for right to use land in long time. So, even if the demand for citrus increases in the future, the area of citrus will not increase proportionally to the increase of yield.

4. Summary of section 2 & 3

1) Rain-fed area

The results of section 2 & 3 are summarized in Fig. 2. Fig.2 shows the present cropping system and the outlook of it in each of rain-fed and irrigated area. About rain-fed area, the horizontal line means farm size managed by a farmer, and the vertical line means number of livestock kept by the farmer. The figure of present cropping system in rain-fed area shows that the larger the number of livestock the farmer keep and the smaller farm size the farmer manages, the frequency that the crop rotation of wheat and barley was chosen by him becomes higher. In reverse case, the frequency that continuous cropping of wheat was chosen becomes high. The figure about the outlook of cropping system in rain-fed area shows that crop rotation of wheat and sunflower replaces the place of continuous cropping of wheat in the present cropping system.

2) Irrigated area

About irrigated area, the horizontal line means size of land owned by a farmer, and the vertical line means size of land rented in by the farmer.

Present cropping system

(a) The farmers, who have big owned land and don't rent in land so much tend to choose single cropping of wheat or maize as the main activity of their farm management.

(b) The farmers, who rent in big land and don't have owned land so much tend to choose double cropping of wheat and maize as the main activity of their farm management.

(c) The farmers, who rent in small land and don't have owned land so much tend to choose vegetables as the main activity of their farm management.

(d) The farmers, who own some land and don't rent in land so much tend to choose citrus as the main activity of their farm management.

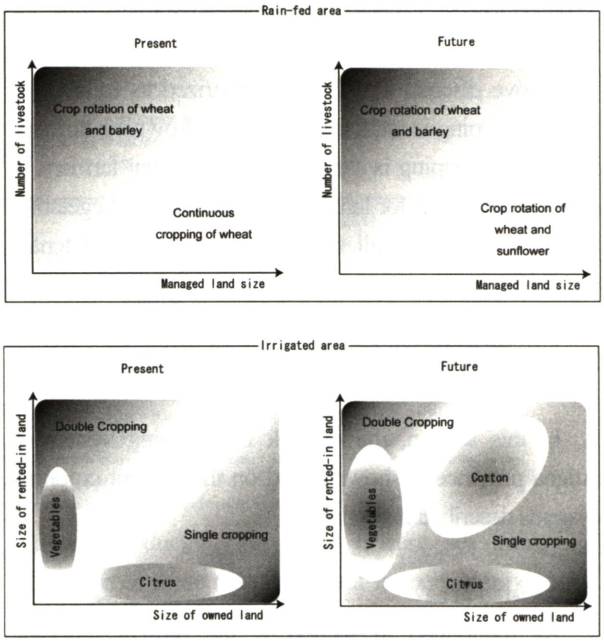

Fig. 2 The present cropping system and outlook of cropping system in Adana province

Outlook of cropping system

(a) The farmers, who choose double cropping at present will decrease influenced by the effect of warming temperature to maize.

(c) Relatively small farmers among the farmers, who choose double cropping under the present cropping system, will choose vegetables in the future.

(d) Relatively big farmers among the farmers, who choose double cropping under the present cropping system, will choose single cropping of wheat, maize, or cotton.

(e) Some farmers, who choose single cropping o wheat or maize under the present cropping system, will also choose cotton.

(f) Even if warming temperature increase the yield of citrus, the planted area of citrus will not change so much, because planting of citrus is constrained by the market condition and the problem of land property.

5. Conclusion

In this report, I showed how we were able to understand the present cropping system in Adana province

through the focus on farmers' characteristics. Then, the outlook of cropping system, which allowed the climate change and the recent trend of other factors in Adana province was shown based on the understanding of the present cropping system

The understanding of present cropping system from farmers' characteristics clarified that, in rain-fed area, livestock production is the key factor in both of the present cropping system and the outlook. So, the change of productivity of livestock caused by climate change must be investigated to describe the detail outlook of cropping system.

In irrigated area, this analysis clarified that the tenant farmers will be most vulnerable to climate change, because they will be forced to leave from double cropping of wheat and maize. Especially for some small farmers, who must change the main activity from double cropping to vegetables, it may be difficult to continue their farming due to the technical difference of production between double cropping and vegetables, and due to the difficulty of management of vegetables farming, related to the high risk of price. Also, it was pointed that the lack of assurance for right to use rented-in land in long time and excess supply of citrus would constrain the expansion of citrus, though the yield is expected to increase under warming temperature.

The understanding of present cropping system presented in this report is not enough. For example, in rain-fed area, it will be needed to understand the decision flow of the multiple farming of cropping and livestock by individual farmers. In irrigated area, it is needed to investigate the role of risk related to yield and price on the decision of crops to understand the detail cropping pattern and rotation. These further understandings of the present cropping system from farmers' perspective allow us to describe the detail outlook of cropping system under climate change by combining them and the results of quantitative analysis about the effect of climate change on each crop.

5. Acknowledgement

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