Rice Agriculture of Tohoku District seen from Yield per Unit Area

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Hideo FUKUI

The rice, indigenous to the tropics, is cultivated in Japan even in the northern part of Hokkaido with an almost subarctic climate. This is nothing but the results of long continued efforts of the people concerned with the improvement and popularization of the cultivation technique. The yield per unit area has been doubled within the last eighty years. The increase of cultivated land during the period was about 2,460 acres, about 95% of which was increased in the Northeastern Japan (Tohoku and Hokkaido districts). With the increase of cultivated land, the northern limit of the rice-culture has much advanced to the north.

However, the advance of the marginal land has inevitably brought the crop extremely colse to its critical climatic conditions, and the crop is susceptible to the damages from the lower temperature or poorer sunshine in the growing season. There is also an increase of rice fields with low productivity. In fact, the distinguishable damages by the cool summer occured 15 times during the period.

As the fundamental causes of damages by cold weather, however, it is pointed out that the failures of rice-culture are the results of the agricultural policy and social or economic condition in Japan, that have kept the farmers from choosing the crops adapted to the land. Therefore, the main efforts of the agricultural improvement in a cold district like Tohoku, have been concentrated to the research on the adaptablity of certain crops such as rice to the cold climate, rather than to the introduction of new crops more adaptable to the district, or turned to expand the individual small farm into the area corresponding to the low land productivity. In recent years, the labour productivity has been raised in the district by the adoption of various agricultural implements, but unitll that time, the reformation of rice agriculture had put emphasis on the increase of low land productivity.

In this paper, the author will explain the efforts mentioned above, based on the historical changes of land productivity (yield per unit area) in the Tohoku district. He will also describe the process of the diffusion of some cultivation techniques to increase the yield, as well as the regional differences of land productivity, taking examples of several prefectures.

I

The most distinct characteristics seen in the changes of the yield is the fact that the yield in the Tohoku district which had always been lower than the average of the nation before World War II, became higher than the averge. The yield per unit area has been increased all over Japan, but its rate is more remarkable in the Tohoku district than that of the Southwestern Japan. This success was obtained mainly by the improvement of rice variety more resistant to the unusually low air temperatures in the growing season, which often caused bad crops in this district.

Table I (koku per tan)*

	1883	1912	1941	1955
All Japan	**1.215**	**1.774**	**2.062**	2.627
Tohoku District	1.078	1.562	1.010	**2.850**

Table II. Yield of Rice per Unit Area (koku per tan)*

	(1933-1942)	Order	(1949-1958)	Order	Difference between both periods	Order
All Japan	2,025		2.229		0.205	
Aomori Pref.	1.733	6	**2.450**	3	0.717	1
Iwate Pref.	1.755	5	**2.324**	5	0.569	2
Akita Pref.	1.950	2	**2.473**	2	0.523	3
Yamagata Pref.	**2.222**	1	**2.635**	1	0.413	5
Miyagi Pref.	1.922	3	**2.366**	4	0.444	4
Fukushima Pref.	1.905	4	**2.292**	6	0.387	6

* (koku per tan) × 1.513=(ton per hectre)

Table III.

	1934			1953		
	Yield in the Normal Year (koku)	Decreased Yield (koku)	Decreased Rate (%)	Yield in the Normal Year (koku)	Decreased Yield (koku)	Decreased Rate (%)
Aomori Pref.	1,123,235	527,600	47.0	1,546,600	139,300	6
Iwate Pref.	944,269	430,010	45.5	1,364,700	108,800	9
Akita Pref.	2,042,259	490,515	24.0	2,348,300	70,500	7
Yamagata Pref.	2,158,000	1,029,000	47.5	2,343,600	78,800	3
Miyagi Pref.	1,851,588	708,666	38.3	2,261,100	164,300	3
Fukushima Pref.	1,887,602	697,307	37.0	2,164,800	703,200	32

Secondly, compared to prewar figures, the prefectural rankings of the yield per unit area has been much changed in favour of prefectures in Tohoku. The prefectures which had been below the averge in the yield of rice, showed much higher rate of increase. Especially the yield in the Aomori Prefecture came up

to the third class from the lowest class during the periods, with the highest rise-rate of 0.717 koku. On the other hand, the yield in the Fukushima Prefecture, situated in the southernmost part of the Tohoku district, dropped to the lowest class from the fourth class, with the lowest rise-rate of 0.387 koku. The yields in the Yamagata and Akita Prefectures, located on the western side of the Central Mountain Range of Tohoku district, were the first and second ranks and thier ranks did not change.

These two facts show that the increase of the land productivity of rice is more striking in the Tohoku district, which had suffered from the damages by the cool summer, in comparison with that in the Southwestern Japan, the increase being much more distinct in prefectures such as the Aomori and Iwate which suffered from the sevearest damages. In his previous papears[1] on the yearly change of cold disaster, the author pointed out that there were critical air temperature below which rice is particularly susceptible to heavy damage. Such critical temperatures are different by region, and vary with the change of times. There is a distinct lowering of the critical temperature in the period 1952–'58, which was accompanied by the universal increase of the yield[2]. One can almost say that the cold disaster has almost disappeared from the Tohoku district.

II

In this section, the author will explain the process of diffusion of some new cultivation techniques in the Aomori and Iwate Prefectures, where there had often been the severest cold disaster before World War II, and in the recent years the increase of the yield took place the most remarkable of all the Tohoku district.

Hitherto, many counter-measures were considered in the laboratory. For example, it is recognized that what greatly decides the degree and the kind of cold damage is at which time of the growing season the low temperature appears. Diversified factors have been recognized important to influence the degree of the cold damages. To name some examples, there are the micro-climate, soil condition of rice fields, varieties of rice, sowing and transplanting time, ways of fertilization, temperatures of irrigation water, and so on. But the results of these experimental studies have not always been introduced to the farming in the fields.

1) H. Fukui: Areal difference and its Yearly Change of Cold Disaster on the Rice Cultivation of Northeast Japan. Sci. Rep. Tohoku Univ. 7th seri. (Geography) No. 7, 1958. pp. 29–38.

2) H. Fukui: Some Geographical Problems on Development of Agriculture in Tohoku District. (in Japanese) Collection of treatises on "Geographical Problems of Development". 1959, pp. 150–156.

This is because it takes a year ordinarily to see the results of new method, and a new technique successful in the experiment, is recieved by the famers with anxieties and suspicions about its success in the fields. Accordingly, the problem of its popularization is directly a matter of farmers' economy and their volitions to improve the rice farming.

In the history of the technical improvement of agriculture, the most efforts were exerted to the improvement of rice, and the efforts were rewarded with reasonable returns. Before World War II, the cold-resistant and early maturing varieties were not so prevailingly adopted by the farmers, because in normal years their yields did not increase too much, although the yield decrease was less than that of the late maturing varieties when the cold disaster occured. Particularly, the farmers managing the small farms, this contradiction has long been hard to solve. Figure 1 shows the yearly changes of the varieties in the Aomori and Iwate Prefectures. It may be noticed that a certain variety or two were dominant for a long time in these districts before the War. It was because of the lack of new varieties to replace old ones. Besides, in this period these few varieties which diffused extensively were grown beyond the areas to which they were fitting, and

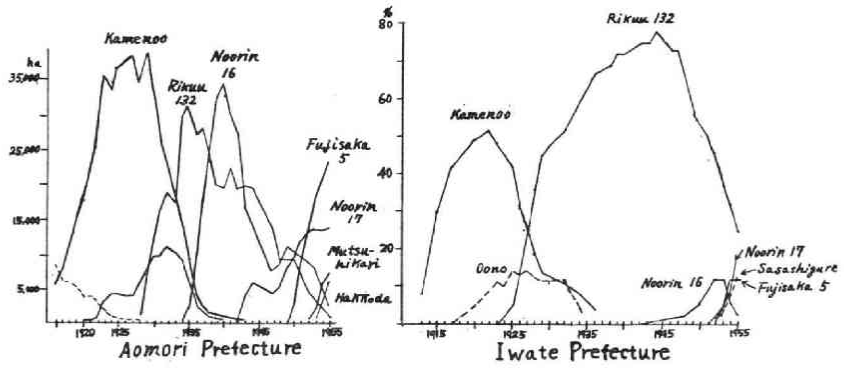

Fig. 1 Change of varieties of rice in Aomori and Iwate Prefecture.

the menace of cold disaster became greater. On the other hand, many of the new varieties which appeared after the War show tendencies to be distributed in the areas to which they are fitting. In the selection of varieties, late maturing ones giving higher yield by heavy manuring in normal years, are generally more preferred to the cold resistant kinds. But the varieties appeared in recent years, have both merits combined. Namely they not only raise rich yields by heavy manuring in normal years, but also are more resistant to cold climate and insects and blights than the early maturing varieties of old days. In the Aomori Prefecture, for

example, the increased yield by such new varieties as Fujisaka 5, Norin 7, Mutsuhikari and Hakkoda, reached to about 389,000 koku in 1954, a year with cool summer, compared with the old varieties. Therefore, the farmers with small farms were able to increase the yield in the normal years, and at the same time they could avid the cold disaster by introducing these new varieties. In future, not only the yield but also the quality of rice will be improved.

Besides the improvement of the varieties, the sowing and transplanting seasons have been made earlier, and the types of seedlng beds have also been improved. The programs of improvement of farms, mainly those of the soils, drinage and irrigation systems, have been carried into effect in the extensive areas. The area of lands under such programs in 1925 to 1955 added together reaches to a surprising figure of 150% of the total area of the existing rice fields in the Iwate Prefecture. On the other hand, the old type of seedling bed, so called "Toshinawashiro", once extensively distributed in the Tohoku district, still takes a fariely high percentage of the total area of seedling beds. By the ordinary type prevailing in the Southwestern Japan, the land is used as a seedling bed only at the sowing time, and after that it is used as an ordinary field. But by this old type, the land used as a seedling bed is heavily fertilized after sowing time, especially organic fertilizer such as barnyard manure and is left vacant until next sowing time. This type of beds has prevailed in the Tohoku District, because the seedlings grown in such beds are resistant to cold climate, though the land is unused for the most of the growing season. But after the War, a new type of seedling bed is devised and is more and more widely adopted in the cold district replacing the old type. By this new type, semi-hot seedling bed, the beds are covered with oil paper in order to raise temperature of the beds. Thus, the sowing time is made earlier and stronger seedlings more resistant to the cold climate are obtained, in comparison with those raised in the beds of old or ordinary type.

According to the distribution of the seedling beds (Fig. 2), the diffusion of the new type is dominant in the northeastern part of the Tohoku district, where the damages from cold climate were severest before the War. The old type remains in the district where the damages were comparatively slight. By means of the more detailed analysis of the distributions, one may be able to presume that the district where the old type still remains are those where people are less eager for the reformation of agriculture such as to avoid cold disasters, to adopt a double cropping system, or to look for other commercial corps.

The farmers in the Tohoku district have not only looked for the measures to avoid the cold disaster which happed ocasionally, but also have eagerly wanted to increase the yield in the normal years. In order to raise the yield, the fertilizer

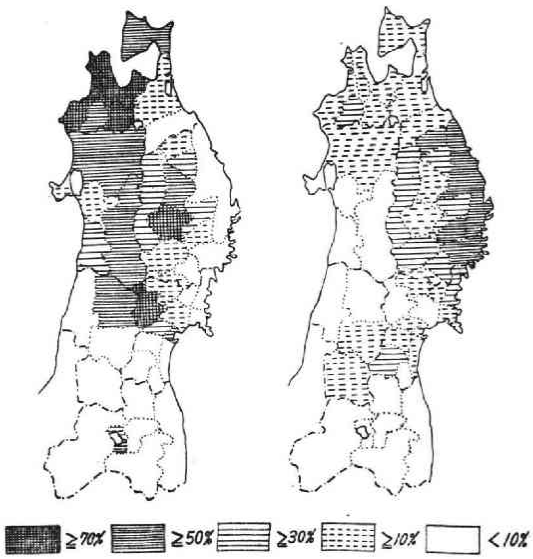

Fig. 2 Distributions of old type (left) and new type (right) of seedling bed in 1954.

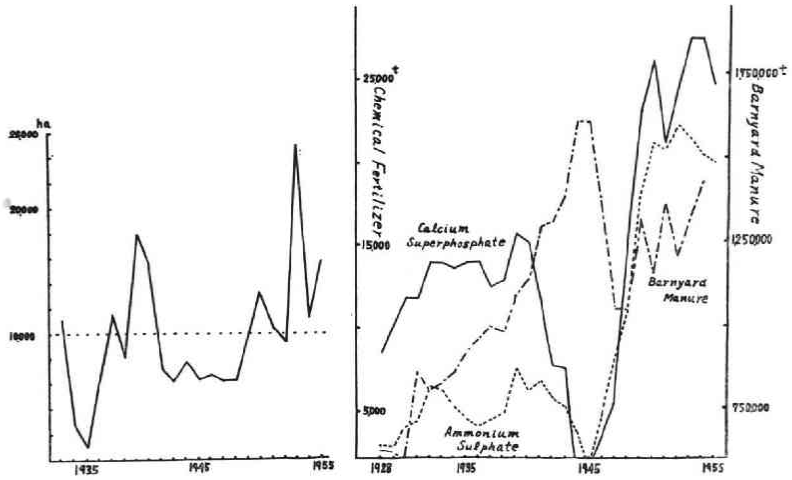

Fig. 3. Area under rice wilting desease (left) and fertilizer consumption in Iwate Prefecture.

consumption has increased year after year, keeping pace with the popular use of chemical fertilizer. (Fig. 3). The effects have gradually been accumulated to cause the damages by many kinds of blights, especialy rice wilting desease (Piricularia oryzae). In recent years, the blight damages became a problem as

serious as, or even greater than the cold disaster, and the cost of its prevention and extermination becomes larger year after year. In the Iwate Prefecture, the rice wilting desease broke out, for the first time, over an extensive area, in 1934 when the summer was unusually cool. Since that time, the area under blight damage has increased year after year, except in the period of World War II when the use of the fertilizer decreased. In recent years, the damaged area corresponds to, or is beyond that of 1934. Thus in the years of cool summers, and when healthy seedlings are not available, the outbreak of the rice wilting desease covers large area, owing to the increased use of fertilizer, such as it occured in 1953. But in such year, the blight disaster was less serious in the Aomori and Iwate Prefecture where various techniques to avoid the cold disaster had been introduced extensively. On the other hand, the greater damages were caused in the Fukushima Prefecture where the agricultural techniques for the warmer district, rather than those for the colder district, had widely been adopted.

In the case of the Iwate Prefecture in 1953, the blight disaster was more serious in the Kitakami Plain with the high land productivity, and less so in the intermountain and coastal regions which were more susceptible to the cold disaster. It made a striking contrast to the aspects of an ordinary year, when the rice blight often brakes out in the latter region caused by the low temperature of irrigation water as well as cold climate, more frequently than in the former region.

We can interpret, therefore, the high yield of rice in the Tohoku district in recent years, as the synthetic results of the improvement and diffusion of the agricultural techniques. However, we can not ignore the influence of the enforcement of the Land Reform just after the end of World War II. The feudal system had most strongly remained in the Tohoku district. Most of the farmers engaged in the agriculture under the strong control of large land owners and merchants of rice. They had been suffering from high rent, and had not always been able to introduce the new techniques. Before the War, many of the land-owner farmers had dropped into the tenant farmers every year, owing to the unstability of rice price and not infrequently as the result of cold damages. As of 1940, the percentage of land-owner farmers in the Tohoku district was 26.3% of the total farmers, much lower than 31.1% of average of the nation. In 1950, it changed to 64.2%, somewhat higher than 62.3% of all Japan, and the tenant farmers decreased from 32.4% to 4.4%. Therefore, the Land Reform, together with the government policy on the price stability of rice, remarkably enriched the economy of the farmers, recovering their confidence on the farming at the same time. The farmers have not only introduced the new techniques to raise the land productivity, but also the agricultural implements to increase the labour productivity.

In proportion to the progress of the diffusion of the improvements and reform of rice farming, we except that areal differenciation will appear not only in the ways of their diffusions, but also in the land productivity.

III

The unit yields, and increased yields of rice in the Tohoku district have become above the average of all Japan after World War II, and the difference among the prefectures has decreased. However, the figures of the Fukushima Prefecture dropped to the lowest class, contrary to the remarkable raise of the Aomori and Iwate prefectures. These striking increase as mentioned above, are brought about mainly by the attainment of the positive measures to avoid the cold disaster, which accelerated the general trend of the elevation of the land productivity. Here some remarks will be made on the case of the Fukushima Prefecture.

As Figure 4 shows, the yield in the Fukushima Prefecture has fairly been influenced by the cold climate. The difference between in the Fukushima Prefecture and the average of all Japan, shows a tendency to increase when the temperature in the Fukushima Basin is low. The difference, howevere, has gradually decreased and since about 1944, the yield in the Fukushima Prefecture has been slightly above the average of the nation. In order to consider about it more in detail, the prefecture will be subdivided into several regions by its topographic and climatic features. Two mountain ranges running parallel with the coastal

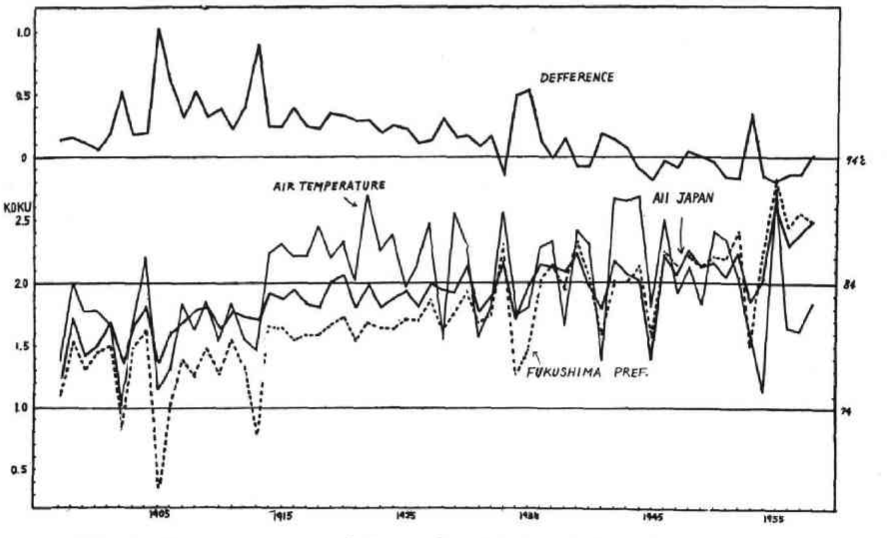

Fig. 4 Changes of yield (koku/tan) and integrated air temperature.

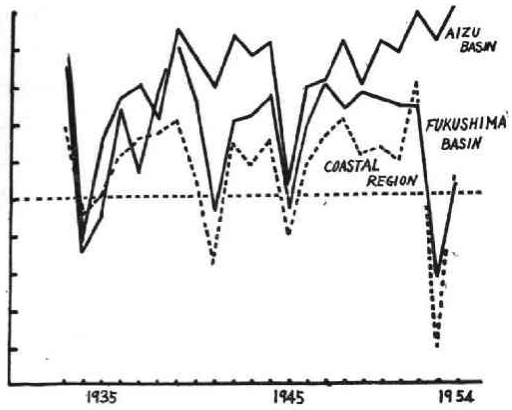

Fig. 5 Yearly Changes of rice yields (koku/tan) in the three regions of Fukushima Prefecture.

line divid the prefecture into the Coastal Region, the Central Inland Region and Aizu District[4]. (Fig. 8). Each of them is an important rice production area of the prefecture. Here, the average values of the ten mura or machi (smallest provincial unit) selected from each of the three regions will be compared. Figure 5 shows the yearly changes of the unit yields in the three regions. It is clearly recognized that the yield is lower as the region lies closer to the ocean, and also that there is a big difference between the Aizu Basin and the others. The yield in the Aizu Basin has increased more strikingly than in other two regions after the War, making the difference between the Aizu Region and the others greater. The yields in the Coastal Region and the Central Inland Region scarcely change during this period, and the increased yield of the Fukushima Prefecture depends mainly upon that of the Aizu Basin. The tendency is more obvious when one refers to the difference between the mean unit yield in the normal years and the unit yield in the year when the cool summer visited. (Fig. 6) The area differences in 1934, 1935 and 1941 were not so clearly, but in 1953, it was distinct.

Next, the relation between the yield per unit area (koku per tan) and the integrated air temperature (mean monthly maximum temperatures from June to August) from 1933 to 1954 is given in Figure 7, using the method mentioned in the

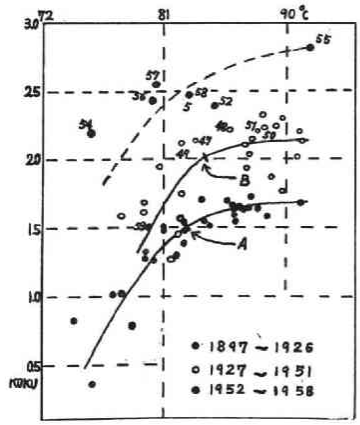

Fig. 7 Relation between integrated air temperature and yield (koku/tan) from 1897 to 1958 in Fukushima Prefefecture.

4) The Coastal Region is here represented by the southern part of it, the Central Inland Region by the Fukushima Basin, and the Aizu District by the Aizu Basin.

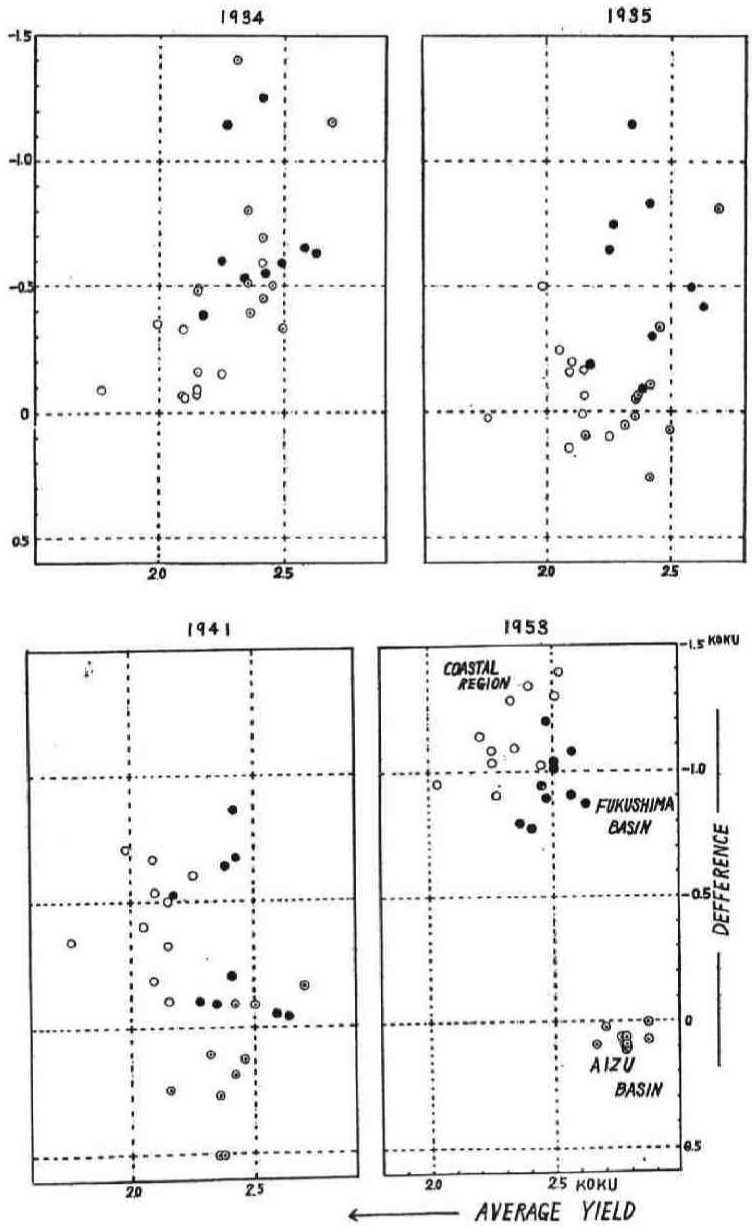
1934
1935
1941
1953
-1.5
-1.0
-0.5
0
0.5
2.0
2.5
COASTAL REGION
FUKUSHIMA BASIN
AIZU BASIN
1.5 KOKU
1.0
0.5
0
0.5
2.0
2.5 KOKU
DEFFERENCE
AVERAGE YIELD

Fig. 6

previous paper.[1),5)] The figures of the air temperature are those of the meteorological stations close to respective regions. The convex point of the trend curve is clearly recognized in the Coastal Region and the Central Inland Region, but it is not so clear in the Aizu Basin. The striking difference exists also among the critical temperatures of the three regions and the normal yields of the years with higher temperatures than the critical temperature. These difference

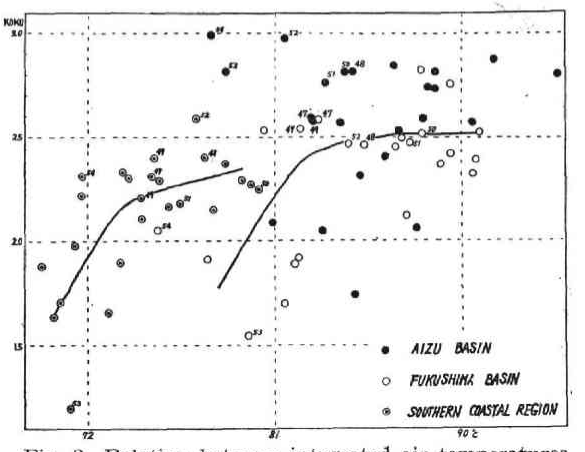

Fig. 8 Relation between integrated air temperatures and yields (koku/tan) in the three regions of Fukushima Prefecture.

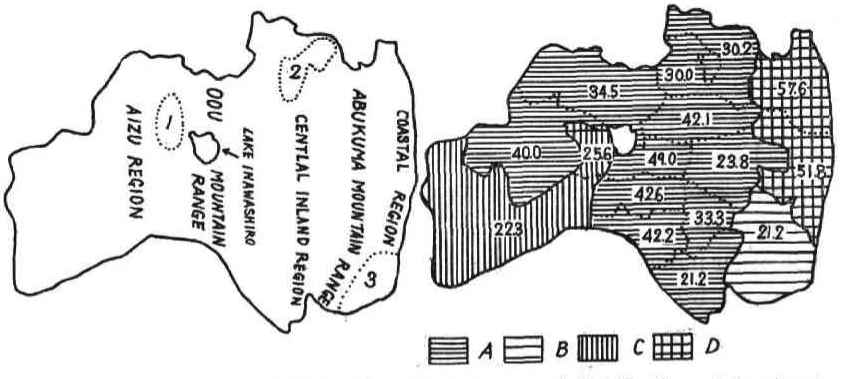

Fig. 9 Index map of Fukushima Prefecture and distribution of dominont variety of rice (%).

A: Norin 21} Medium Maturing variety B: Kokonoe } Late Maturing Variety
C: Rikuu 132} D: Norin 10}

1: Aizu Basin, 2: Fukushima Basin, 3: Southern Coastal Region

5) Here, the author adds the recent data to the reported data.

depend mainly upon the differences of the varieties of rice cultivated in the regions. Especially, the early maturing and cold resistant varieties are very scarse in the Coastal Region, where the cold damages are caused the most frequently of the prefecture. (Fig. 9). The varieties dominant in the Central Inland Region are same as those in the Aizu Basin. As the physical environments of the regions are different from the Aizu Basin, the yields cannot surpass that of the Basin, unless they introduce other varieties and different cultivation techniques well adapted to the lands. In the Aizu Basin, the monoculture of rice farming is extensively carried out, while in the other regions, especially in the Fukushima Basin, diversified crops are grown as well as double crop system in rice fields, vegetable, pear, apple, peach and milch-cow – keeping. Thus, the latter regions are not always concentrated to the rice farming, and this is one of the reasons of the lower yield.

IV

In recent decades, the rice growing region of the World has been much expanded into the tropical and subtropical regions other than the so-called monsoon climate region of Southwest Asia.[6] However, in Japan, the striking tendency has, in recent years, appeared to show the high yield in her northeastern district, once frequently suffered from the cold weather damage, than that in the Southwestern Japan. Even in the Tohoku district, the most rapid increase of the yield has appeared in the Aomori and Iwate Prefectures, and within them in their northeastern parts, which formerly suffered from the severest cold damages. As its reason, one can point out that the improvement of agricultural techniques, Agrarian Reform, and stability policy of rice price are carried out with considerable success. It is worthy of a particular notice, as the Tohoku District, is heavily handicapped by its cold climate which gives the great hinderance on the growing of rice. The Southwest Japan is favoured by a higher temperature than this district, but there the priority is generally given to many kinds of commercial crops or even to other industries. The rice farming in the Southwest Japan suffers from great damages by the typhoon almost every year, in the head sprouting or maturing season of rice. This naturally affects the yields. There, following method is used to avoid the damage in recent years. It is to finish the harvest of rice before the attack of typhoons, introducing the such early maturing varieties as are raised in the Tohoku district.

The center of rice producing area which was obviously in the Southwest Japan

6) Fore example, see "World Rice Zone" by K. Nishimura, (in Japanese) Bulletin Dep. Literature Hiroshima Univ. 1956, pp. 167–188.

before the War, has definitely moved to the Tohoku district in recent years. In other words, areal differentiation of Japanese rice agriculture is taking place in this form. For the future of the rice agriculture in the Tohoku district, there are problems of the improvement of rice quality, the prevention of rice blights and the areal differentiation of land productivity, besides the more increase of yield. One may add the problem of increasing labour productivity by the modernization of labour means and the introduction of other commercial crops, as well as the arrangement of the relation between the introduced crop farming and the rice farming.