

The Structure and Trends in Crops and Livestock in Hokkaido

— The mechanism of post war crop combination —

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I. Preface

The characteristics of Hokkaido agriculture include the visitation by frost damage on the average of one year out of ever four, large scale operations, single crop farming, low soil productivity, the large number of operations specializing in agriculture and the introduction of large scale farm machinery. (Perhaps it would be best to attach the word 'relatively' to the above.) Here, when considering overcoming environmental conditions, including frost damage, not only do you have to think of development, land improvement, crop selection and agricultural techniques, but in agricultural history it is certain that the effect of the difference in fertility of land which in turn creates price differential and with it an instability in management, is very great. Since single-crop production predominates because of the intensity of operation it is difficult to compare Hokkaido with the other parts of Japan simply on the basis of larger size.

It is said that for a farm to be solvent in Hokkaido it must have 10 hectares of rice paddies, 20 hectares of other field crops or 50 hectares of dairy farming land. But 50 hectares in dairy farming land is still very small and the average in Hokkaido is still below this. Naturally, the productivity of land is less than that of other prefectures and even with the introduction of large-scale machinery, the productivity is not very high.

However, within the industrial structure of Hokkaido, agriculture plays a big part. While in national statistics Hokkaido has only 3 percent of the agricultural households, as of 1981 it accounts for 37 percent of the cultivated land, 79 percent of the grazing land, 32 percent of the rice, 67 percent of the potatoes, 100 percent of the sugar beets, 38 percent of the red beans, 91 percent of the green beans and 33 percent of Japan's milk. Hokkaido is number one in the amount of rice growing area reduced under the government's rationalization program, the present total being only 54 percent of the area used for rice production when the program began and rice production only 64 percent of the total at that time. Cultivated land has increased, but this has been mainly in grazing crops for dairy cattle. Farms which raise milk cows in Hokkaido amount to 19 percent of the national total, but have 36.6 percent of the country's milk cattle and produce 31.3 percent of the nation's milk. It goes without saying that during the high economic growth period, when manufacturing and agriculture were both promoted, overproduction of rice was followed close after by overproduction in milk, and Hokkaido, which was just coming into its own found itself facing a new dilemma.

From the past, in order to promote the agricultural policies of the government in

Hokkaido, there has been a division of Hokkaido into different districts and in each district agricultural guidance particular to that district was carried out. Guidance for commodity crops tended to rice paddies for central Hokkaido, bean and root crops for the Tokachi area, field crops for Iburi and Shiribeshi and dairy farming for eastern Hokkaido and the Tenpoku areas. But management guidance by official agencies is, in the final analysis, only the fuse. Land use and especially crop selection has always been done against the background of the current economic situation. Here, I would like to examine the changes in crop combination up to the present in ten year periods beginning with 1950 and continuing through 1960 and 1970 to 1980, using the Revised Weaver Method to find the crop combinations and define the mechanism of the pattern of crop structure in each district.

II. Patterns of Crop Combination

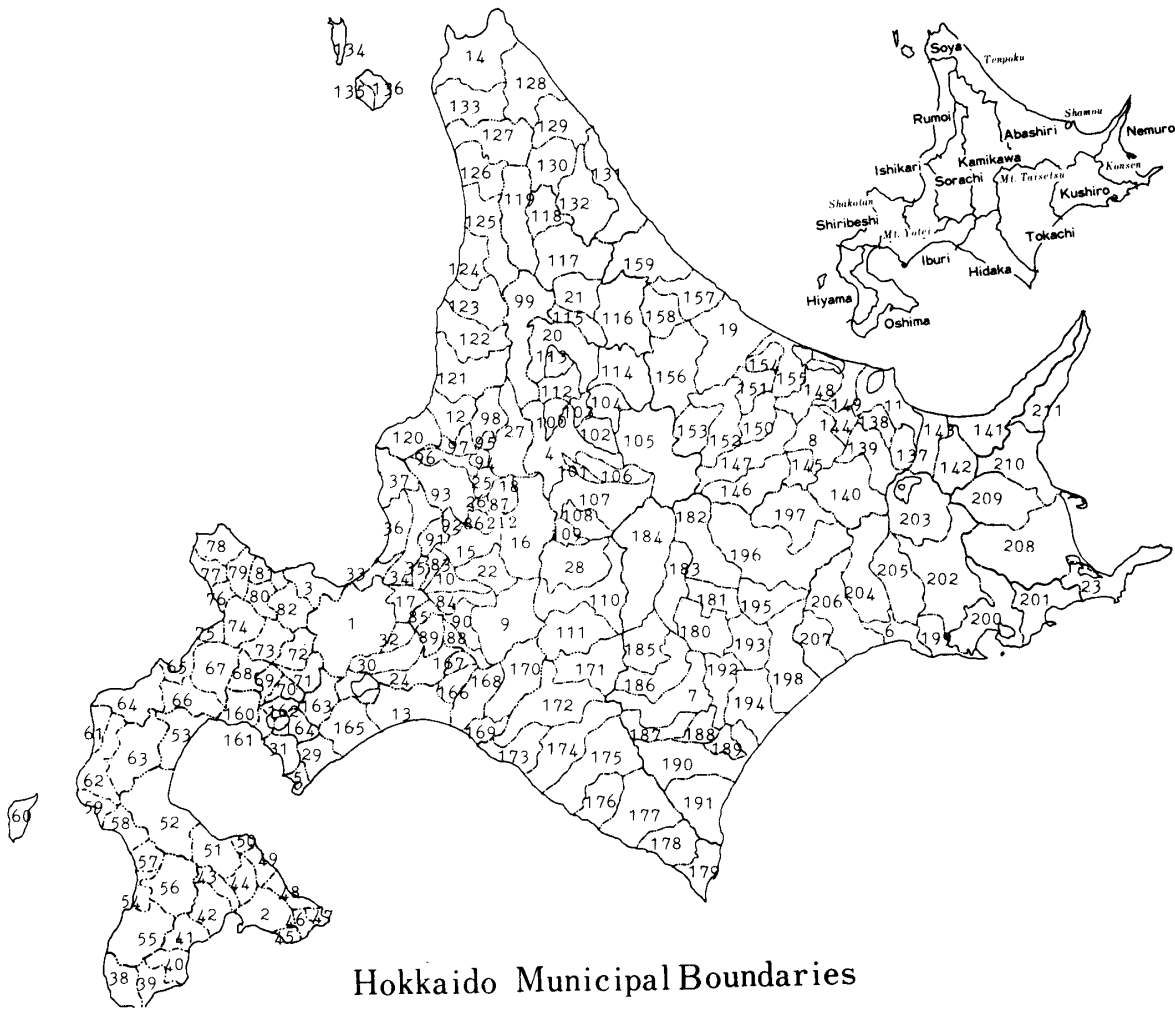
1) Method

Since J.E. Weaver used the Weaver Method in Research in America's middle west for finding the district patterns of crop combination, J.T. Coppock used the Thomas Method in revising the value of deviation in elucidating the combination of crops and animal husbandry in England, and afterwards, was successful in completing a map of the agriculture of England, Wales and Scotland, showing the character of each district as seen from the point of view of agricultural structure in the combination of crops and animal husbandry. K. Doi discontinued use of Weaver's method in dividing the number of crops and showed the structure of prefectural industry through a 'Revised Weaver Method', in which a combination is sought by finding the smallest sum of the square of the differential. Reports on the use of the Revised Weaver Method have been published by Birukawa, Yamamoto, Andoh, Arizono, Ukita and others. In order to help understand the structure of the agricultural districts I have constructed a model of crop combination with the Revised Weaver Method for the years 1950, 1960, 1970 and 1980 to show the special characteristics of the changes in Hokkaido's agriculture during the thirty-six-year period since the end of World War II.¹⁾ Making a pattern of the various crops and livestock should give a standard by which the characteristics of each district can be discovered and we can get a view of the spatial distribution with a cross-sectional view of the sequential changes in Hokkaido agriculture. We can also see, with this model, the necessary relationship between the various phases of the changes in agriculture of each district. As data, the harvest area of each crop reported in the annual forestry and agriculture census was used. For the figures that show the organic connection to livestock, we used the production totals found in the agricultural income statistics. These income statistics were published beginning in 1960 so the same method was used in constructing the models for 1960, 1970 and 1980.

The crops used in computing the crop combinations were rice, wheat, potatoes, cereals, vegetables, fruits, industrial crops, feed crops and hay, a total of ten. However, 'cereals' in 1950 were divided into 'wheat' and 'cereals' from 1960 on, while 'feed crops' and 'hay' were combined into one in 1960. In the production totals of the agricultural income statistics are listed under rice, wheat, beans, cereals, potatoes, vegetables, fruit,

District Boundaries

Sub-Prefectural Boundaries



Hokkaido Municipal Boundaries

1	Sapporo	44	Nanae	87	Kamiesunagawa	130	Nakatonbetsu	173	Monbetsu
2	Hakodate	45	Toi	88	Yuni	131	Esashi	174	Nikappu
3	Otaru	46	Shirikishinai	89	Naganuma	132	Utanobori	175	Mituzunai
4	Asahikawa	47	Todohokke	90	Kuriyama	133	Toyotomi	176	Mitsuishi
5	Muroran	48	Minamikayabe	91	Tsukigata	134	Rebun	177	Urakawa
6	Kushiro	49	Shikabe	92	Urausu	135	Rishiri	178	Samani
7	Obihiro	50	Sawara	93	Shintotsukawa	136	Higashirishiri	179	Erimo
8	Kitami	51	Mori	94	Moseushi	137	Higashimokoto	180	Otofuke
9	Yubari	52	Yakumo	95	Chippubetsu	138	Memabetsu	181	Shihoro
10	Iwamizawa	53	Oshamanbe	96	Uryu	139	Bihoro	182	kamishihoro
11	Abashiri	54	Esashi	97	Hokuryu	140	Tsubetsu	183	Shikaoi
12	Rumoi	55	Kaminokuni	98	Numata	141	Shari	184	Shintoku
13	Tomakomai	56	Assabu	99	Horokanai	142	Kiyosato	185	Shimizu
14	Wakkanai	57	Otobe	100	Takasu	143	Koshimizu	186	Memuro
15	Bibai	58	Kumaishi	101	Higashikagura	144	Tanno	187	Nakasatsunai
16	Ashibetsu	59	Taisei	102	Toma	145	Kunneppu	188	Sarabetsu
17	Ebetsu	60	Okushiri	103	Pippu	146	Obedo	189	Churu
18	Akabira	61	Setana	104	Aibetsu	147	Rubeshibe	190	Taiki
19	Monbetsu	62	Kitahiyama	105	Kamikawa	148	Saroma	191	Hiro
20	Shibetsu	63	Imagane	106	Higashikawa	149	Tokoro	192	Makubetsu
21	Nayoro	64	Shimamaki	107	Biei	150	Ikutahara	193	Ikeda
22	Mikasa	65	Suttsu	108	Kamifurano	151	Engaru	194	Toyokoro
23	Nemuro	66	Kuromatsunai	109	Nakafurano	152	Maruseppu	195	Honbetsu
24	Chitose	67	Rankoshi	110	Minamifurano	153	Shirataki	196	Ashoro
25	Takikawa	68	Niseko	111	Shimukappu	154	Kamiyubetsu	197	Rikubetsu
26	Sunagawa	69	Makkari	112	Wassamu	155	Yubetsu	198	Urahoro
27	Fukagawa	70	Rusuttsu	113	Kenbuchi	156	Takinoue	199	Kushiro
28	Furano	71	Kimobetsu	114	Asahi	157	Okoppe	200	Akkeshi
29	Noboribetsu	72	Kyogoku	115	Furen	158	Nishiokoppe	201	Hamanaka
30	Eniwa	73	Kutsuchan	116	Shimokawa	159	Omu	202	Shibecha
31	Date	74	Kyowa	117	Bifuka	160	Toyoura	203	Teshikaga
32	Hiroshima	75	Iwanai	118	Otoineppu	161	Abuta	204	Akan
33	Ishikari	76	Tomari	119	Nakagawa	162	Toya	205	Tsurui
34	Tobetsu	77	Kamoenai	120	Mashike	163	Otaki	206	Shiranuka
35	Shinshinotsu	78	Shakotan	121	Obira	164	Sobetsu	207	Onbetsu
36	Atsuta	79	Furubira	122	Tomamae	165	Shiraoi	208	Bekka
37	Hamamasu	80	Niki	123	Haboro	166	Hayakita	209	Nakashibetsu
38	Matsumae	81	Yoichi	124	Shosanbetsu	167	Oiwake	210	Shibetsu
39	Fukushima	82	Akaigawa	125	Enbetsu	168	Atsuma	211	Rausu
40	Shiruiuchi	83	Kita	126	Teshio	169	Mukawa	212	Utashinai
41	Kikonai	84	Kurisawa	127	Horonobe	170	Hobetsu		
42	Kamiiso	85	Nanporo	128	Sarufutsu	171	Hidaka		
43	Ono	86	Naie	129	Hamatonbetsu	172	Biratori		

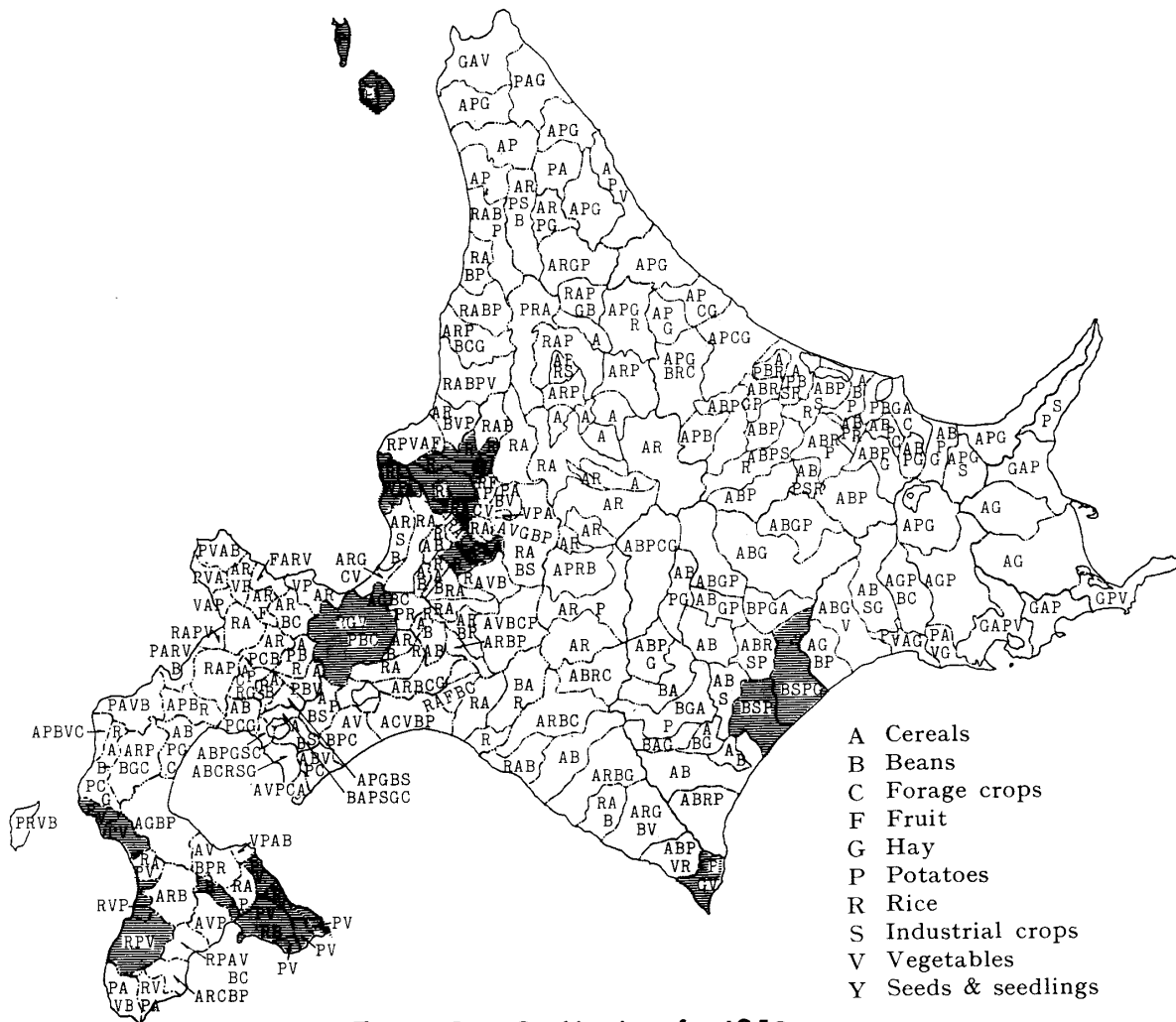


Fig. 1 Crop Combinations for 1950

flowers, industrial crops, nursery plants, beef cattle, milk cattle, hogs, chickens, and other livestock, for fourteen crops and livestock. However, in 1960 wheat, beans and potatoes were all listed under potatoes and cereals and livestock was all listed under one heading, so there were only eight headings, including livestock, for that year. Since beans, cereals and potatoes are the main field crops in Hokkaido, these were specially separated for 1970. Calculations were done by computer and the Weaver Method was also applied, but we will not go into particulars here. Calculations were made in the same way for the year 1981, about which I would like to mention a few items.

2) Transitions in crop combination

Figure 1 shows by letter symbols the crop combinations in 1950. At that time the main crop over the whole of Hokkaido was 'A' (cereals), so the villages and townships in which 'A' is not found are shaded. In this case the ranking of crops was not considered.

Before getting into the main discussion, a look at the contents of 'cereals' in 1950, excluding rice, finds included barley, rye, two-row barley, wheat, corn, oats, millet, sorghum, barnyard millet, finger millet, Job's tears and buckwheat. 'B' (beans) includes soybeans, red beans, peas, broad beans, kidney beans, black-eyed peas and 'other'. 'P' (potatoes)

is mainly the ordinary potato but also includes some sweet potatoes and taro root. 'S' (industrial crops) includes cotton, flax, chinagrass, chinese jute, tobacco, rushes, chinese mat grass, sugar beets, pyrethrum, peppermint, willow and 'other' along with rape seed, sesame and other crops used for making vegetable oil. 'C' (feed crops) includes maize, rutabagas, feed beets, green soy beans, Chinese milk vetch, burn clover, common vetch, etc. There is a combination of ten categories; rice (R), beans cereals, potatoes, vegetables (V), industrial crops, fruit (F), feed crops, hay (G), nursery plants (Y) (besides plants for seeds, this includes flowers and tree nurseries). It should be noted that from 1960 on wheat 'W' was separated from cereals 'A' and hay and feed crops were combined under 'G'.

In figures 2, 3, 4 and 5 are shown the crop-combination patterns for the years 1950, '60, '70 and '80. In constructing the figures, the combination of, at the most, six categories of crops was necessary for each year and each village, township and city district. Important crops were considered to be rice, potatoes, fruit, vegeta-

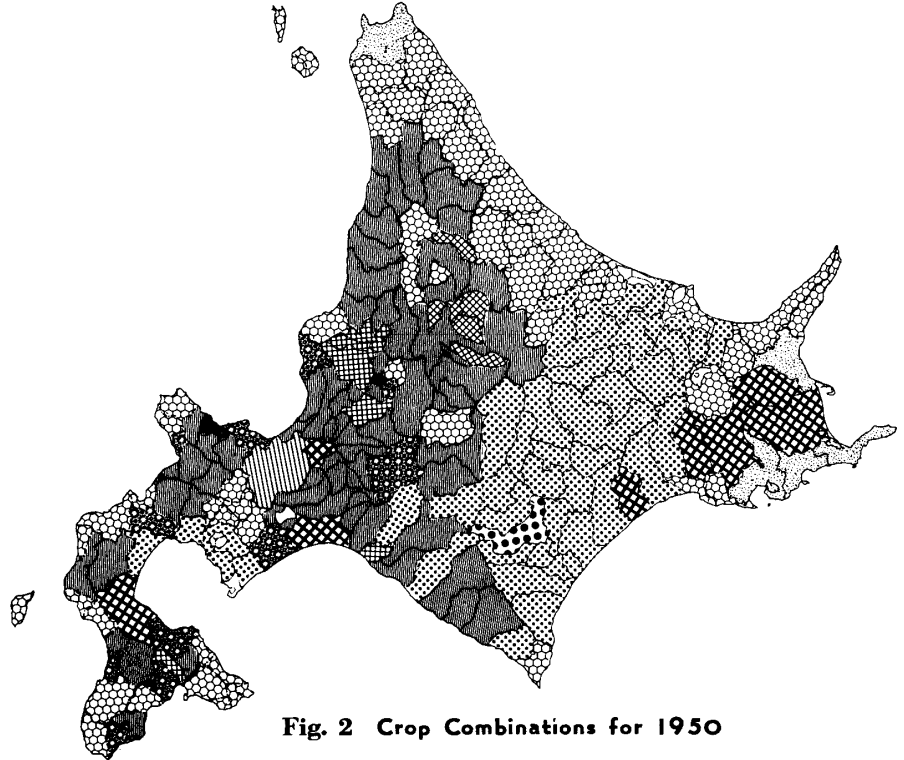


Fig. 2 Crop Combinations for 1950

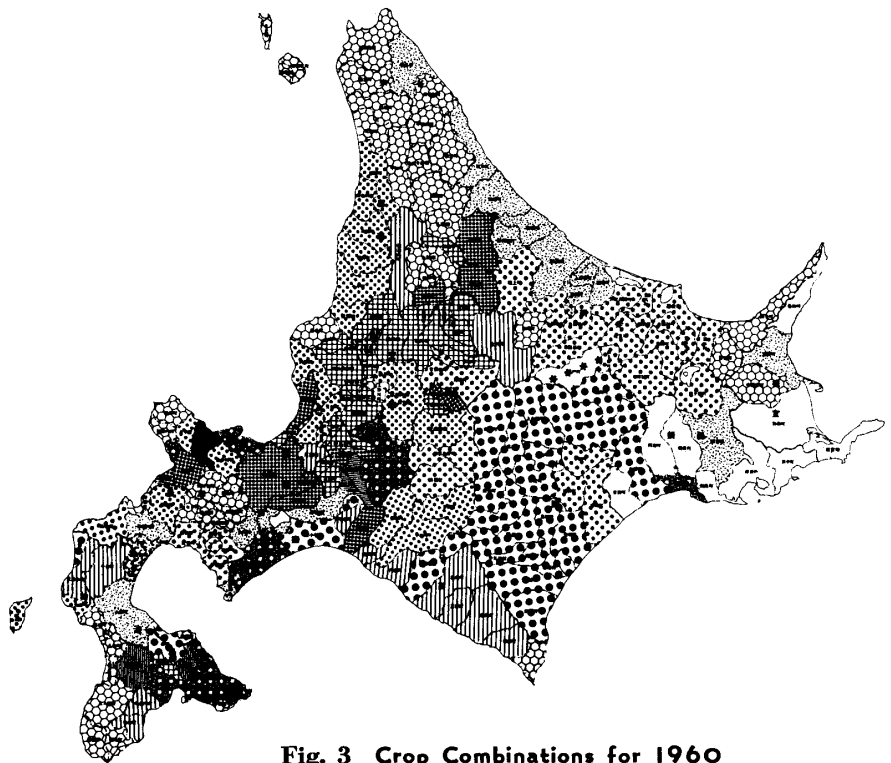


Fig. 3 Crop Combinations for 1960

Key for Figure 2~5

1 hay 2 hay+other 3 rice 4 rice+wheat+other 5 rice+hay+other
10 beans+other 11 potatoes+other 12 cereals except rice in 1950

bles, beans, cereals and feed and 'other' crops. Up to three of these crops, regardless of rank, were put into the figure. To bring out the special characteristics of Hokkaido agriculture, bean crops were given precedence, and next in line of precedence were potatoes, fruit and vegetables. With these, fifteen different expressions of crop combinations were settled upon.

The largest number of districts had a combination of four crops in 1950 (fig. 6), and 185 districts, or 87 percent, had two-to five-crop combinations. In 1960 one-crop districts began to increase as did five-crop districts, the others decreasing. In 1970, townships and villages with a single crop amounted to 97, two-crop districts came to 41, or 65 percent, while three-crop areas diminished. In 1980, one-crop districts remained more or less the same, while three-crop and six-crop areas stopped decreasing and remained steady, and four-crop and five-crop areas decreased.

One-crop and two-crop districts made up 68 percent of the total in 1980 and, if three-crop districts are added, together they total 83 percent. The same trend continued in 1981 pre-

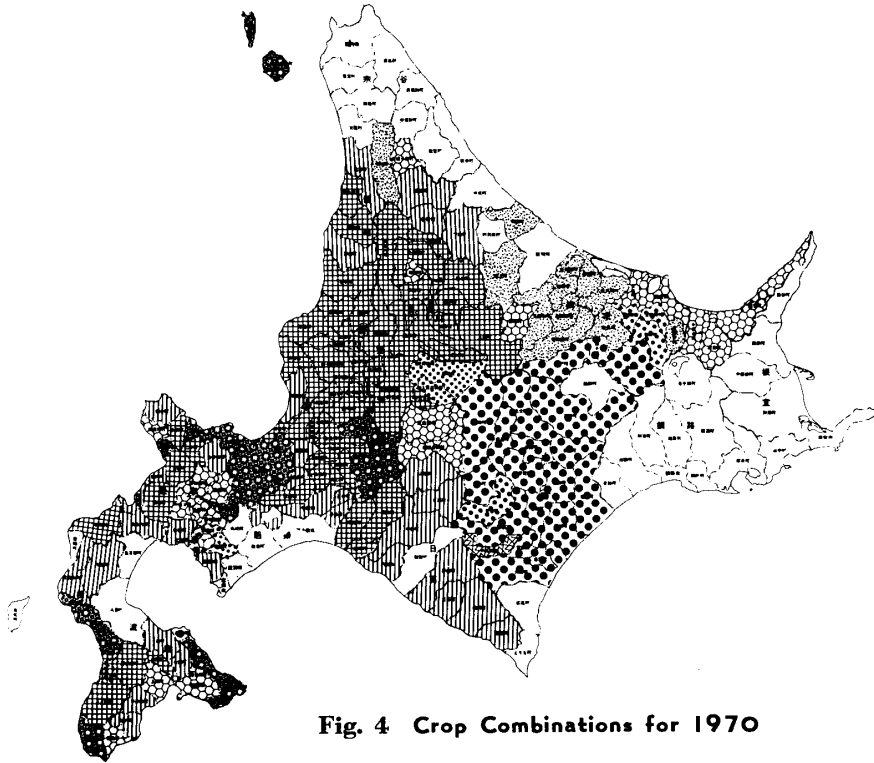


Fig. 4 Crop Combinations for 1970

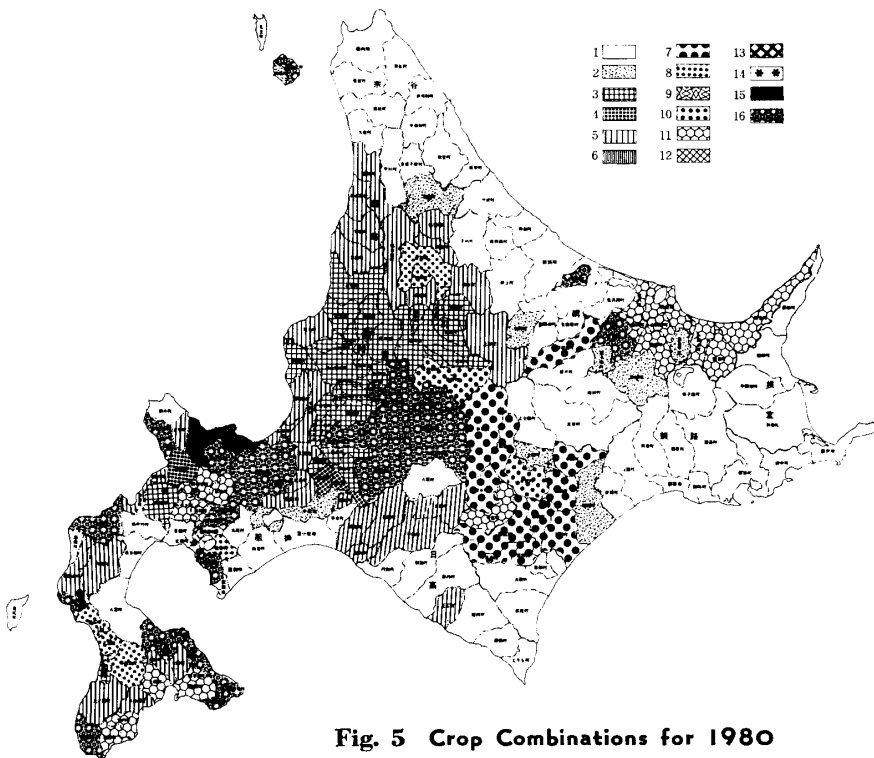


Fig. 5 Crop Combinations for 1980

- 6 rice+cereals+other
- 7 beans+hay
- 8 beans+rice
- 9 beans+potatoes
- 13 cereals+other
- 14 wheat+beets
- 15 fruit+other
- 16 vegetables+other

1981 was the same single crop thirty years ago, though there may have been some mixing of other crops in the meanwhile. There were thirty cities, towns and villages having rice as a single crop, 64 having forage crops as a single crop, one with fruit and one with vegetables; two-crop types included 25 RG, 3 RW, 1 FR, 4 VG, 1 VW, 4 VP, 6 BG totalling 96 one-crop districts and 48 two-crop districts.

Table 2 Combinations of livestock and crops by district (%)

Year	1-type	2-type	3-type	4-type	5-type	6-type	7-type
1960	32.1	42.9	20.8	3.8	0.5	—	—
1970	38.2	21.7	19.8	11.8	7.5	0.5	0.5
1980	35.8	21.7	19.3	10.8	9.0	2.8	0.5

Note: In 1960 there is a combination of eight types and in '70 and '80 there is a combination of fourteen types so '70 and '80 cannot be directly compared with 1960.

Table 2 shows the combinations of agricultural crops and livestock as seen from the standpoint of production totals; one-variety types account for 36 percent of the total, two-variety types 21 percent, and three-variety types 19 percent and it is peculiar to this group that only the one-variety and three-variety types show a tendency to simplification of crop. I will discuss the reasons for the above in the following chapter.

III. District variations in crop combinations and crop-livestock combinations

1) 1950

The whole of Hokkaido is covered with grain. The exceptions to this where some other crops were planted are only those indicated by the shaded areas in Fig. 1. Every town and village district has some kind of combination of compound crops and, as can be seen in Fig. 1 and 2, those with only single crops number only seventeen, the greatest number having four crops combined, three crops, five crops and two crops following in that order.

The most common types of four-crop combination are, in Sorachi RABV (V also potatoes with P, C and S). In Tokachi ABPG (with PG also becoming SP, CG etc.), and in Abashiri too, ABPG, sometimes including R. In other words, the rice paddy areas tend to have combinations of cereals while the areas of field crops tend to have combinations of rice or beans. Of course, if you take into account those combinations which are in third place or lower, RA or AB types will be found. If the specialty is rice then R, or if the specialty is beans then B is normal and while rice as a single crop is possible, beans or various cereal crops do not exist alone. The reason is that areas of cold climate like Hokkaido are basically one crop per year areas; rotation of crops is necessary and a combination of crops spreads out the risk. Therefore, it comes down to a selection of either cereals or beans, that is, either AB or BA. These were both treated the same in the figures; however, they are somewhat different in fact. Areas which make beans their main crop, Memuro, Obihiro, Nakasatsunai in Tokachi, and Hombetsu, Urahoro and Toyokoro differ from the crop combinations brought up in the next section of this chapter, and those differences were true not only in 1950, but have continued down to the present.

Further, in the foothills areas, at that time, the third crop 'G' (hay) appears, so that dairy farming grasslands that appeared afterwards had already had a start, so to speak, at this time. Looking at the Kosen area in this respect, there is already a two-crop combination of AG, and inland there is an AG+P type combination. In contrast to this Eastern Hokkaido type, Northern Hokkaido is basically AP (cereals and potatoes) with a third crop of G occasionally appearing. Southern Hokkaido has different combinations in the Uchiura Bay section and on the Japan Sea side, and the area at the end of the peninsula differs again. In the Uchiura Bay area we find A+R•B•G•V+P and in the area bordering the Japan Sea, P•R+V•A+B. Rather complicated in makeup but, in short, the former is cereals with rice, beans, hay or vegetables as a third crop, while in the latter, vegetables or cereals are added to potatoes or rice. It is interesting to note that in the towns and villages where G (hay) appears as a crop, there is, afterwards a strong connection arising with dairy farming.

In the PV type combinations, in the foremost can be seen the Shakotan Peninsula, Erimo and the offshore island areas. This same combination continues down to the present in the Oshima district, with the other districts having turned to grassland.

Next, looking at the crop combinations left over after having applied the Revised Weaver Method, that is three-crop and six-crop combinations, if we view them without ranking them, in the same way as we considered A, we find them present over almost all of Hokkaido. So, if we consider a relatively few crops, that is to say we examine the relatively major crops of the time with the areas selected through the Weaver Method, the results are very interesting. Looking at rice, we find that there is not very much change from 1970 when the formation of new rice paddies was at its peak. In other words, while there was a change in second and third crops then and afterwards, and while the emphasis shifted more to rice and the areas of production were enlarged so that it became the major crop in the the Okoppe and Abashiri districts, the basic pattern had already been formed as early as 1950. Actually there are many more districts on the east side of Hokkaido that planted rice, but these were dropped from the statistics in the process of selecting crops for the model.

Potatoes appear in second place in crop combination in many places and there are twenty-one districts that put P in first place, and it was found in the 67 percent of districts which did not have A or R single crops or RA, AB, or AG type rice combinations.

Those districts having a major crop of beans included the whole of Eastern Hokkaido, excluding that area east of Shari and Shibeche, and extended to 63 percent of the districts, the rice-paddy areas of Central Hokkaido, the coastal areas of Shiribeshi, the vegetable and potato-crop area of Oshima referred to before excepted.

So, the selected crop combinations of 96 percent of Hokkaido's districts include these three crops of rice, potatoes and beans with only eight districts, Wakkanai with GAV, Nakashibetsu and Bekkai with AG and Furen, Aibetsu, Toma, Higashikawa and Takasu with A not including them.

2) 1960

Looking at crop combination from the point of view of numbers of crops, in the

graph for 1960 there is a division evident between the levels of combination. There are districts tending toward becoming single-crop types and those becoming multi-crop compound types, the dividing point being the three to four-crop compound type. As seen in figure 3, Abashiri has become distinguished from Tokachi in crop combination. Tokachi has increasingly taken on the color of a heavy reliance on bean crops with BGW evident in the surrounding areas and BG or B type combinations in the center. Abashiri has increased the ratio of wheat and sugar beets showing a pattern of adding a third or fourth crop to BS or BW with potato crops moving into the bordering areas. Among other multi-crop areas outside of Abashiri, the foothills on the southern slope of Mt. Yotei are similar in pattern while the potato areas extending from Shari to Naka-Shibetsu are similar to the north slope of Yotei. While the Konsen district has become the single crop G as far as Akan, on the Okhotsk coastline there is a relatively simple combination structure with barely the addition of P to GW.

The single crop R has become widespread in Central Hokkaido and in the surrounding areas there is generally an RB pattern. The Furano basin is BW or, where there are paddies, RB, and Rumoi follows the same pattern. In Southern Hokkaido the division between hay, vegetables and potatoes has progressed in a relatively small area.

3) 1970

Single-crop planting has, by 1970, progressed to the point where the whole of Hokkaido can be divided into four areas. (Figure 4). From Konsen to Soya, jumping over Abashiri hay prevails; in Central Hokkaido single-crop rice; in Tokachi beans and hay; in Southern Hokkaido rice, hay and vegetables; potatoes have spread in the Abashiri-Shari area and similarly in Furano and Yotei.

4) 1980

Here it seems as if the whole island is tending to become hay and forage crops with the appearance of single-crop G, the limitation of single-crop R in Central Hokkaido and the division of the area surrounding into three distinct districts, G, B or V. In the north Kamikawa and Rumoi have turned to hay, Shibetsu and northern Furano to beans and wheat, and two or three-crop combinations of rice and vegetables, etc. in the area extending from Ashibetsu, Mikasa and Iwamizawa as far as Yubari. Hidaka, which, in 1970 had been GR has, except for Mitsuishi, become a G type, demonstrating the character of a horse-raising district in its crop selection as well.

The grasslands extending from Tomakomai to Muroran show evidence of the industrialization process more than agricultural evolution. The forage and hay fields needed for the dairy farming of Oshamambe and Yakumo in Southern Hokkaido have increased in area. While the area at the foot of Mt. Yotei which were PGR and PGSV type have become VP or VR like some of the vegetable raising districts contiguous to Sapporo, or have changed to compound small-field crop including edible potatoes and beans from potatoes for starch production, reflecting the trends of the times. There is one uniting factor to be seen, that is the contrast to the tendency to specialize in beans, hay, wheat

or sugar beets of Tokachi.

5) The crop distribution characteristics seen serially

Looking at the changes in cereals over ten-year periods, production which had extended over all of Hokkaido in 1950 remained outside of Southern Hokkaido in 1960 only in the eight districts of Tokachi, Shintoku, Ikutahara in Abashiri, etc. in 1970 was reduced to only fourteen districts including Southern Hokkaido and by 1980 remained only in the one district of Toya.

Rice disappeared from Eastern and Northern Hokkaido and inclined toward concentration in the districts of Central Hokkaido. The change to other crops in southern Furano and Hidaka is the result of the government policy of rice production regulation and shows a tendency towards rice plus hay, vegetables and wheat.

Between 1950 and 1960 beans spread throughout the island and by 1970 had concentrated in the eastern part with Abashiri and Tokachi being the main producers. By 1980 they were concentrated in Tokachi and the areas of Kamikawa which had converted from rice paddies. The Southern Hokkaido districts of Yotei and southern Hiyama became areas of bean production in combination with other crops.

In 1950 potatoes had been present throughout the island except for the rice paddy area of Central Hokkaido, Hidaka and Nemuro but by 1960 had already begun to concentrate in Northern Hokkaido and around Shari and in Southern Hokkaido. By 1970, as a result of the increase of grassland, potato crops had withdrawn from Northern Hokkaido and by 1980 remained a specialty crop of Abashiri, Tokachi, Furano, Yotei, and the end of the Southern Hokkaido peninsula.

Potatoes for starch production are easily grown on a large scale and, as a result, the Tokachi and Abashiri districts which have farms of large acreage became the chief production areas, and conservation of energy through mechanization of planting, harrowing and harvesting became possible.

Three companies process sugar beets at a total of eight factories; Nihon Sugar Beet operates in Shibetsu, Memuro and Bihoro; Hokkaido Sugar in Kitami, Hombetsu and Southern Hokkaido (Date); and Hokuren operates in Shimizu and Naka-Shari. The Memuro and Naka-Shari plants turn out 70-100 thousand tons of sugar (using 600-700 thousand tons of beets) and are of large size while the others are smaller, turning out 30-40 thousand tons per year. Naturally, considering the cost of transportation to the farmer, the areas close to the factories have an advantage, so that the planting of this crop is limited to Abashiri, Tokachi and Yotei.

While the production of other crops diminished, hay production increased in acreage reflecting the development of dairy farming, beef and horse raising. The distribution of hay crops as seen on the map display the underlying fact that, the ease of growing forage as opposed to other crops promoted the tendency to increase the number of milk cattle in the area and thus is directly connected to the over-production of milk.

Finally, examining the situation in vegetables, we find them concentrated in the area around Sapporo, Yotei, the areas of Southern Hokkaido and around Hakodate in farms

whose acreages are too small to support dairy farming, Mikasa, Yubari, Furano and Kitami, having disappeared from Rumoi, eastern Hidaka and Tomakomai where they had been present in 1950. The onion, for which Sapporo's Okadama was famous, has moved to Iwamizawa and Kitami, and fruit is now limited to the areas around Niki and Otaru.

6) Combinations of crops and livestock from the point of view of production totals

The only way to see directly the connection between crops and livestock is through examining production totals. The results of computation from the production totals in the Agricultural Income Statistics are shown in figure 7. There were no statistics for 1950 so there could be no comparison for that year; in 1960, wheat, beans, cereals and potatoes are lumped together so that year cannot be directly compared with 1970.

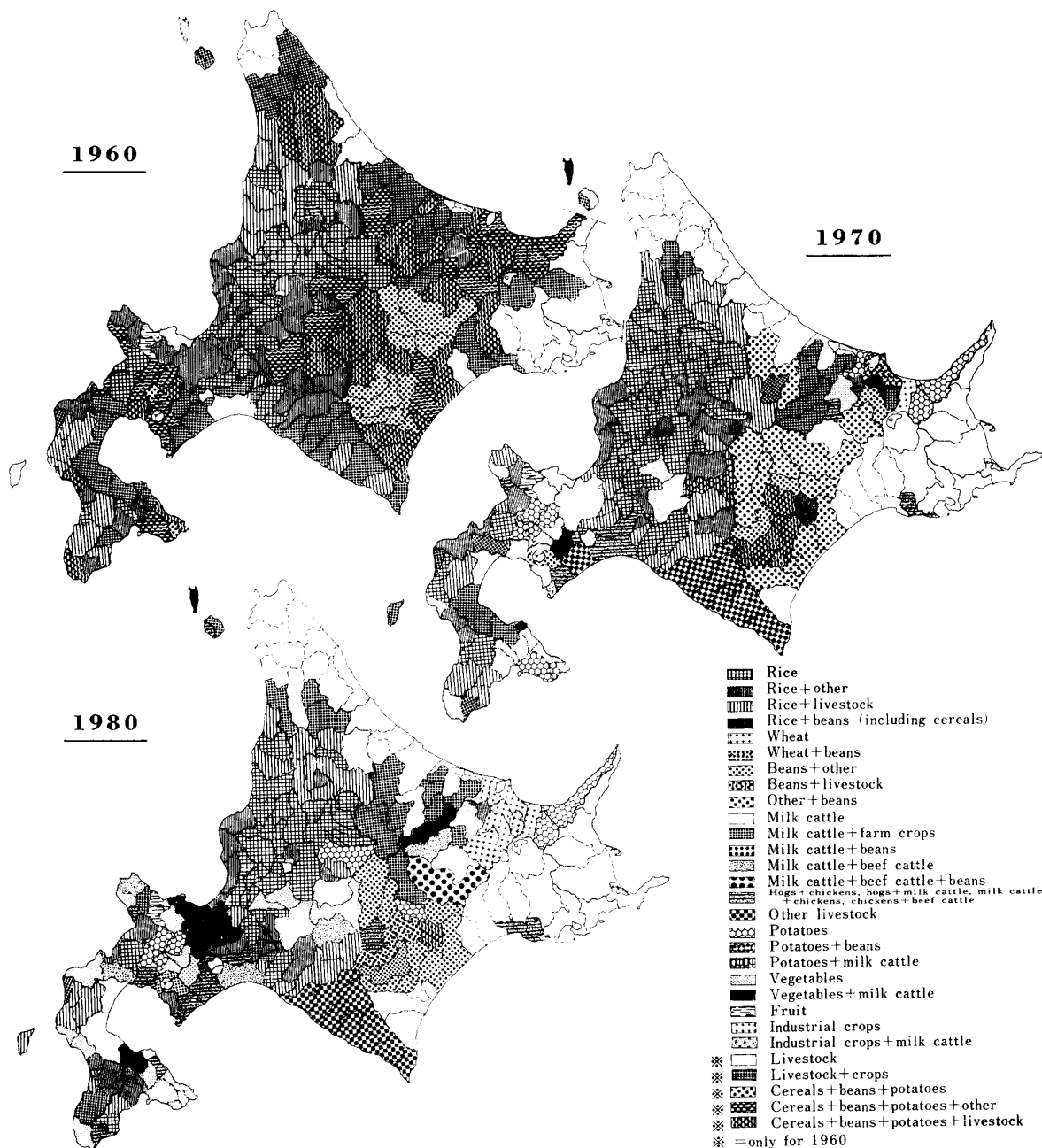


Fig. 7 Combinations of crops and livestock in 1960, 1970, 1980

Examining the figures for the years 1960, '70 and '80 we find first that in 1960, the districts in which livestock appeared high on the list of agricultural production were distributed throughout Hokkaido except for the rice paddy and bean crop areas. However, areas in which livestock production accounted for fifty percent or more of the production totals included only the three districts of Konsen and Soya with dairy farming, the Tomakomai-Muroran district with chicken and hogs, and Hidaka with horses.

In 1970, milk cattle had spread over all of Eastern Hokkaido and the Southern Hokkaido district along the shores of Uchiura Bay, Hidaka was horses, Tomakomai-Muroran chickens and milk cattle and Sapporo, Otaki, Sobetsu, Kami-no-Kuni and Furano were hog-raising areas. However, the districts in which livestock production was fifty percent or more of the production had a wider distribution than in 1960, being found in Soya, Nishi-Mombetsu, Konsen, Tokachi, along the mountains and coastal areas of that district; Hidaka, except Biratori; Tomakomai with Chitose and Hayakita; the Muroran district, Kuromatsunai, Yakumo, Mori, Fukushima, etc. Twenty-six villages and townships had 50-75 percent of their production from livestock and thirty-four had over 75 percent. In 1980 these numbers increased to thirty-two and fifty-three respectively, for a total of eighty-five. The distribution of these districts was increased by the addition of northern Kamikawa and Rumoi which had been at the northern borderline for rice production, the areas close to the mountains and seacoasts in Tokachi which were unstable as bean-crop locations, and Nishi-Mombetsu and Abashiri. The newly added areas have a livestock, i.e. dairy, production ratio of 50-70 percent, while the other older areas have a ratio of 75 percent or more. In other words, there has been an increase in density of dairy farming in the areas that have specialized in that type of farming.

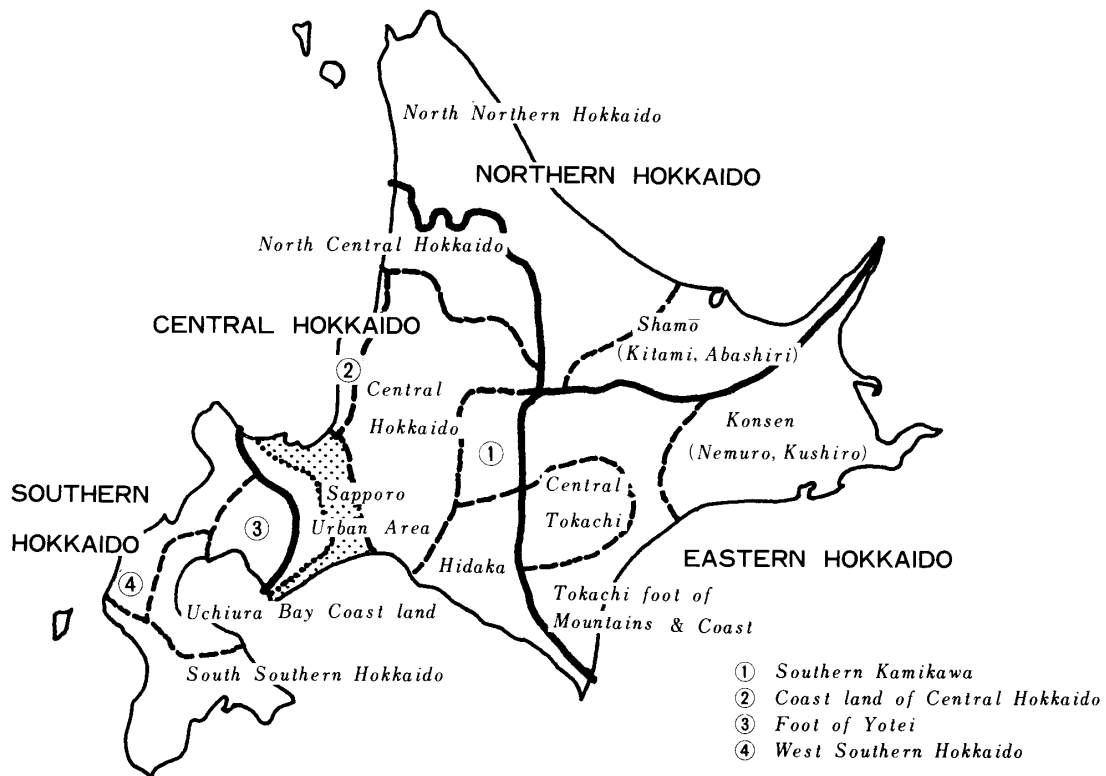


Fig. 8 Hokkaido Agricultural Regions (1983)

Here we will avoid discussion of the ranking of production of agricultural products and the crop-livestock combinations since they are readily apparent from examination of the charts. If it is necessary to add something, we may point out that, from the fact that there are a relatively large number of towns and villages whose production totals derive from a single crop, the line which defines the limits of a multiple-crop district is also the line which denotes the boundary=dividing line between district characteristics so that the use of the Revised Weaver Method in dealing with the statistics for division of districts has validity. The results of the application of the Revised Weaver Method to Hokkaido agricultural districts are depicted in Figure 8 which shows four regions and fifteen districts.

IV. The Mechanism of Crop Combination

Having seen the crop and livestock types serially in cross section, we would like to consider briefly here the changes since the war in the main crops and the causes of the same. Looking at the trends in agriculture since the end of World War II, it is possible to divide the period into 1) time of agricultural reorganization and swift development from the upheaval of the immediate post war period till 1960; 2) the period of the formation of the basic agricultural laws and administration and agitation within the structure of agriculture from 1960 to 1970; and 3) the stagnant period marked by agricultural surpluses from 1971 to the present. We would like to make a careful examination of the meaning of the crop combinations from the point of view of the special characteristics of each of these periods. As a first step we will consider frost damage and the measures used to cope with it.

In the post-war years from 1946 to 1952, though there may have been some poorer harvest years in the frost susceptible areas, there was no great loss of harvest to frosts, and during this period there was wide dissemination of cultivation techniques for a wide variety of crops and in rice paddies, methods of production in warm and cold beds, and there was great progress in land organization. In 1953, '54, '56 and '57 however, there came a series of years of frost damage, and again 1964, '65, '66, '69, '71, '76, '80 and '81 were frost-damage years, and the damage in 1956, '64 and '71 was especially heavy. The harvest per 'are' in the frost-damaged year of 1976, however, was as much as the average harvest year of the '55-'65 period. This was due to the establishment of the system of growing the rice seedlings in vinyl 'hot houses' beginning in 1967 and, after '69 the establishment of rice types that are cold-resistant and easily planted by machine and cultivation methods which are conducive to frost resistance. In 1972 the harvest of rice reached a level of 500 kilograms per 'are' and 537 kilograms in 1978 which was fifth nationwide in per 'are' harvest.

In the effort to find methods of cultivation that would conserve energy, 94 percent of the farms had seedling transplanting machinery by 1980. In the growing of seedlings, also, the original 'string' method gave way to the 'mat' method, and the spread of 'pot' seedlings, the research into weed killers, improved species of rice have been very effective.

As opposed to rice, bean crops of unstable areas especially susceptible to frost damage gave way to sugar beets and dairy farming after the heavy frost damage year of 1953 and to mainly dairy farming after the frost years of 1964 and '66. The way of coping with the frost damage in each area joins with the socio-economic factors of each period to form the basis of crop selection.

1) First Period (1950-1960)

Specially characteristic of the post-war period of confusion for Hokkaido were the

Table 3 An Index of Hokkaido Agriculture

Index		Year					
		1950	1955	1960	1965	1970	
Total farms		245,757	234,091	233,634	198,969	165,978	
By specialty Part-time farm	percentage specializing (%)	50.0	57.9	50.4	50.2	48.9	
	Part-time farm	Type 1	17.2	17.6	22.2	23.6	25.9
		Type 2	32.8	24.5	27.4	26.2	25.2
By cultivat- ed land area	1 ~ 5 (%)	80.4	78.2	74.9	69.3	60.1	
	5 ~ 10	15.4	17.8	20.3	22.9	24.9	
	10 ~ 15	} 4.0	3.3	4.0	6.0	8.2	
	15 ~ 20		0.6	0.7	1.4	3.9	
	over 20 hectares	0.2	0.1	0.1	0.4	2.9	
By type of cultivated land area	Cultivated land area (hectares)	760,159	779,394	826,465	812,961	890,422	
	Rice paddy	152,596	161,273	187,302	227,432	276,590	
	Field crop	607,563	618,121	635,013	580,554	608,701	
	Orchard and other			4,150	4,973	5,130	
By Agricul- tural machinery	Tractor - (over 30 Hp)				2,972	12,868	
	Rice transplanter				984	368	
	Combine with automatic thresher					1,405	
	Rice, wheat dryer					36,987	
	Milker				6,826	28,295	
Livestock	Number of farms with milk cattle	25,144	39,200	63,690	49,630	39,290	
	Head of milk cattle	53,182	88,950	182,810	317,690	489,200	
	Milk production (tons)	99,443	210,490	397,150	663,546	1,184,999	
	Head of beef cattle	893	447①	4,650	13,690	34,580	
	Hogs	38,716	53,372	97,910	169,390	274,700	
	Chickens (1000)	762	1,800②	2,370	3,987	6,256	
Harvested area of main crops	Rice (hectares)	134,618	143,571	169,953	201,437	249,476	
	Wheat	25,546	15,815	14,071	12,676	9,515	
	Potatoes	71,269	68,340	72,834	70,265	68,151	
	Soy beans	78,102	54,506	63,262	33,598	8,886	
	Red beans	15,951	32,394	42,517	39,259	31,318	
	Peas	28,533	56,928	59,769	83,400④	46,251	
	Sugar beets	14,666	16,200	44,200③	55,200	54,758	
	Vegetables	35,837	32,652	24,720	20,473	21,907	
	Hay	25,199	36,066	79,240	135,413	327,700	

Data: Annual agricultural census. Computed from the statistics for the agricultural structure palities and livestock statistics: (1) special agricultural census for 1955, (2) basic statistics of culture for 1957, (3) 1961, (4) municipality statistics.

Noto: Part-time farm Type 1...Farm households earning main income from farming
Type 2...Farm households earning main income other jobs

urgent need for development, agricultural land reform and the system of selling rice to the government in order to secure food supplies. In 1950 there was the Hokkaido Development Law, in 1952 the first Five Year Plan, in 1953 the Special Ordinance for the Establishment of Beet and Livestock Farms, in 1954 the Dairy Promotion Act and in 1957 Hokkaido's second Five Year Plan.

Table 3 shows the trends in farms and crops over five-year intervals beginning with 1950.

1975	1980
134,263	119,644
42.8	42.0
28.8	32.1
28.4	25.9
56.1	51.2
24.2	24.8
7.5	8.3
4.7	5.0
7.5	10.7
908,138	968,668
258,095	261,797
645,117	702,865
4,926	4,007
32,859	63,490
11,538	33,683
11,714	28,638
40,793	49,364
35,659	27,528
27,380	21,400
614,800	751,600
1,447,640	2,117,231
125,500	190,145
438,010	571,433
5,697	6,021
185,500	166,662
23,100	61,092
71,400	59,551
17,100	22,038
46,700	31,963
40,000	15,493
48,100	56,305
32,662	34,280
492,200	540,400

of the municipi-
Japanese agri-

From 1948 when the number of farms was the greatest to 1960 there is a slight diminishing of the number of farms with about a three percent variation and a rise in the ratio of specialized agriculture. In 1950, 80 percent of the farms were less than 5 hectares (12.35 acres) in area and 96 percent were under 10 hectares (24.71 acres), indicating a preponderance of very small farms. Even by 1960 the number of farms under 10 hectares had diminished by only two percent. Tilled land area in 1948 was at its lowest and it took until 1956 for it to return to something like its pre-war levels, but the increase did not match the great increase in farming land of 1937, and rice paddies alone continued to increase until 1970.

The main crops up to 1950 were rice, wheat, beans and potatoes. In 1955 there was an increase in rice but a reduction in wheat and cereals. Under the influence of imported crops and raw materials there is a decrease in the special industrial products flax, rape seed, peppermint and pyrethrum. Potatoes remained the same and vegetables and orchard fruits increased but slightly while there was a definite increase in only feed crops. In livestock there was an decrease in horses, sheep and goats while milk cattle, beef cattle, hogs and chickens increased. Milk production was 100 thousand tons in 1951, 200 thousand tons in 1955, 300 thousand tons in 1958 and milk cattle increased from fifty thousand to one hundred and eighty thousand. The number of cows per farm, however, increased to only 2.9 per farm from 2.0, due to the increase from twenty thousand to sixty-thousand farms owning livestock, an increase from 10 percent to 27 percent of the total number of farms. The 63,690 farms engaged in raising livestock in 1961 was the peak for Hokkaido.

2) Second Period (1961-1970)

The selective expansion of agricultural production after the promulgation of the 1961 Basic Agriculture Law and land improvement operations through structural agricultural improvement works after 1962 as well as the introduction of large machinery gave rise to the great outflow of agricultural labor from the farms during

the high economic growth period and was the occasion of a heretofore unheard of unrest in farming areas, enlargement of farms, the northward movement of rice growing areas and the district division of field crops. It was a period of great agricultural upheaval.

The number of farming households diminished to 70 percent of the number in 1960 during this period; those specializing in agriculture to 69 percent; those with one other occupation to 83 percent and those with two other occupations to 65 percent of the previous figure. The decrease in categories specializing in agriculture and two other occupations is the greatest, those with one other source of income showed a relative increase. Herein can be seen a characteristic of Hokkaido where the labor force left the farms without going through the process of first finding other sources of income, as apart from other prefectures in Japan where the outflow of labor was unaccompanied by a reduction in the number of farming households.

The number of farms with less than 10 hectares went down more than 36 percent and those with over 10 hectares more than doubled. There was an increase of 7.7 percent in tilled land, but in this rice paddies increased by 89 thousand hectares while field crop area diminished by 26 thousand hectares, wherein can be seen an extraordinary concentration on increasing rice paddy area. The 275 thousand hectares in which rice was planted in 1970 represents the extreme.

In this "paddification" trend, the number of farms with rice paddies diminished while the size of the average paddy grew to twice the previous size in many municipalities, paddies of under one hectare diminishing while those of three to five hectares increased to over five hectares in area. A difference in the various districts as to mechanization, drainage management, soil enrichment and other land management programs can be seen with the increase in new paddies especially in the areas subject to frost.

In the central areas, along with this paddification trend, there was a movement to larger-scale fields, high productivity and specialized management and the economic efficiency of large-scale machinery systems heightened noticeably. Opposed to this, a tendency appeared in the surrounding areas to combine rice with other crops and in the peripheral limits of rice growing, the diffusion of large-size machinery such as motorized rice planters, combines and dryers, with the problems they pose in connection with size of farm management, were introduced as energy saving techniques in coping with the shortage of labor.

Rice crop adjustment planning began in 1969 and was actually a planting limitation stemming from an oversupply created from a contradictory government agricultural policy which had previously emphasized rice production. Up until about 1960 there were some three hundred and fifty different species of rice being planted. These were frost resistant species cultivated with large amounts of fertilizer giving large harvests.

In 1969, however, with the beginning of the system of non-governmental rice distribution, the species of rice became determined in each rice-growing area and with this sudden change in the distribution system Hokkaido also began to unify, planting a single species.

The characteristics of field crops after 1961 began to become pronounced in 1965. By acquisition of the lands of those who had departed from the farms, the area per farm of

those who had remained continued to grow, and with the continued outflow of labor force, tractors were bought and the farms began to tend toward large-scale high efficiency. As the land area per farm increased, the tendency to reduce the numbers of crops increased also, which continued till the time of the first oil crisis.

In field crops wheat, cereals and beans decreased sharply while root crops, sugar beets and hay increased and potatoes showed a slight decline. As a result of measures to cope with frost and the tendency to largeness for management stability, bean crops declined and sugar beets increased after 1962 and from '65 to '75 this tendency accelerated. Two directions can be discerned, one of compound management tending toward dairy specialization and another decreasing or doing away with the livestock section. The former is seen in the inland areas of Tenpoku and Shamo (Shari-Abashiri) and at the foot of the mountains in Tokachi, the latter in the inland areas of Tokachi and in the areas around Kitami and Abashiri. With the enlargement in scale, investments in mechanization and land competed with one another causing the price of land to rise. This in turn tended to cause the subdivision of land which in turn was a factor in making the rotation of crops difficult.

Beginning with this period dairy farming underwent a great change. In 1965 the so-called "deficit payments" system or the Dairy Products Material Producer's Financial Compensation Temporary Measures Law was passed and went into effect in 1966. This law was especially helpful in stabilizing the price of milk in Hokkaido where 80 percent of the milk is used for processed dairy products, and through the determination in that same year of the basic policy for modernization of dairy farming the first Hokkaido Dairy Modernization Plan was made. Dairy farms which had shown an increase in 1960 decreased by a factor of 38 percent, or 24 thousand farms, to 39 thousand in 1970 while the number of cattle increased by 300 thousand head, a factor of 1.67, to 2.7 times the 1960 total number of cattle. The number of cattle per farm was 2.9 head in 1960, 6.4 head in 1965 and 12.3 head in 1970. Further, the milk per head went from 3,694 kilograms to 4,140 kilograms, reaching an average four-thousand kilogram per annum level. There was a triple increase in total milk production to 1.18 million tons. This trend, at the next stage was again doubled, and here can be seen a representative example of selective enlargement.

3) Third Period (1970 to present)

During this period the tendencies we saw in the second period turned a corner where their directions were considerably altered. Domestically, the contradictions of the high growth economy came out and we entered into a slow growth economy brought about by a recession and a weakened yen exchange. Agriculturally, the contradictions in the basic agricultural policy appeared in the farm surpluses, surpluses in those crops that had developed into the two major crops in Hokkaido, rice and milk. On one hand, continued specialization and increased productivity sustained the move toward larger-scale farms from the previous period; on the other, the rice production limitation policy which was put into effect in 1971 caused a great upheaval from the effects of switching from rice to other crops. After the first oil crisis, farm management faced a very serious situation

brought about by the rise in price of agricultural equipment, importation of field crops and dairy products and slow economic growth, and in response to these "outside" pressures the modernization of the farms in turn created larger investment burdens as well as debts and further diminished the fertility of the land.

The number of farms decreased to 80.9 percent of the figure for 1970 by 1975 and to 72.1 by 1980. If we take 1960 as a standard, then the number of farms in 1980 is only 51 percent. The ratio of specializing farms is high but decreased to 42 percent by 1980 while the ratio of one-type compound farms increased to 32 percent. In size of farm, those under ten hectares decreased, 10–20 hectare farms increased relatively and those farms over 20 hectares increased 2.7 times to over ten percent of all farms. Since 1975 the tendency of farms to decrease seems to be slowing down compared to the 1970–75 period. Here, in Table 4, which shows the increase and decrease and the structural comparison in numbers of farms according to size and the products which produced the largest income for the farm, rice crops farms diminished by 40.7 percent during this period, but farms over 7.5 hectares increased, farms having wheat as the biggest income source increased while farms with cereals, potatoes and beans as the main money-makers diminished by 30 percent until the size of the farm reaches 20 hectares where the number increases. The dividing point of industrial and fruit crops is 10 hectares and 15 hectares for horticulture facilities, the number increasing for both over these sizes.

Figure 9 shows the trends in planted area of field crops since 1945; wheat includes wheat, barley, rye, naked barley, oats; beans includes soybeans, red beans, peas; industrial crops includes kidney beans and flax. Crops which disappeared by 1970 begin with flax and include rye and naked barley, with oats, barley, buckwheat and peas barely remaining.

Table 4 Fluctuations in number of farms selling one type produce and gross

Category	Number of farm households selling produce	Rice	Wheat	Cereals, potatoes, beans	Industrial crops	Nursery-gardens	Vegetables	Fruit	Other crops
1980/1970 Total	△27.2	△40.7	3,447.8	△32.7	18.7	257.6	12.2	△17.1	195.1
under 3.0 ha	△36.9	△56.9	1,807.3	△12.0	△36.4	236.1	△11.1	△21.6	157.3
3.0~ 5.0	△43.4	△52.9	3,892.9	△27.8	△37.0	431.6	24.6	△ 7.3	309.0
5.0~ 7.5	△33.4	△30.5	4,083.3	△52.0	△35.3	175.0	115.7	△ 8.5	299.0
7.5~10.0	△19.9	23.2	3,811.1	△56.0	△ 7.1	600.0	263.7	△14.3	232.1
10.0~15.0	△26.9	79.3	6,015.7	△56.1	51.4	33.3	384.4	400.0	150.0
15.0~20.0	△ 6.7	117.6	10,333.3	△30.7	274.7	—	966.7	—	138.1
20.0~30.0	77.3	118.8	5,725.0	93.8	640.5	—	400.0	0.0	245.5
over 30.0 ha	521.1	450.0	4,400.0	252.6	2,600.0	—	—	—	345.5
1960	100.0	51.7	0.1	16.0	2.7	0.1	5.8	1.3	0.9
1970	100.0	40.1	0.3	22.2	1.9	0.3	9.1	1.5	2.4
1980	100.0	42.1	3.1	14.8	4.4	0.5	8.9	1.5	3.5

Data: Agricultural Census

While showing tremendous fluctuations among those that finally decrease are red beans, kidney and soybeans. Rather than ask what was left, it is better to think in terms of those crops which were somehow able to maintain a large planting area, and these include potatoes and sugar beets. Sugar beets and wheat show almost an abnormal increase ratio, but for wheat this is because it is a crop which can easily be included in the crop rotation as it lends itself to mechanized methods which were introduced in the search for energy conservation, and the growth coincides with the general distribution of agricultural machinery, so that wheat can be thought of as an offshoot of the conversion from rice. In terms of cultivated area, oats, buckwheat, barley, peas and naked barley are all under five thousand hectares, red, kidney and soybeans are from twenty to thirty thousand hectares, potatoes and sugar beets seventy thousand and wheat over 100 thousand hectares. The previous high in cultivated area planting for sugar beets was 60 thousand hectares in 1972 which means that in 1981 there was an increase of only ten thousand hectares. In other crops, if you look at the peaks in planting area since the war you find that potatoes and buckwheat decreased by 30 thousand, red beans by 40 thousand, soybeans by 60 thousand, kidney beans 70 thousand and

income amounts (Hokkaido)

Dairy	Hogs	Chickens	Other livestock	Number of farms not selling farm produce
△34.4	△17.9	△70.9	67.8	
△73.9	△39.9	△71.7	△ 5.6	
△77.1	56.3	△70.5	21.5	
△77.4	65.7	△81.2	53.2	
△73.1	105.7	△68.7	102.0	
△61.4	134.1	△46.3	192.8	
△33.7	238.5	△10.0	307.0	
37.2	325.0	—	400.0	
585.5	300.0	200.0	480.6	
17.2	1.7	1.1	1.4	12.7
16.6	1.9	0.8	2.9	13.4
15.5	1.9	0.4	3.3	11.8

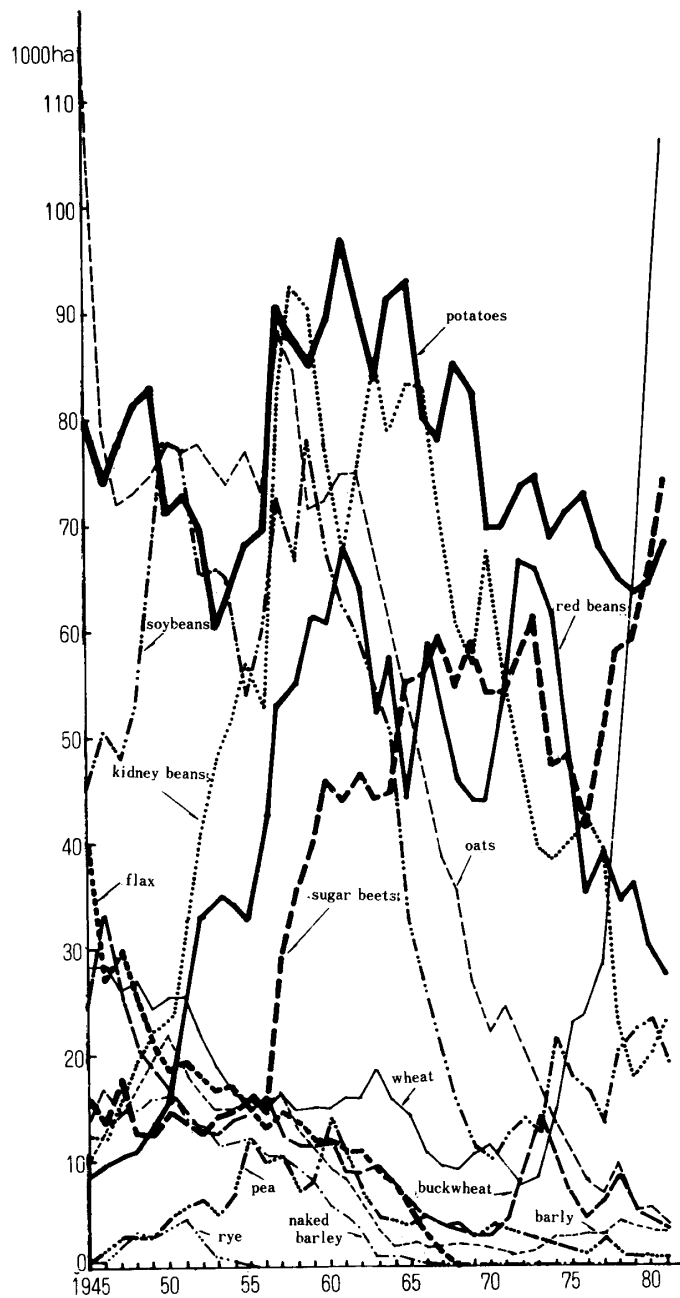


Fig. 9 Trends in field crops - wheat, potatoes, beans, cereals, industrial crops - by cultivated area (Hokkaido)

oats by 80 thousand hectares.

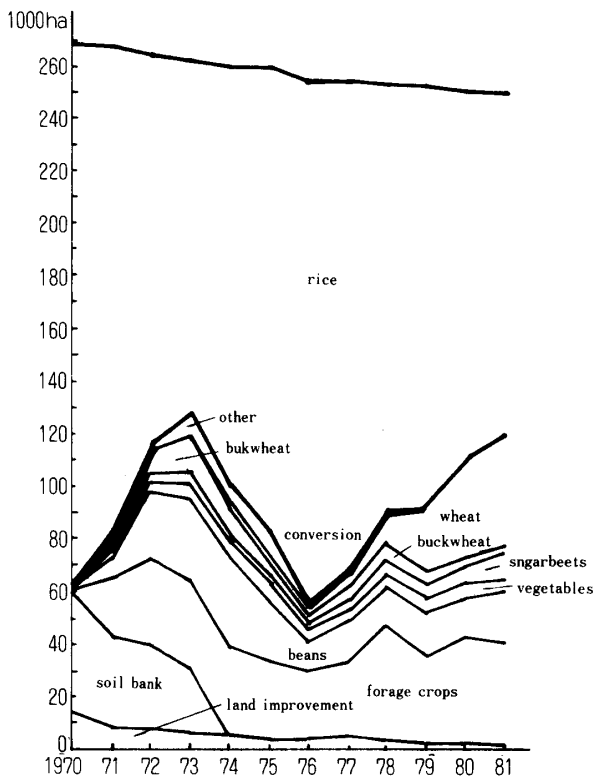
The variations in the normal crops tended toward those with better financial returns so the numbers of crops diminished. As bean crops decreased, root crops increased as did hay. If we focus on the differences between the variation in regular field crops and forage crops after 1960, we see that regular field crops, started in 1960 with 77.4 percent of the planted crop area (573 thousand hectares), and diminished in five year intervals to 64.3, 52.8, 38.5, and 37.3 percent (361 thousand hectares); feed and hay crop land was 22.5 percent (166 thousand hectares) in 1960 and increased to 35.7, 47.2, 61.5 and 61.7 percent (607 thousand hectares), passing regular crop land in 1970.

Rice paddy area declined ten thousand hectares from 270 thousand in 1970, and rice planting declined to 66 percent of the amount before the beginning of the rice production adjustment program and besides the years 1970, '72 and '73 when the target amount of rice crop reduction was over-achieved by 100 percent or more, the targets were generally more than met and accounted for 15 to 30 percent of the total national rice reduction.

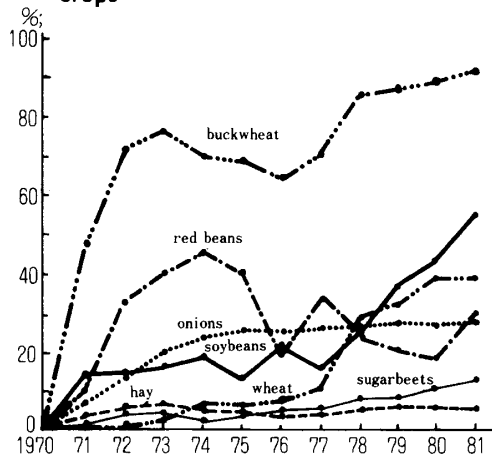
There is a close relationship between the increase in wheat, the variations in potatoes, cereals and beans, and the production adjustment program, as well as the problems of the rice growing districts in Hokkaido and some of their effects on other crops. With old rice in government storage amounting to nine million tons in 1970, a new rice adjustment program was adopted in 1971; in 1969 there had been a single-year rice crop conversion policy which had a target of ten thousand hectares, reaching an actual total of five thousand, a 1970 rice production adjustment program and a 1974 rice conversion program were also single-year programs spread equally over the whole country. The million-ton production reduction target of 1970 was over attained by 40 percent, (298 percent in Hokkaido). Through a policy of converting 30 percent of the rice harvest total of 1971 to other crops there was a certain amount of success achieved in 1973-4. There was a return to rice in 1974, however, when the rice-grower's price was raised by 32.2 percent over the previous year.

The volume of stored rice began to rise again in 1975, '77 and '78 when the quality of the rice harvest increased, and thus a policy was developed whereby the crops in which the domestic reliance ratio was low such as soybeans, wheat, buckwheat and forage would, through measures of rice paddy re-organization in a much stronger form than before, be awarded better subsidies than normal crops in a plan to increase production over the following ten years. In 1980, however, there came a turn toward greater pressure to reduce the amount of rice-growing land. Figure 10-A shows the cultivated land area in rice and conversion crops in Hokkaido from 1970. Subsidies for promotion of land banking were stopped in 1973 so the area in land bank diminished and conversion concentrated on a few special crops. The largest crop was forage, followed by beans, cereals, sugar beets and wheat in that order, but in 1977 wheat increased sharply. In beans, red and kidney beans were largest in volume between 1971 and 1974, decreasing after this period. "Cereals" indicates buckwheat.

Looking at the ratio of land area occupied by conversion crops in their various respective crops we see in Figure 10-B that buckwheat makes up over 70 percent of the



A Rice paddy area and trends in conversion crops



B Percentage of cultivated area of various crops taken up by conversion crops

Fig. 10 The percentage of cultivated crop area taken up by conversion crops (Hokkaido)

conversion crops, red beans at their peak exceed 40 percent while showing extreme variation. In that case is it not a fact that these conversion crops have had a steady increase through the rice paddy reorganization? The answer is in the negative. The reason is because production adjustment promotes conversion by compensating for the loss of rice income under a system of incentive subsidies. We might add that the incentive subsidies for Hokkaido up to 1981 totaled 565 billion yen, 1.171 million yen per farm and 67,620 yen per ten 'are' in 1981.

The Rice Paddy Utilization Reorganization Measures Expenses accounted for 48.2 percent of the Foodstuffs Supervisory Bureau budget in 1978 and 46.5 percent in 1980. Since the Paddy Utilization Reorganization Measures means the conversion from rice to other crops, if the income from the other crops is less than that of rice the conversion is not going to proceed. Do such crops exist? Naturally, this being the first time Japan has had a government policy of limiting food production where a limited rice paddy land area is to be converted, problems of income had to arise, and the returns per 10 hectares for specially designated soybean and wheat crops plus the incentive subsidy was insufficient and additional subsidies had to be included in the plan.

The problem is whether obtaining the greater part of such income through the payment of subsidies is good for farm management or not. In the case of Hokkaido, in recent years the conservation of energy through the mechanization of rice planting and harvesting has pretty well been established, in the rice paddy areas livestock raising has been done away with and specialization in rice growing has come to be the standard, and in these areas the situation has arisen where forcible conversion to other crops has become necessary. It becomes doubtful as to whether the expenses for the machinery needed for the conversion crops can be absorbed on top of the debt payments for that heretofore used in the cultivation of rice. Beyond this the

necessary techniques involved in converting to other crops have not yet been fully developed. It seems that the contradictory Basic Agricultural Law which established the supremacy of rice in selecting it for expansion can only be thought of as a short-sighted single-year plan that considered only whether the rice reserves were large or small. There is a total lack of a long-range plan and the farms which are affected by the frequent variations in policy cannot but feel their own management plans are being basically undermined, and the self-sufficiency of the nation's food supply is being radically diminished.

The special industrial crops of Hokkaido have totally disappeared due to importation from abroad. With the importation of cheaper wheat, the price of wheat has fallen and the imported quantity increased. While there is a certain increase in wheat for noodles due to a policy of government subsidy, this is only part of the measures to reduce rice production and can hardly be expected to continue. The same situation is even more evident in soybeans and feed crops. Thus it is evident that there must be a government policy developed which is based on a far-reaching view.

I have touched upon one aspect of incentive subsidies using rice subsidies as an example. Sugar beets, as a further example, occupy a favorable position in regular crop rotation, but, on account of the connection with sugar manufacturing, cannot be considered apart from the price subsidies to the sugar processors. On the other hand, a policy aimed at promoting local production of a stable supply of sugar beets has been attempted through the development of various related operations: the system of transplanting seedlings from nurseries, the introduction of transplanting machinery and the mechanization of harvesting machinery made possible large-scale cultivation of sugar beets. It may be said that to a large extent the technical advances would not have occurred separately from the governmental agricultural policy in which subsidy is an integral part. Still, these legal measures were, in any case, temporary.

If we examine the situation in the dairy farming section of livestock, we see that in the second period after the policy of deficit payments went into effect, scale enlargement proceeded up to 1970 to the point that it was called "aimless enlargement". There was an annual increase of ten percent or more in milk production up to that point. In 1971-72 with the sudden rise in beef prices the increase fell to 6.2 percent, and in 1972-3 with the rise in feed prices with the world-wide shortage of grains and the sudden inflation in materials due to the oil crisis in 1973, the increase fell to 1.4%, 3.3%, and 3.5% in the years from 1973 to 1975. These years from 1970 to 1975 saw only a temporary relaxation in the increases. With the revival of high annual increase in production due, among other things, to the resumption of a stable supply of feed, resulting in eight and fourteen percent increases in 1976 and '77 respectively, the situation changed from one of balanced supply to one where production coordination became necessary to cope with the oversupply. In spite of this there was a seven percent increase in production in 1978-9. However, during this time, because of the change in the economic situation, the Second Agricultural Modernization Plan of 1971 was revised to form the Third Modernization Plan of 1976 which aimed at an annual increase in production of 7.3 percent or 3.04 million tons over the next ten years. In 1973 the construction of the New Dairy Farming Village in Ne-

muro was begun and this model farm became one of the orphaned offspring of the period of intense economic growth. With the beginning of planned production of milk products in 1979, dairy farming went route of rice in receiving production controls. The Third Modernization Plan's aims had to be adjusted and the Fourth Modernization Plan was published in 1981 limiting the annual increase to four percent with a slow-growth aim of 3.14 million tons in 1990 and limiting Hokkaido's share of the national market to 37.3 percent. Limitation of milk production has the purpose of allowing a slow increase in number of cows, raising the proportion of self-supplied feed and raising the quality of the milk.

The number of farms raising cattle dropped from 39 thousand in 1970 to 20 thousand in 1981 and the proportion of farming households raising cattle fell from 23.7 percent to 17.2 percent while the number of milk cattle increased from 489 thousand to 771 thousand and the number per dairy farming household rose from 12.5 head to 38.4 head, showing a high head-per-farm condition. Further, the milk produced per head per year increased from 4,140 kilograms to the 5,000 kilogram level in 1979. Comparing these statistics to those of 1960 we find that the number of cows doubled by 1968, tripled by 1972 and quadrupled by 1980. Milk production was 400 thousand tons in 1961, 53 thousand tons in 1963, 66 thousand tons in 1965, 70 thousand tons in 1966, 90 thousand tons in 1968, afterwards increasing yearly by 100 thousand tons until 1972 when there was a temporary slowdown. In 1975 the increase began again in earnest and there was an increment of 177 thousand tons in 1977, 190 thousand tons in 1978 and 200 thousand tons in 1979. These figures reflect the demand for a larger number of cows per farm, a better quality milk product due to the addition of a standard of percentage of non-butterfat solids in milk in addition to butterfat content so that there was an outstanding advance in the quality of cow; the advance in techniques due to there being more farms specializing in dairy operation; an increase in the use of combination feed, (a ratio of 20-25 percent of combination feed to milk output per cow).

The milk production per head diminished when farmers were caught between spiraling costs and government controls on milk prices in 1979, and when the poor weather of 1980-81 caused a decrease in quality and quantity of home-grown feed. Furthermore, there were great repercussions from the penalty system for production beyond the allotted amounts. These movements in dairying were accompanied by an increase in self-produced feed crops so that if we examine grasslands, we see that there was an annual increase of 5.1 percent from 1970 when there was 327,700 hectares in grassland, to 1980 when there were 500,400 hectares and Hokkaido's grasslands made up 69 percent of the nation's total. Hokkaido's feed grasslands include little bean-related grass; rice species of feed are generally about the same but somewhat less in proportion, dropping from 24 percent to fifteen percent of the grassland crops while a mixture of bean and rice species of feed grass accounts for 72 to 83 percent of the feed grass, helped by a per-hectare rise in productivity. Especially outstanding recently in feed crops is maize or "green-cut" corn, which has increased by a factor of 1.8. While hay increased by about 3,200 kilograms in the Konzen and Soya districts, maize increased by some 5,590 kilograms in 1978.

The future of Hokkaido dairy farming as a region basically producing milk for various processed products, can in no way be thought bright when the above condition of overproduction of raw milk is added to the considerations. There is a question as to how many dairy farms will survive when the deficit payments systems is gone. The same thing can be said for the rice farms as well as the field-crop farms.

V. Conclusion

While the crop and livestock combinations in Hokkaido agriculture during the thirty years since the end of the Pacific War would seem simple at first glance, there is a complexity evident in the selection of rice, field and hay crops. While there are obviously similarities, the content is complex and strongly effected by government policy. The problem is that a long-range agricultural policy is necessary for the permanent establishment of the place of Hokkaido Agriculture as a food base for Japan differing from other islands of the country. Also, there is the necessity of perfecting an environment in which a continuing stable management of farms is attained through establishing a firm pattern of crop rotation. The remaining problem is to find the particular character of each geographical region so that the agricultural development of each district can be carried out comprehensively and can be placed within the ongoing agricultural developmment. For that reason it is necessary to study the changes within the districts of the municipalities which are representative of each area.

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Note :

1) The Weaver Method : $\sigma^2 = \frac{\sum d^2}{n}$ The Revised Weaver Method : $S_i = \sum di^2$

σ : deviation, d : the difference between the percentage shown by the theoretical curve and the percentage of the total obtained by observation, n : the number of crop groups, i : the numerical value. It is argued that the Revised Weaver Method is superior in examining the relationships arising from crop combination. This is because it uses as a standard the combination of the smallest observed values of the numerical values. In the Weaver Method, however, the numbers of groups often decrease geometrically so that the smallest value often does not agree with final value, so I have revised this by not dividing by 'n'.

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