Slide 1

Agriculture in Tokachi
History and Present Situation

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Slide 2

Map of Japan/Hokkaido, published in Amsterdam. Yan Yansonius (1658)

Agriculture in Tokachi, History and Present Situation

Kiyoshi Tsutsuki

Slide 1:
Nice to meet you on the web-lecture.
I am Kiyoshi Tsutsuki.
I am a Emeritus Professor of Soil Science in the Obihiro University of Agriculture and Veterinary Medicine.
I also have engaged in the various training programs of JICA including this course for many years.

On this lecture, I will talk about the “Agriculture in Tokachi, history and present situation”.
Due to the limitation of web-lecture, I had to minimize the contents of my power-point file. Formerly I used around 160 slides, but this time I can use only 40 of them.

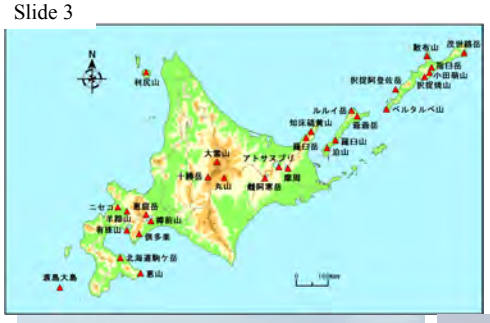
Anyway, I would like to select the most important points for you.

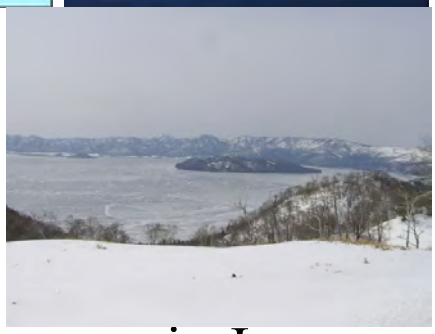
My university is located in Hokkaido, the northern largest island of Japan.
Obihiro is a middle scaled city in Tokachi plain, whose main industry is agriculture including field crops and dairy farming.

Produced amounts of wheat, potato, sugar beet, red beans and cow milk are very large and occupy sometimes more than or nearly half of the total production in Japan depending on the items.

However, the history of modern agriculture in Tokachi is not so long. It was started by the ambitious elite pioneers (Bansei-sha company) who reclaimed the uncultivated land just since 1883.

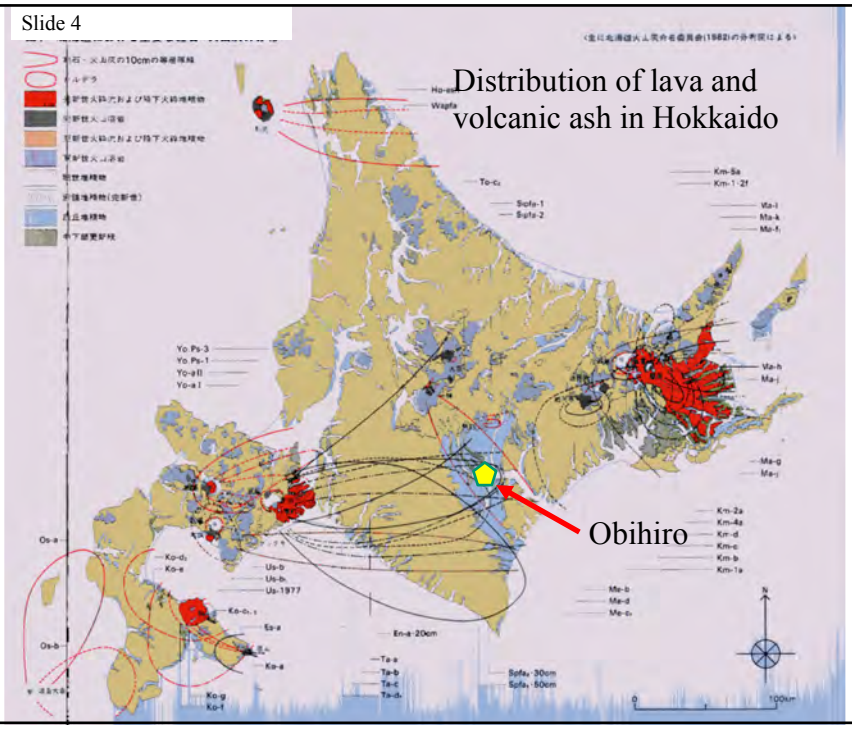
Slide 3





Active volcanoes in Japan

Slide 4



Slide 2:
Several years ago, I visited an exhibition of ancient maps of Hokkaido held at Nemuro city in the eastern end of Hokkaido.

There, I could see a map made by a Dutch sailor Yan Yansonius in 1658. In that map, the northernmost part of the main island of Japan was missing, and the shape of Hokkaido was incorrect. However, some names of the villages in the eastern Hokkaido were recorded on the map. On the map, Tokachi is designated as "Tacapsy", Shiranuka as "Shirarca", while Hidaka mountains as "Snee Gebirche (Snowy mountains)". The Dutch sailor may have made this map by hearing from the native villagers at the coast in Hokkaido and from the available map of main islands in that age. During the age of "Edo era" from 1600 to 1868, Japan closed the country to foreign countries, and direct surveying of the main islands was not allowed.

This also indicates that Hokkaido had been the most unknown part in the world. Even the people in the main island of Japan did not know the detail of Hokkaido 300 years ago. However, native people lived here since more than 20,000 years ago and a special culture had been brought up.

Slide 3:
Hokkaido is a part of the volcanic belt in Japan, and many active volcanoes are existing in Hokkaido. Tokachi district is located in the eastern part of Hokkaido, and includes a very large plain. No volcano is existing in the Tokachi plain, but it is surrounded by several volcanoes, such as Mt. Tarumae, Shikotsu caldera lake, and Mt. Usu to the west beyond the Hidaka mountain range, Mt. Tokachi, Mt. Maruyama, Mt. Akan and Mt. Me-akan to the north around the Daisetsu mountains, and Kussharo caldera lake and Mt. Mashu to the north-east.

Slide 5

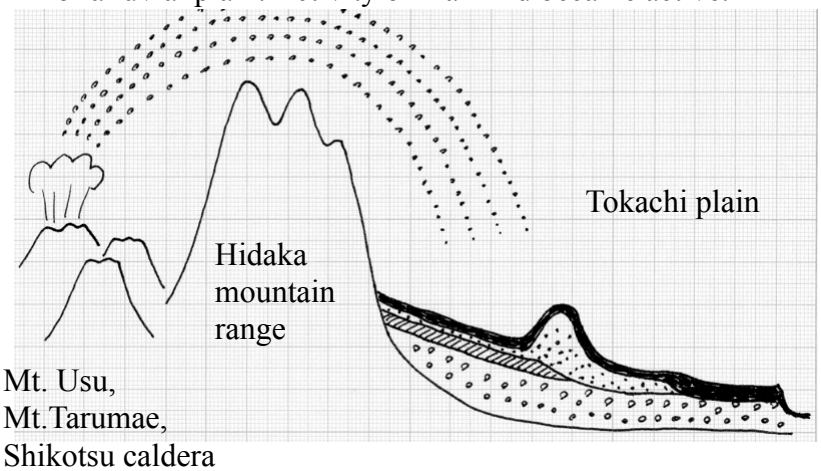
Major volcanic ashes fallen in Tokachi plain

Tarumae a (Ta-a) 1739 AD
Komagatake c_2(Ko-c_2) 1694 AD
Tarumae b (Ta-b) 1667 AD (Rebellion of Ainu people led by Shakushain)
Usu b (Us-b) 1663 AD (fell in the southern Tokachi plain)
Tarumae c (Ta-c) ca BC1000 (Wide distribution)
Tokachi c_2 (To-c_2) 3000-4000 BP (Cold again)
Tarumae d (Ta-d) 8940±160 BP (Rising sea level)
Eniwa soft loam 11,940±240 BP (Eniwa-a tephra was weathered)
Eniwa Ball shaped loam15,010±400 BP (Warming again)
Eniwa-a (En-a) 17,000-19,000 BP (Glacial maximum)
Shikotsu 1 (Spfa-1) 39,000-41,000 BP (Sub-interglacial)

Slide 6

Holocene epoch (<10,000 years BP)

Climate warming. Progress and retreat of sea. Fall of new volcanic ashes. Erosion of terrace and formation of alluvial plain. Activity of mankind became active.



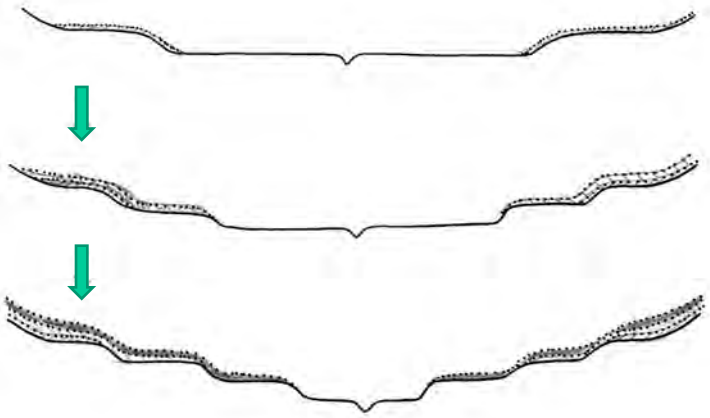
Slide 4:
As a result, the land of Hokkaido is covered with volcanic ash and volcanic lava in large area. Tokachi plain is also not the exception. The surface is covered with volcanic ashes from various volcanoes as well as mud flows originated from the gigantic eruption occurred near the Mt. Daisetu area to the north of Tokachi plain.

Slide 5:
Major volcanic ashes which covers the top few meters of land in Tokachi plain are listed here. They fell in the last 40,000 years and mainly erupted beyond the Hidaka mountain range to the west of Tokachi plain. They were transported by the westerlies wind.
Around 40,000 years ago, an ancient volcano which existed in the present Shikotsu lake made a gigantic eruption. After the eruption, a huge caldera was formed and the surrounding area was covered with the pyroclastic flow. Volcanic ash and pumice flew beyond the Hidaka mountain range and covered the Tokachi plain thickly. With the ashes from Eniwa volcano which erupted 20,000 years later, these pumice and volcanic ashes formed sand dune topography in Tokachi. The pumice from Shikotsu caldera is now brown colored and feel like a saw dust.

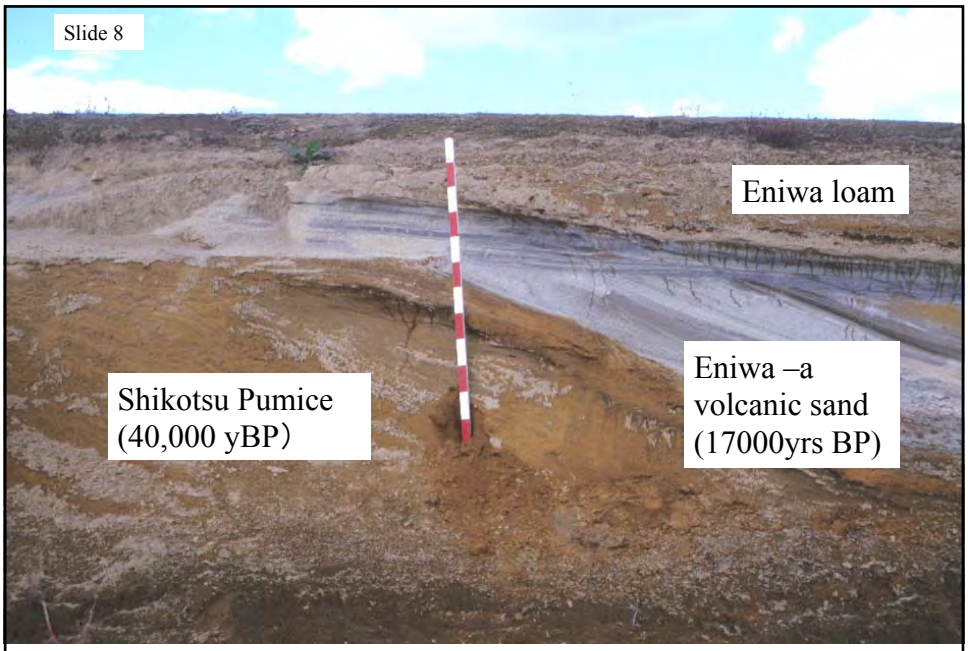
Eniwa volcano is located on the outer rim of the Shikotsu caldera crater, and it erupted around 17,000 years ago. The eruption was so huge that its volcanic pumice is accumulated thickly even on Tokachi plain. The pumice of Eniwa volcano is white colored and sandy.
Tarumae volcano is also located on the outer rim of Shikotsu caldera, and it erupted around 9,000 years ago. Tarumae volcano is very active, and erupted again around 3,000 years ago, in 1667 AD, and in 1739 AD. Volcanic tephra of each eruption was designated Tarumae-d, Tarumae-c, Tarumae-b, and Tarumae-a, respectively from the old eruption to recent eruption. Volcanic pumice from Tarumae-d eruption was rich in iron and is colored red.
In the Tokachi plain, volcanic ashes from Mt. Tokachi in 3000-4000 years BP, from Mt. Usu in 1663 AD, and from Mt. Komagateke in 1694 AD are also accumulated.

Slide 7

How terraces were formed and volcanic ashes were accumulated. Recently, contribution of yellow dust from China is also considered remarkable.



Slide 8



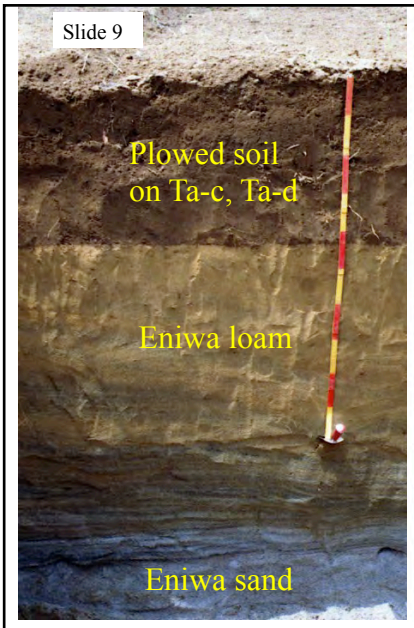
Volcanic ash sand dune（Kawanishi town, Obihiro）

Slide 6:
This slide shows how the volcanic ashes from western mountains were transported beyond the Hidaka mountain range and accumulated on the hills and terraces of Tokachi plain. Old volcanic ashes are preserved in the higher terraces and only the recent volcanic ashes are covering the lower terraces because old volcanic ashes had been washed away by river flow.

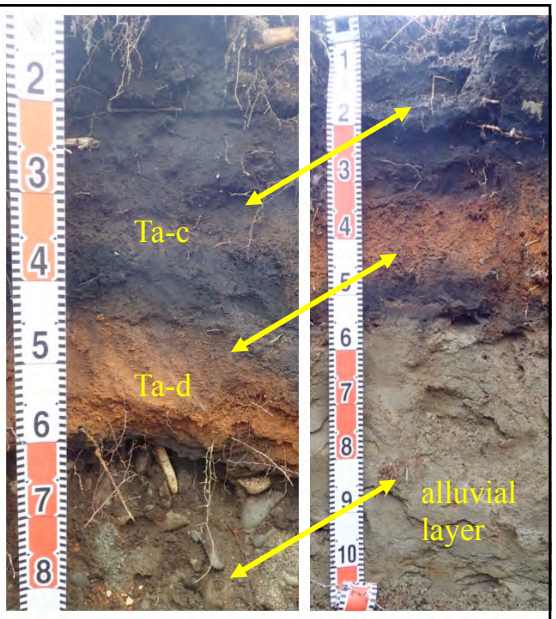
Slide 7:
This slide shows how terraces and plain were formed in the Tokachi plain.
Hidaka mountain range started to rise due to the collision of two tectonic plates, Eurasian plate and Pacific plate around 13 million years ago and it is rising up even at present.
When mountains were elevated, soils eroded from hills were accumulated in plain, and cliffs along the terraces were formed.
In the glacial period, the sea retreated and wide plain was formed. Erosion of hills proceeded in accordance.
In the interglacial period, accumulation of sediments occurred preferentially.
When volcanoes erupted, the plain and terraces were covered with volcanic ash. Yellow aeolian dust from China also deposited on the terraces. However, the volcanic ash on the lower terrace was removed due to erosion.
In the higher terrace, old volcanic ashes remained unwashed.

Slide 8
This slide shows the soil profile in the higher middle terrace in Kawnishi town where volcanic ash and pumice from Mt. Eniwa and Mt. Shikotsu are accumulated thickly like a sand dune. Top layer with young volcanic ashes is removed for leveling the land surface. White layer is sandy and originates from Mt. Eniwa which erupted 17,000 years ago. Thick brown layer is the pumice from Shikotsu caldera, which exploded around 40,000 years ago. Top light brown soil is the loamy soil formed by the weathering of sandy Eniwa volcanic ash.

Slide 9

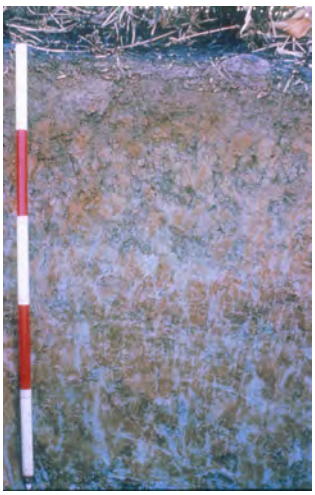


Andosoil profile in OUAVM farm



Soil profile on a lower terrace in the fores of Obihiro Agricultural High School

Slide 10



Gray terrace soil
（Takikawa）

Heavy clay soil

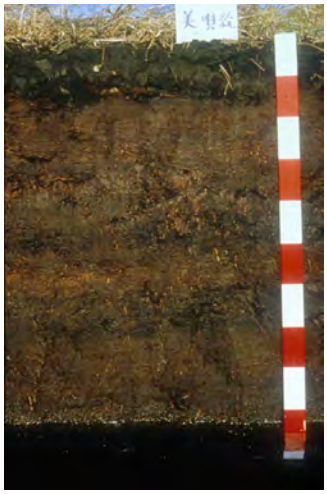
Slide 9 (left):
This slide shows the soil profile in the Obihiro University of Agriculture and Veterinary Medicine. Here also, thick layers of Eniwa sand and Eniwa loam are observed. The top dark brown layer is formed from several volcanic ashes younger than 9,000 years, but they were mixed by tractor.

Slide 9(right):
This soil profile was observed in the forest of Obihiro Agricultural High School lying on the lower terrace. Here, the lowest layer is alluvial origin, and Eniwa volcanic ash and its loam are missing. Volcanic ash layers younger than 9,000 years are lying directly on the alluvial layer.

Slide 10:
In addition to volcanic ash soils, I will show you two more common soils in Hokkaido. This soil is a heavy clay soil in Takikawa, central Hokkaido. This soil is formed on the pyroclastic flow deposit once sedimented below water. It is rich in clay and very hard. Iron mottles are formed in the soil profile due to the intermittent changes in the ground water level.

Slide 11:
This slide shows the peat soil profile. Peat soils are also very common in Hokkaido. They are distributed along the coastal area and big rivers. Peat soils in this slide were observed in the flood plain of Ishikari river. To use peat soil for rice production, farmers had to put mountain soils on the surface of peat. It is called soil dressing technique, and it took many years and hard work.

Slide 11

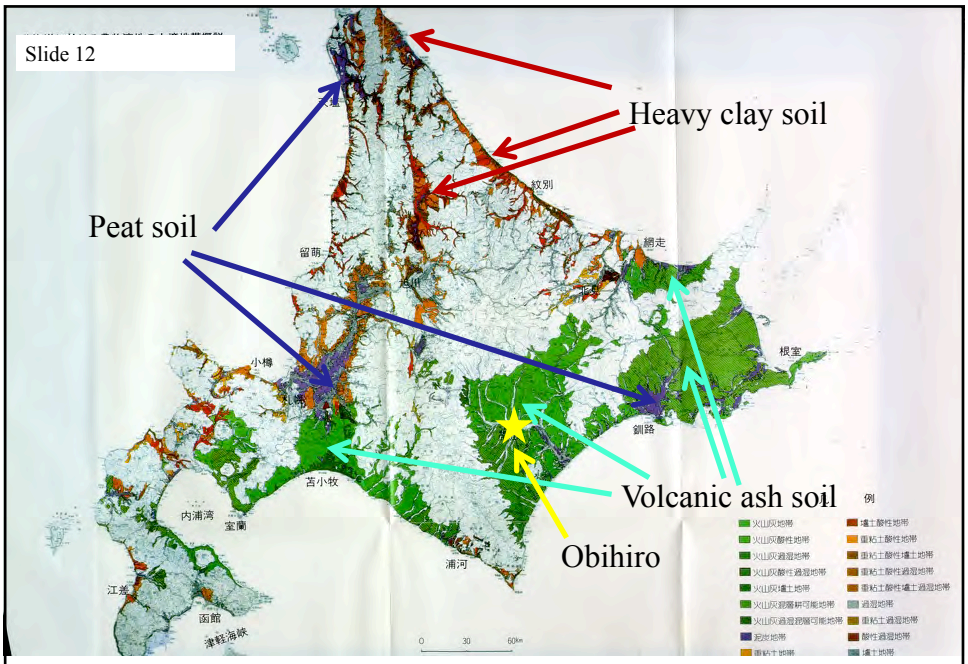


High moor Peat
（Bibai）

Top dressed peat
（Nanporo）

Peat soil

Slide 12



Disribution of special problem soils in Hokkaido

Slide 12:

Hokkaido is a very cold place. Farmers can work in the field only from the middle of April to the end of October. In winter, we have also much snow and the temperature often reach – 30 degree C.

Not only the harsh climate, soil related problems also hindered the fruitful reward of harvest for the pioneers and farmers in Hokkaido. In Hokkaido, volcanic ash soil, heavy clay soil, and peat soil are called as special problem soils.

This slide shows the distribution of the three problem soils in Hokkaido.

Volcanic ash soils in green color are distributed mainly on the large plains in the Pacific ocean side.

Peat soils are distributed along the big rivers in the large plains and in the coastal area.

Heavy clay soils are distributed mainly in the inner basin and along the shore of Okhotsk sea.

Slide 13:

This slide shows the major soils in Hokkaido. Most of soils are not fertile inherently and bear various problems for the crop production.

Andosols are derived from volcanic ashes and distributed mainly on terraces.

Brown forest soils are distributed mainly on the hills.

Gley soils are distributed in the wet landscape on terraces and coastal plains.

Fluvic soils are distributed in the lowland and subdivided by their dry or wet conditions.

Peat soils are distributed in the wetland along big rivers and coast.

Slide 14:

Professor Kikuchi, the former course leader of the Soil Diagnosis Course of JICA, and a professor of soil survey and land improvement at the Obihiro University of Agriculture and Veterinary Medicine, explained the soil fertility as follows.

Soil fertility is not a fixed unchangeable property of the land. It can be changed and promoted in three stages. His idea was epoch-making, because other definitions of soil fertility have described it as a fixed property.

Slide 13

Major soils in Hokkaido

- Andosols (volcanic ash soils)
- Wet Andosols (wet volcanic ash soils)
- Brown forest soils (soils on the hilly area)
- Pseudogley soils (heavy clay)
- Stagnogley soils (heavy clay)
- Brown Fluvic soils (lowland soil)
- Gray Fluvic soils (lowland soil)
- Peat soils (wetland soil)

Slide 14

Three stages in soil fertility

Concept by Prof. Kikuchi

- Stage 1: Natural soil fertility with various constraints
- Stage 2: Improved fertility by adjustment of relief, land drainage, mixing and reversing soil layers, soil acidity amelioration, etc.
- Stage 3: Improved fertility by proper fertilizer application, cropping system management for high quality and sustainability.

According to his idea, the first stage of the soil fertility is the natural soil fertility with various constraints. It is like the condition just after the pioneers entered the land and started cultivation. Natural nutrition succeeded from the forest did not last long, and farmers faced the various problems related to soil properties and geographical conditions.

Second stage of the soil fertility is achieved by improving the fertility by adjustment of relief, enhancing land drainage, mixing and reversing soil layers, and amending soil acidity, etc.

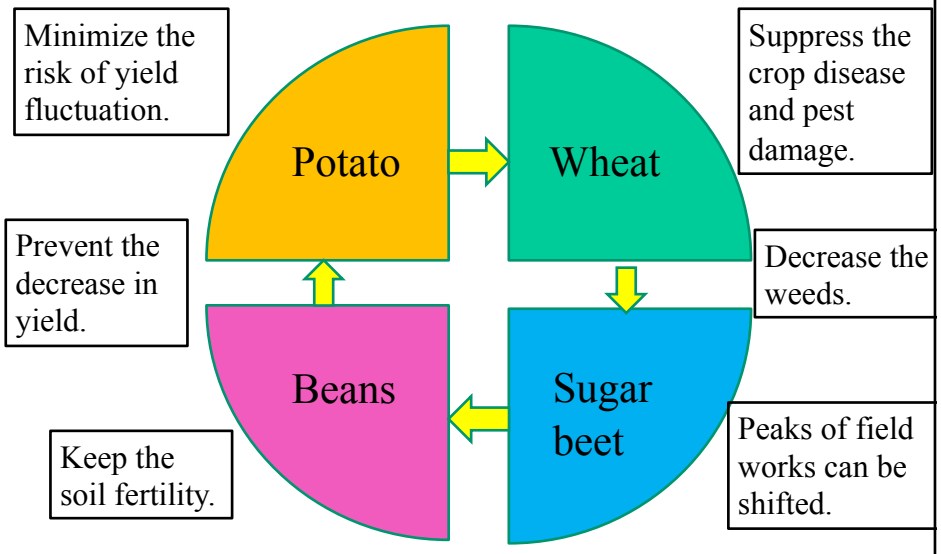
The third stage of the soil fertility is achieved by proper fertilizer application, and by adopting proper cropping system for achieving high crop quality and sustainability.

Agriculture in Tokachi has been advanced by the farmer's effort to improve the soil fertility of the soil.

Slide 15:
This slide shows the crop rotation system carried out in Tokachi.
Wheat, sugar beet, beans and potato are grown in this order. Farmers divide their field at least in four sections and change the crop in each section every year. Other crops such as sweat corn, dent corn, and various vegetables, and green manures are also grown between these crops.

By adopting crop rotation system, soil fertility of the crop field can be maintained, and the decrease in the yield of each crop can be prevented, the risk of yield fluctuation can be minimized or leveled, crop disease and pest damage can be suppressed, weeds are decreased, and the peaks of field works can be shifted, so that farmers can work effectively in the field.
Crop rotation is the core technique of agriculture in Tokachi and supports its sustainability.

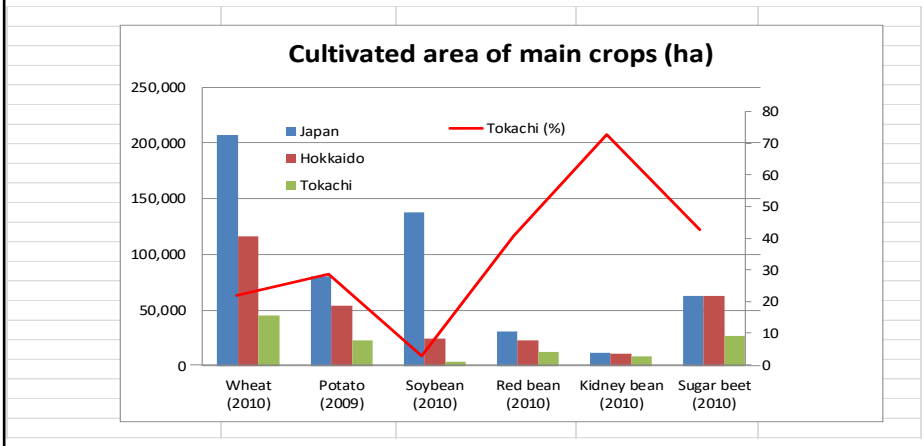
Slide 15



Crop rotation in Tokachi

Slide 16

Cultivated areas of main crops in Japan, Hokkaido, and Tokachi



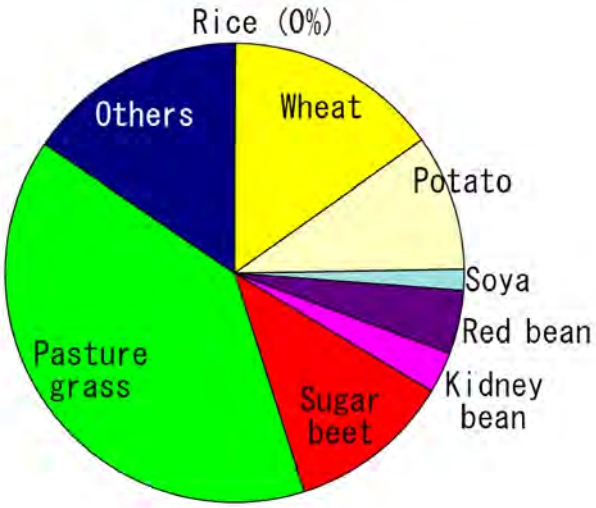
Slide 16:
This slide compares the cultivated areas of major field crops in Japan, Hokkaido, and Tokachi.
Blue bar indicates the cultivated area in Japan, and red bar indicates the cultivated area in Hokkaido. Cultivated areas for wheat and potato in Hokkaido occupy 60 – 70 % of the total cultivated area in Japan. Cultivated areas for red bean, kidney bean and sugar beet in Hokkaido occupy 75 – 100 % of the corresponding areas in Japan.
Green bar indicates the cultivated area of each crop in Tokachi. As shown in this figure, cultivated area for each crop in Tokachi occupy large percentage even in Hokkaido.
Red line shows the percentage of the cultivated area for each crop in Tokachi compared with that in Japan. The cultivated area in Tokachi for each crop except soy bean occupies very large percentage even compared with that in Japan.

Slide 17:
This pie graph shows the percentages of cultivated area of major crops in Tokachi.
Rice is not grown in Tokachi, because the climate is too cold for rice cultivation.
Cultivated areas for wheat, potato, beans and sugar beet occupy 10 – 15 % of the total crop area in Tokachi. This reflects the crop rotation system in Tokachi.
Pasture grass field occupies around 40% of the total area, which means dairy farming is also very important in Tokachi.
Others include vegetables, horticultural crops, and fruit trees. They occupy around 15 % of the total crop area.

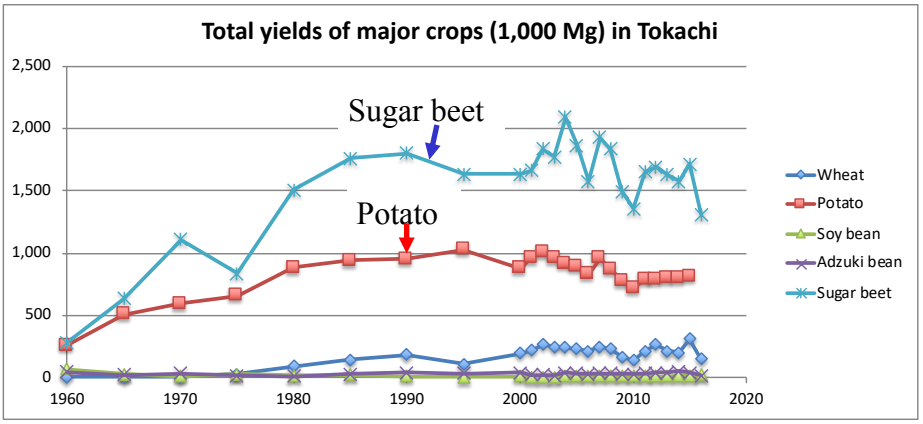
Slide 18:
This slide shows the change in total yields of sugar beet and potato in Tokachi. Yields of other crops will be discussed in the next slide.
Yields of sugar beet and potato are very large, because they are root crops.
Yields of sugar beet was around 1.5 million tons, and that of potato was around 800 thousand tons in 2016.
Yields of these crops increased remarkably from 1960 to 1990.

Slide 17

Area of main crops (Tokachi)



Slide 18



After 2000, yield of sugar beet showed a decreasing tendency. It is around one thousand and five hundred thousand tons in these years.
It is due to the decrease in farmers number and the decrease in the cultivated area for sugar beet.
It is considered to result from the hard labor for the sugar beet production. Farm machines owned by farmers have also become old.
To lessen the hard labor work for sugar beet production, direct seeding of sugar beet is promoted again these years.

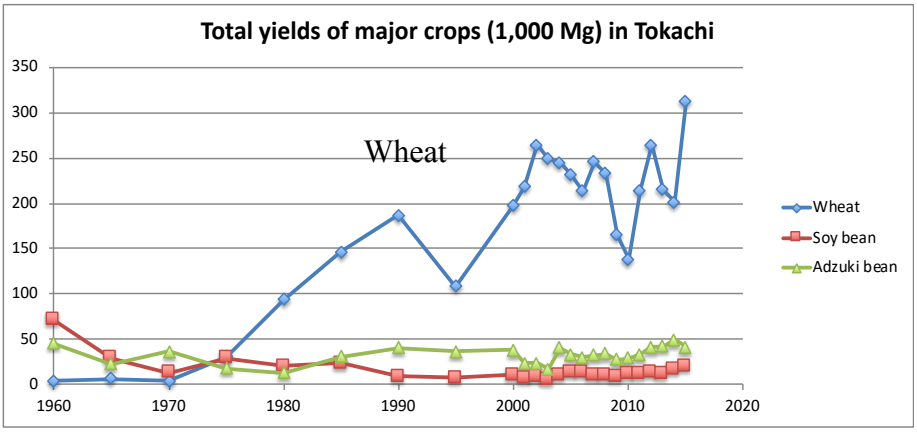
Total yield of potato in Tokachi is around 800 thousand tons in 2016. It decreased slightly since 2000, but almost stable now.

Slide 19:
This slide shows the change in total yields of wheat, soy bean, and Adzuki bean.
The yield of wheat increased remarkably from 1970 to 1990. Though yearly fluctuation is large, the total yield seems to increase even these years. In 2016, it reached 300 thousand ton in Tokachi.

Formerly, large amount of soy bean was produced in Tokachi, and soy bean was the main crop in Tokachi, but it is decreasing after 1960. It is due to the low international price of soy bean.
After 1970, the yield of Adzuki bean is larger than that of soy bean.
Tokachi is famous for producing Adzuki bean with very good quality. Therefore, Adzuki bean produced in Tokachi can be sold at high price.

Slide 20:
These photos show the potato which I cultivated for the student experiment practice in 2020. Seed potato is transplanted to field from end of April to early May. It is harvested from end of August to early September. Soon after the harvest of potato, the same field is usually sown to wheat in the end of September.

Slide 19



Slide 20

Potato

Transplanting seed potato:
end of April – early May

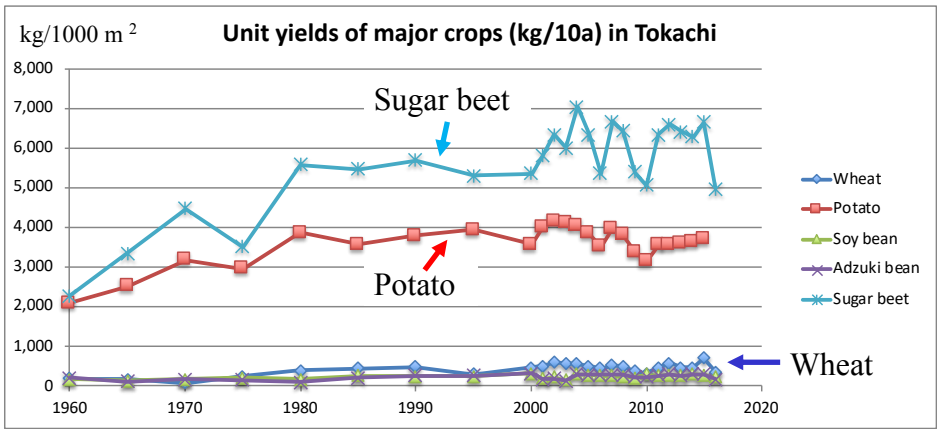
Harvest:
August - September

July 10, 2020

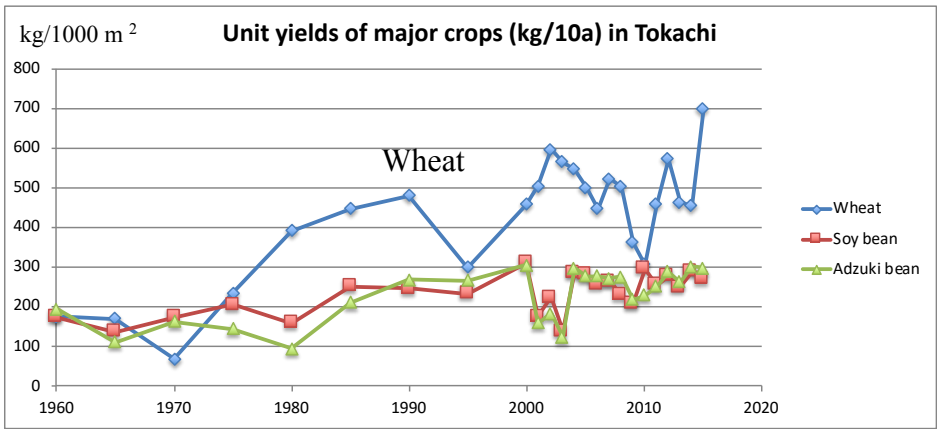
September 8, 2020

Variety: Kita-akari

Slide 21



Slide 22



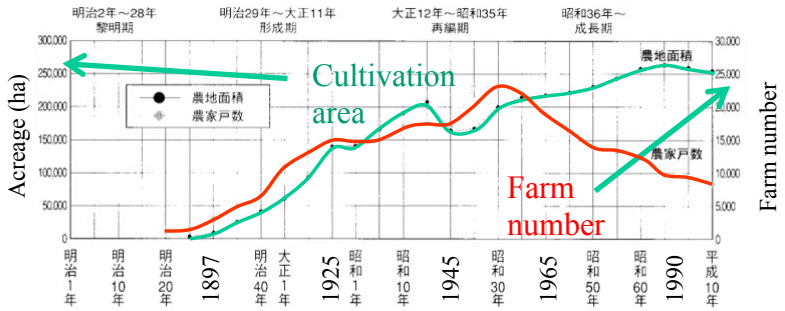
Slide 21:
This slide shows the change in the unit yield of major crops in Tokachi, especially sugar beet and potato. Yields of these root crops are very high compared with wheat and beans. Unit yields of these crops increased remarkably from 1960 to 1980.
In general, land improvement such as correction of soil acidity, phosphate deficiency was carried out. Drainage condition was improved by introducing open ditch and under-drains. Use of chemical fertilizers and agricultural chemicals increased. Introduction of agricultural machinery was advanced in these years. Improvement of the productivity of crops was improved by the selective breeding techniques. Various other factors also contributed to the increase in the unit yields of crops. I will explain this later.

Slide 22:
This slide shows the change in the unit yields of wheat, soy bean and Adzuki bean. Considerable fluctuations are observed in the unit yields of these crops. These decreases in the unit yields reflect the change in annual temperature and precipitation. However, in a long trend, unit yields of these crops increased remarkably from 1960 to 1990. In addition to various factors, introduction of new high yielding varieties contributed to these increases.

Slide 23:
This slide shows the change in number and cultivated area of farms in Tokachi.
Agriculture in Tokachi was started by elite pioneers of the members of Banseisha company in 1883. Following them, many groups of farmers moved from various villages in the main islands and settled in Tokachi area. Their motives for the movement were the natural calamities they suffered from in their original villages and the lack of agricultural area to succeed for the family members except the first son.
Cultivated area and farm numbers increased almost proportionally from 1890 to 1950. However, after 1950, farm numbers decreased in spite of the increase in cultivated area.

Slide 23

Number and cultivation area of farms in Tokachi



図－1　十勝管内における農家戸数と農耕地面積の推移

Slide 24

Why agricultural population decreased in Tokachi?

- Merit of large scale operation of agriculture.
- Necessary man power decreased, as agricultural machinery was introduced.
- For efficient farm management, small farm lands had to be combined into a large field.
- Outflow of the excess labor force to industrial, commercial, and civil service.

Slide 24:

In this slide, I would like to consider why agricultural population decreased in Tokachi.

It was not a special trend in Tokachi, but a general trend in Japanese agriculture.

In accordance with the development of economics in other sectors of industry, agriculture also had to seek for the higher efficiency. It was also necessary to compete with the farm products produced at low cost in foreign countries.

For this purpose, merit of the large scale farming was sought for also in the agriculture in Tokachi.

For the operation in a large scale, introduction of farm machinery was necessary.

For the introduction of new agricultural machinery, a large amount of investment was necessary. Small farm could not afford the investment, and for the efficient farm management, small farm lands had to be combined into a large field.

In consequence, small farmers abandoned their farm management, and their lands were absorbed by larger farmers, and the excess labor force moved from agriculture to industrial, commercial and civil services.

Slide 25:

This slide shows the photos of sugar beet field near my house in Obihiro in 2020.

The left photo was taken on May 8, soon after the transplantation of the paper pot seedlings. Right photo was taken on October 26, while the farmer was harvesting the sugar beet.

Sugar beet is seeded in paper pots in the early March, and the seedlings are grown in a greenhouse or vinyl house where the temperature is controlled suitable for the growth of seedlings. In the end of April, the seedlings in paper pots are transplanted in the fields with proper spacings. Weed control and pest management also became easier by this method. After transplanted, seedlings can grow healthy and strongly and higher yield can be expected.

Slide 25

Sugar beet

Seeding in a vinyl house: March
Transplanting: end of April

Harvesting: end of October

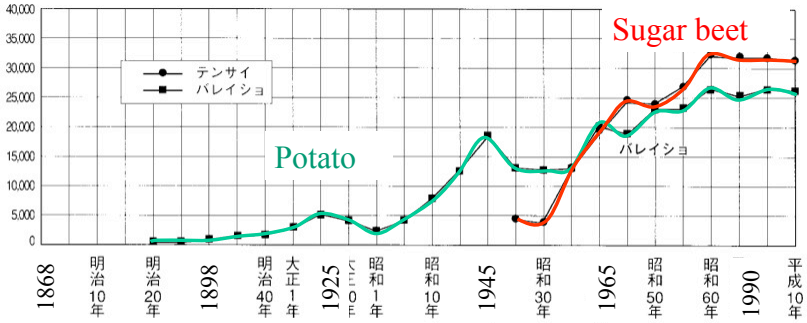
May 8, 2020

October 26, 2020

Slide 26

Areas of sugar beet and potato cultivation in Tokachi

Acreage (ha)



図ー7　十勝管内におけるテンサイおよびバレイショの作付面積の推移

Slide 26:

This slide shows the change in the areas of sugar beet and potato cultivation in Tokachi.

Cultivation of potato was started from the ages when pioneers started agriculture in Tokachi before 1900. The area for potato showed a peak in 1945, because potato was produced for compensating the food shortage during the war. Even after the war, area of potato continued to increase. It is an indispensable crop for the agriculture in Tokachi.

On the other hand, the production of sugar beet was started after the war in around 1950. Cultivation of sugar beet was started even in 1870's in other areas in Hokkaido, but it was not successful. After the war, the production of sugar beet was promoted by national and prefectural agricultural experiment stations and sugar production companies. Sugar beet was a suitable crop to be cultivated in the cold area, and by developing new high yielding varieties and adopting new cultivating technique such as paper pot seedling method. By introducing sugar beet into the rotational cropping system, soil fertility could also be enhanced.

Slide 27:

In this slide, factors which contributed to the sugar beet production were summarized.

Techniques for growing the seedlings in a paper pot and transplanting them to the field were developed in 1961, and recommended to farmers. By growing the seedlings in a vinyl house, cultivation of sugar beet can be started earlier when the field temperature is still low. After transplanting, the seedlings can grow healthy and strongly in the field even the temperature fluctuate in the late April and early May. Consequently, high yield of sugar beet was achieved.

Secondly, various machineries for transplanting, field preparation, weeding, spraying, and harvesting were developed. By this, farmers could save the labor power and time for sugar beet cultivation.

To the third, variety of sugar beet has been always improved. Most of the seeds adopted by farmers these years are F1 varieties produced in foreign countries.

To the fourth, agricultural land has been improved by amending soil acidity,

Slide 27

Contribution to sugar beet production

- Introduction of paper pot seedling and transplanting technique.
- Development of machineries for transplanting, field management, and harvesting.
- High yielding variety.
- Land improvement (amending soil acidity, increasing soil fertility, improving the drainage of land).
- Development of infrastructures (road, transportation, sugar beet processing factories)

Slide 28

Red bean (Adzuki bean)

June 25, 2013

Seeding: middle May

October 6, 2013

Harvest:
early – middle October

increasing soil fertility by compost and green manure, and improving the drainage of land by installing open ditches and underdrains.
To the fifth, various infrastructures for supporting the sugar beet production have been developed, such as the good roads in the rural area, vehicles for transporting harvested sugar beet, and the factory which process them.

Slide 28:
This slide shows the plant of Adzuki bean which I grew in the university field in 2013.
The left photo was taken on June 25, one month after seeding.
The right photo was taken on October 6, on the day of harvesting.

Slide 29:
Yield of Adzuki bean also have increased remarkably since 1970 to 1990.
The main reason for the yield increase was the introduction of the new variety developed in Tokachi called “Erimo-shozu”.
Tokachi is the place where high quality Adzuki bean can be produced due to the meteorological condition.
Adzuki bean brings high income for farmers, when they grow good quality beans.
However, Adzuki bean is the crop which does not like continuous cropping.
Yield of Adzuki bean is also easily affected by the yearly change in temperature and precipitation.
For getting the good quality beans, farmers grow Adzuki bean with 7 – 8 years interval.

Slide 29

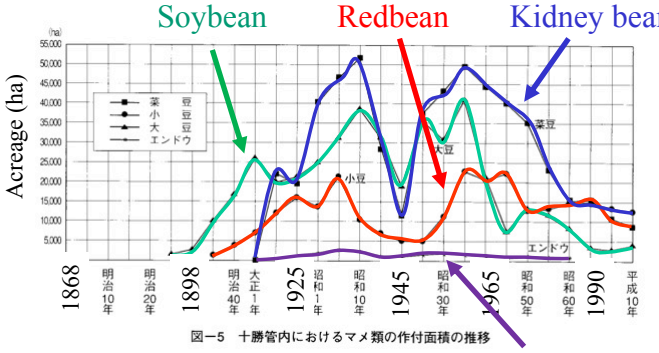
Contribution to red bean (Azuki) production

- High yielding variety (Erimo variety since 1981)
- Special product of Tokachi due to high quality.
- High income for farmers.

Slide 30

Cultivated areas of pulses in Tokachi

Soybean Redbean Kidney bean



図—5 十勝管内におけるマメ類の作付面積の推移

— 7 —

Green peas

Slide 30:
This slide compares the change in cultivated areas of four kinds of beans with age. Compared beans are soy bean, red bean (Adzuki bean), kidney bean, and green peas. Cultivated area for green peas has been very small, so I will discuss mainly on other three beans.

Soy bean was the most important crop in Tokachi for many years since farmers started agriculture here. Soy bean grew well in the newly opened field with very little fertilizer application. It was also exported to foreign countries and brought a big profit to traders and farmers. Adzuki bean has been also a profitable bean, but farmers could not grow Adzuki bean in large area because it had to be grown with long interval years. Cultivation of kidney bean started later than other beans, but since 1925, it had been grown in largest areas.
Until 1955, soy bean and kidney bean had been grown in largest areas, but since then the cultivated area started to decrease.
It may be because soy bean was grown in many other places in the world, and the international market price of soy bean decreased, and large amount of soy bean was imported to Japan from USA, South America and China. However, Tokachi is still the suitable place for growing high quality soy bean. Therefore, farmers in Tokachi select the soy bean variety which can be sold at high price.
On the other hand, the best quality Adzuki bean was produced in Tokachi, and the farmers in Tokachi continued growing Adzuki bean.
There are many kinds of kidney bean. They are used for popular vegetables and raw materials for the sweets. It had been cultivated in the largest area until 1980, but decreased thereafter due to the market price and the necessary time and labor.

Slide 31

Wheat

Seeding: end of September – early October

Harvest: end of July

Early October

August 2, 2020

Slide 32

Contribution to wheat production

- Agricultural policy to support wheat production.
- High yielding and better quality varieties (Chihoku, Hokushin, Kitahonami).
- Low labor input.
- Connection with the dairy farming.

Slide 31:

This slide shows the photos of wheat field.

There are two types of wheat. One is the winter wheat which is seeded in September and harvested in the end of July. Another is the spring wheat, which is seeded in the end of April and harvested in early August.

In Tokachi area, the winter wheat is grown in much larger area than the spring wheat. Many wheat varieties suitable for bread are grown as the spring wheat.

The left photo was taken in early October, soon after the germination of wheat. Wheat is usually seeded from the end of September to early October.

The right photo shows the wheat field on August 2 just after the harvest.

The seedlings of wheat are covered with snow from December to March in the field and start growing again in the next spring and harvested in the end of July.

Slide 32:

In this slide, I would like to consider the factors which contributed to the wheat production in Tokachi.

The first factor is the agricultural policy to support wheat production. Japanese government controls the buying price and market prices of the imported and domestic wheat, so that the domestic wheat need not compete with the imported wheat with low price.

The second factor is the high yielding and high quality varieties (Chihoku, Hokushin, Kitahonami) developed by the agricultural experiment station.

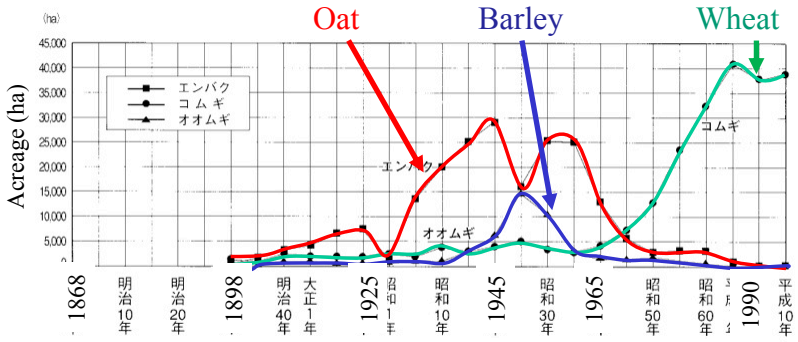
The third factor is the low labor input in the cultivation of wheat. Cultivation of wheat is highly mechanized in land preparation, seeding, spraying agricultural chemicals, and harvesting.

The fourth factor is the connection with the dairy farming. The wheat straw after harvesting is brought to dairy farmers and used as the bed material for cows. After using, the straw with cow feces are composted and brought back to the upland field farmers. The compost contributes to increase the fertility of field soils.

The period after harvesting the wheat can be used to grow green manures to enhance the soil fertility.

Slide 33

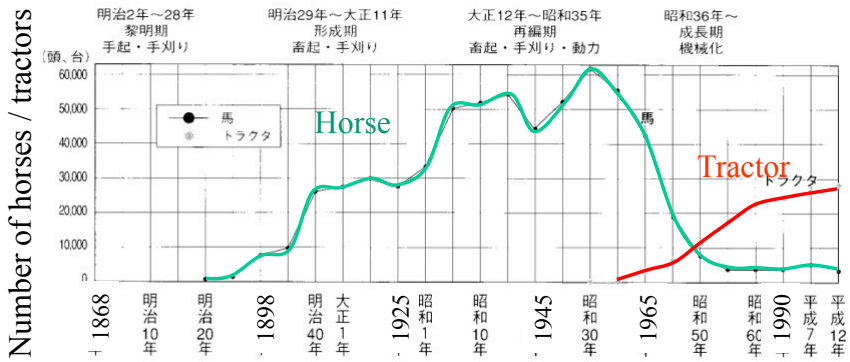
Areas of wheat, barley, oat in Tokachi



図－6　十勝管内におけるムギ類の作付面積の推移

Slide 34

Numbers of horses and tractors in Tokachi



図－3　十勝管内における馬の頭数・トラクタの台数および作業形態の推移

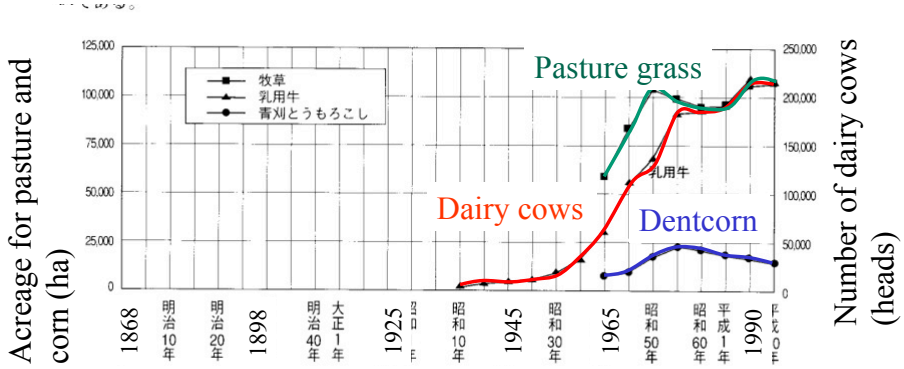
Slide 33:
This slide compares the change in the areas of oat, barley, and wheat in Tokachi. Before the World War II and for several years after the war, oat was the main crop. Oat had been used as a forage for horses, which were the main labor power in the field. During the war time, barley was grown to compensate the lacking staple food for people.
After the war, the numbers of horses decreased gradually and the area for oat also decreased. Working power by horses was replaced by tractors since 1965.

Slide 34:
This slide shows the change in the numbers of horses and tractors in Tokachi.
Before 1960, horses were the main labor power in the agriculture of Tokachi. Therefore, the number of horses increased proportionally with the development of agriculture in Tokachi. Before the war, horses for military use were also produced in Tokachi. After 1960, tractors were introduced by the farmers in Tokachi and the horses were replaced.

Slide 35:
This slide shows the number of dairy cows and areas of pasture and corn in Tokachi.
Number of dairy cows increased remarkably after the World War II and replaced the number of horses. The areas of pastures and dent corn cultivation also increased. Now, dairy farming has become one of the main agricultural industry in Tokachi.

Slide 35

Number of dairy cows and areas of pasture and corn in Tokachi



図－8　十勝管内における乳牛頭数・牧草地・青刈りとうもろこしの作付面積の推移

Slide 36

Various soil problems in Tokachi

- Decreasing soil pH
- Imbalance in soil nutrition (Excess P_2O_5, decrease in Ca, Mg)
- Micronutrient deficiency (Cu, Zn, Mn, B)
- Deterioration of soil physical properties
- Soil erosion
- Water and land pollution by animal wastes

Slide 36:
Now I would like to return to the problems related to the soils in Tokachi.
Large area of the agricultural field in Tokachi is covered with volcanic ash. Therefore, these problems are also related to the special characteristics of volcanic ash.

Soil pH has been originally low in volcanic ash soils. Therefore, farmers in Tokachi have improved the soil by applying lime to their field. However, in the middle of 1980's, scab disease of potato has become the serious problem in the potato production. As it was clarified that the scab disease is likely to occur at high soil pH condition, farmers stopped applying lime in their field. As a result, soil pH started to decrease again in the farmer's field. However, it was not good for other crops such as sugar beet, wheat and beans, agricultural cooperatives and agricultural experiment station recommended the farmers to apply lime again, while developing the liming methods which do not affect potato production.

Volcanic ash soils fix phosphate, and crops grown on volcanic ash shows the symptom of phosphorus deficiency if proper amount of phosphate fertilizer is not applied. Phosphate fertilizer increases the crop yield and the excess problem is rare, farmers in Tokachi have applied excess amounts of phosphate fertilizers for many years. As a result, the level of available phosphate in the field soil has become too abundant to show the excess symptoms. Therefore, proper application of phosphate fertilizer based on the result of soil diagnostic analysis was recommended by agricultural experiment station and agricultural cooperatives.

Volcanic ash soil fix copper and zinc strongly and shows the symptoms of deficiencies. Contents of magnesium is also low in volcanic ashes. Boron is the important element to promote the growth of sugar beet and other root crops and broad leaf vegetables. In the volcanic ash soils, boron is easily washed out from soil, and it should be supplemented properly based on the soil diagnosis.

In the large-scale agriculture, a heavy tractor is used, and the soil beneath the

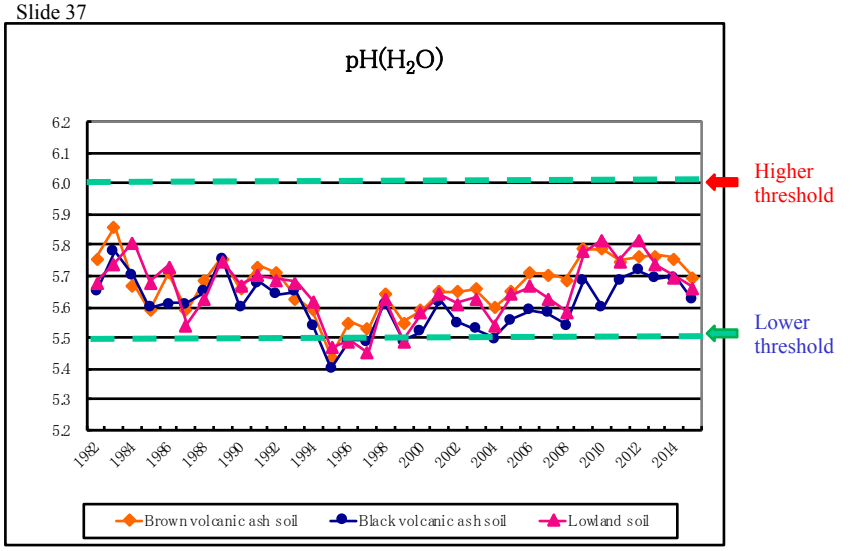
plowed layer become very hard and the plowed pan is formed. Decrease in the application of compost also accelerated the soil compaction.

Soil erosion is also a serious problem in Tokachi. In the early spring, when snow melts, large amount of soil is lost by the snow melting water. While in April and May, when the crops in the field are still small, strong wind blows in Tokachi plain. This causes the wind erosion of soils.

As many cows are raised in Tokachi, proper management of the feces and urine of cows has become an important subject for the dairy farming in Tokachi, to prevent the pollution of soil and water. Feces and urine of cows can be used as raw material for preparing compost. They can also be used for generating energy by biogas plants.

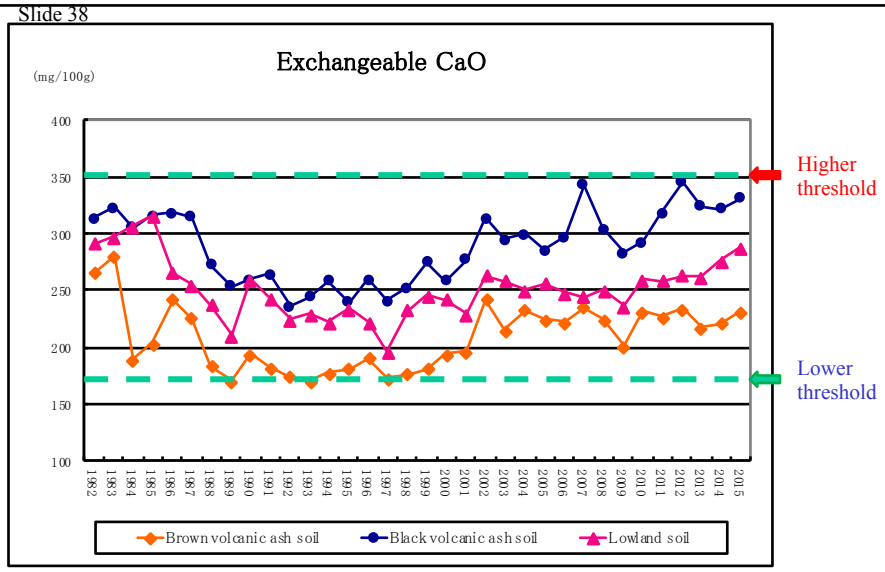
Slide 37:
Tokachi Federation of Agricultural Cooperatives has its own laboratory for soil analysis, and 20,000 to 30,000 soil samples are analyzed yearly in this laboratory for the farmers in Tokachi.
Tokachi is the place where soil diagnosis is most utilized by farmers.
This slide shows the result of soil pH analysis from 1982 to 2016.
The data of analysis are grouped into three types of soils, brown volcanic ash soil (normal Andosol), black volcanic ash soil (wet Andosol) and lowland soil (alluvial soil).
In 1982, the pH of the soil was between the lower and higher thresholds and optimum for all types of soils, but started to decrease thereafter and reached below the lower threshold for all types of soils in 1995. It was because the farmers refrained from liming to prevent the scab disease of potato.
The agricultural cooperatives and the agricultural experiment station advised the farmers to apply lime again, and during the following 20 years, the levels of soil pH returned to the optimum level again.

Slide 37



Change in soil pH in Tokachi; normal Andosols, wet Andosols, and lowland soils. Data: Tokachi Federation of Agricultural Co-operatives.

Slide 38



Change in exchangeable CaO in Tokachi; normal Andosols, wet Andosols, and lowland soils. Data: Tokachi Federation of Agricultural Co-operatives.

Slide 38:

This slide shows the change in the level of exchangeable calcium. Exchangeable calcium reflects more clearly farmer's response on the level of liming. The level of exchangeable calcium was highest in the black volcanic ash soil due to the high exchangeable capacity of the humus contained in the soil, while it was lowest in the brown volcanic ash soil. The level of exchangeable calcium in the brown volcanic ash soil was very low from 1988 to 2002.

Slide 39:

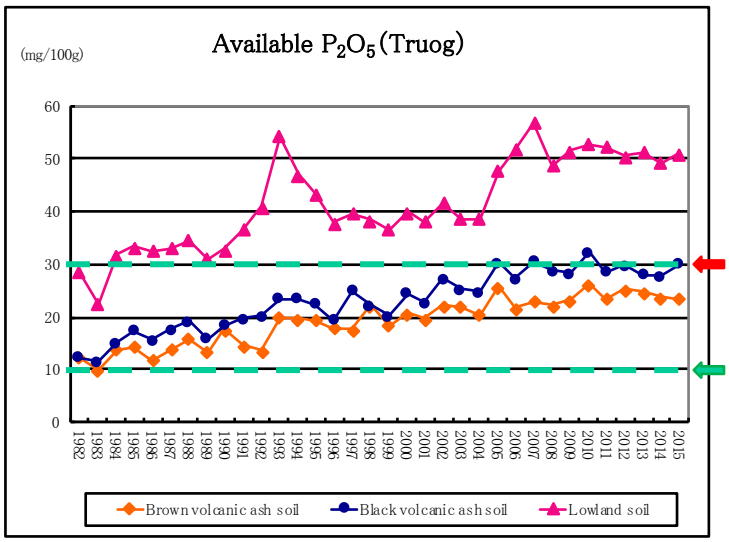
This slide shows the change in the level of available phosphate by the Truog method.

The level of exchangeable phosphate was very low in the two types of volcanic ash soils, and high in the lowland soil. Phosphate is fixed by the special clay mineral, allophane, contained in the volcanic ash soil. In the lowland soil, the content of allophane is very low and the phosphate can remain in the available state for longer period after application.

From 1982 to 2016, the level of phosphate increased gradually and reached near the higher threshold even in the two types of volcanic ash soils.

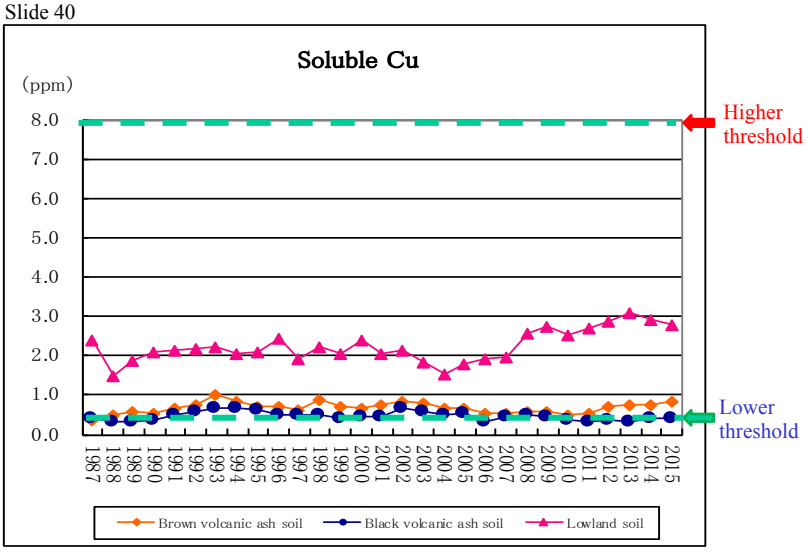
The level of available phosphate in the lowland soil is much higher than the higher threshold now. This may be because the same level of phosphate as the volcanic ash soils has been applied also in the lowland soil, and it is also because vegetables which require more phosphate are grown more widely in the lowland soils.

Slide 39



Change in available P_2O_5 in Tokachi; normal Andosols, wet Andosols, and lowland soils. Data: Tokachi Federation of Agricultural Co-operatives.

Slide 40



Change in soluble Cu in Tokachi; normal Andosols, wet Andosols, and lowland soils. Data: Tokachi Federation of Agricultural Co-operatives.

Conclusion

Farmers in Tokachi have faced various difficulties originating from severe climate conditions and unfavorable soil conditions.
However, they solved the problems by themselves and with the help of agricultural cooperatives, agricultural experiment station and
the local and national government policies,
and have built the most important upland and dairy farming area in Japan.

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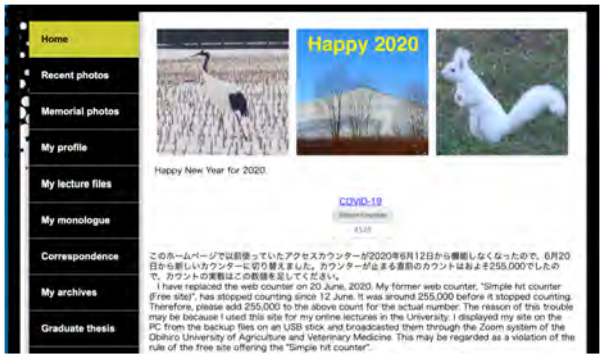

Slide 40:
This slide shows the change in the level of soluble copper in the soils of Tokachi. The level of soluble copper has been very low in the two types of volcanic ash soils. The level of soluble copper in the lowland soil is in the optimum level between the lower and higher thresholds. Copper is fixed strongly by the humus contained in the volcanic ash soil. The same trend is also observed for the soluble zinc in the soil.

Slide 41:
Farmers in Tokachi have faced various difficulties originating from severe climate conditions and unfavorable soil conditions. However, they solved the problems by themselves and with the help of agricultural cooperatives, agricultural experiment station and the local and national government policies, and have built the most important upland and dairy farming area in Japan.

Slide 42
I have uploaded the pdf files of this lecture on my home page.
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Thank you for your attention, and please enjoy the “Soil Diagnosis Course” further.