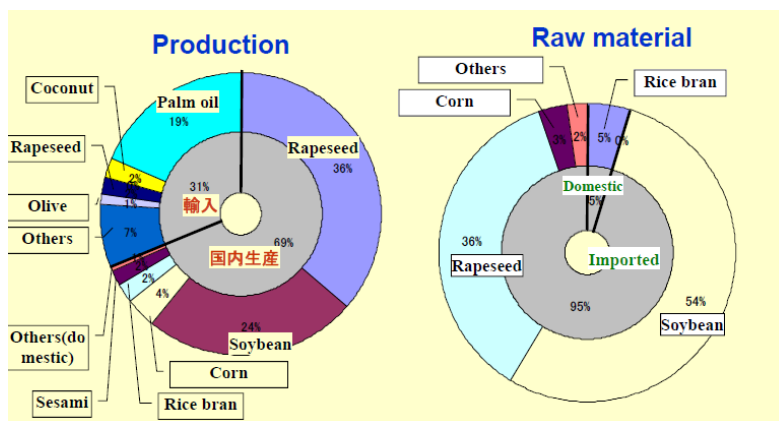


Case Study for Group 6: "Jiabura"/Sunflower oil

Introduction: Vegetable Oil demands in Japan/Jiabura

Vegetable Oil has become an essential ingredient for cooking in Japan, whether it be in households or restaurants. The overall demand has risen significantly since the 1970s, with a 2.5 fold increase from 1970-2005. Ever since 2005, the demand has remained relatively constant. Three major methods of generating vegetable oils exist in Japan today. (1) The original produce (i.e. rapeseed, soybeans) is either harvested in Japan or shipped from a foreign country, crude oil is extracted and its impurities are removed to create the finalized product. (2) Crude oil is imported from foreign countries, and the impurities are removed within Japan to create the finalized product. (3) The finalized, purified product is directly imported from foreign countries. It must be noted that Japan's vegetable oil production is heavily dependent on the overseas market. Out of all raw materials used as resources of vegetable oils, only rice bran, which makes up for 5% of the produce is grown within Japan. 69% of the vegetable oil production process is done within the country, while 31% (including palm oil, coconut, olive, etc) are directly imported. 97% out of the 2.6 million tons of oil production in Japan is reliant on overseas, in some form or the other.



Pie Chart of the breakdown for Japan's oil production- as you can see, only 5% of the raw material is domestic and the rest are imported from overseas.

Conventional vegetable oil goes through a lengthy process of extraction. For example, plants rich in oils such as rapeseed must go through an initial oil extraction via compression, which separates the plant into oil cake/meal and the actual oil product. Further oil extraction via the use of solvents such as hexane is administered to get the initial crude oil. Once the crude oil is obtained, it is purified by removing impurities, bleaching, and removing the odor. While large companies widely use this conventional extraction method, some small-medium sized enterprises have found alternatives. Known as the cold-press oil extraction method, this process uses a cold-press to physically extract the crude oil instead of chemicals such as hexane. The vegetable oil produced as a result is known as Jiabura(地油) in Japan. Jiabura has been known to contain more nutrients, including vitamin E and carotene compared to its conventionally extracted partner. As a result both the oil product as well as the oil cake can be sold at a higher price. Furthermore, Jiabura garners a high reputation from its users, who state that this type of oil retains its original flavor, and brings out the best taste in many different types of cooking methods. Our group visited Naka City as well as a small-medium scale farm called Club Core, located in Namegata City of Ibaraki prefecture to get a first-hand experience of Jiabura production. Naka City grows sunflowers with the aid of Club Core. When harvest season arrives, Club Core takes the sunflowers and extracts the oil, producing sunflower Jiabura. The Jiabura is then returned to Naka City, where they are commercialized and sold to households as well as restaurants and factories within the city. The goal of our group was to understand how Jiabura is made, identify its issues, and provide potential solutions, both in terms of quantitative Jiabura production and marketing to the outside society.

Entrance to Club Core



Namegata City, Ibaraki Prefecture



Background Information: Club Core

Club Core is a small-medium sized farm located in Namegata City, Ibaraki Prefecture. Currently, they produce 30 different varieties of organic vegetables, as well as processed foods including vegetable chiffon cakes. Instead of focusing on solely the production aspects, Club Core attempts to widen the capacity of agriculture as an industry. Specifically, they have put in significant efforts for “experience/tourism agriculture” where they provide a farm tour, harvest experience, lunch with ingredients made in the farm for their clients. Initially these agricultural tours were only held 4-5 times a year, but since then it has grown to 20 in 2013. Club Core does an amazing job linking agriculture with “tourism” and “personal experience”.

Naka City, Ibaraki Prefecture



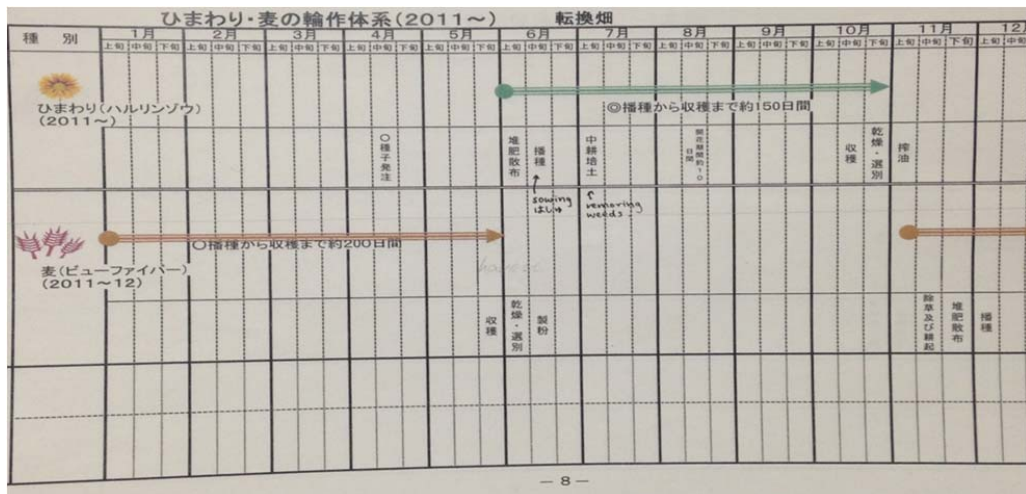
Introduction: Naka City

Members of group 6 travelled to Naka City of Ibaraki prefecture, where sunflowers were being grown for both tourism and jiabura purposes in association with Club Core. Located in the northern region of Ibaraki, the modern Naka City was established in January of 2005 through the merging of previous Naka as well as Urizura town. Currently, the city is home to approximately 55,797 residents.

As the city’s symbol flower is the sunflower, Naka has been growing sunflowers for revitalization of the city and for attracting tourists. A sunflower festival held every year in late August has become one of the largest and most successful events of Naka City. Until seven or eight years ago, the sunflowers had been grown solely for the purpose of tourism and were simply incorporated back into the soil after the flowering season. However, Naka City Shoukoukai (商工会- Commercial and Industrial Association) felt that flowers were being put to waste, and proposed to extract sunflower oils and commercialize them with Club Core’s help. Group 6 had the opportunity of directly speaking with members of the Shoukoukai to obtain information on how this sunflower project was currently being managed.

Background Information: 商工会/Shoukoukai

The Naka City Shoukoukai, or Commercial and Industrial Association we visited is a strictly non-profit organization funded by Naka City. Their primary purpose is promoting the revitalization of Naka City and aiding local business. The Shoukoukai is in charge of planning the sunflower festival mentioned in the above, where local shops also put up outside vendors and sell foods and goods to tourists.



Sowing Schedule

Sunflower planting season is from June to October. As we can see in this figure, at start of June, they spread fertilizer in the farm and then sow sunflower in the middle of June. At the start of July, they try to optimize the soil condition. In the later part of August, sunflower harvest takes place for around 10 days and attract lots of tourists to Naka city. The sunflower sowing area is 4 hectares and they leave around 5% of area for rotation with wheat. The rotation schedule is from November to May in next year as showed in this figure.

Seed Cost

They are using Harurinzou (spring-haru, rinzou-shape of sunflower) 63 and 82 these two varieties of seed. They have to buy seeds every year, the cost of the seeds is 3750yen/kg, use 5kg/ha seeds, spend about 15000yen/ha just for seeds. For fertilizer they use oil cake, but mix it with other compounds. Oil cake has high calories and can increase other compounds' temperature very quickly.

Issue:

1 Typhoon

For Naka city, the final amount of sunflower seed is 2.6 tons /hectare before drying. Sunflower harvesting fluctuates year by year. Sometimes farmers can get higher yield, but sometime not. The main problem is typhoon that dramatically affect sunflower yield.

2 Continuous planting

Naka city continuous to grow sunflower year by year, they leave a small part of land for sunflower rotation with wheat. Although sunflower yield can be improved by rotation, they are not interested in rotation method because they do not want to plant large amounts of wheat which is time and energy consuming. They cannot get significant benefits from rotation. So continuous planting is one impact on sunflower production.

3 Plant disease

Plant disease also influence sunflower yield. Some sunflower disease usually caused by various fungi, bacteria and viruses. Sunflowers can be affected by some disease problems, but this issue is rarely as these plants are typically quite hardy.

Possible solution:

1 Typhoon resistance management

Develop a typhoon-resistance plant cultivation device, the device is formed by a cultivation unit, a fixed unit, and a buffering unit; The typhoon-resistance plant cultivation device effectively solves problem of easy breakage of plants by wind during plant cultivation at wind belts.

2 Disease resistance sunflower

We can use molecule biology techniques and plant improvement methods. By inserting certain genes into plants, we can get the transgenic plants to enhance resistance to diseases and pests.

3 Management

Construct a management system considering irrigation and fertilizer. Collect basic parameter information, then use some application, like Apsim to make modeling and improve decision-making.

4 Reason for yield increase using rotation

Sunflower rotation with wheat can get higher yield, but what is the reason for yield increase? Is that because the wheat root? If the reason is the wheat root, we can use wheat residue into sunflower soil mixed with fertilizer to get the yield increase.

Harvesting

Head loss

After the Sunflower Festival at the end of August, the sunflowers will be harvested for Ji-Abura oil extraction. The tasks of both harvesting and oil extraction are carried out by the staff of Club Core and the supervisor is Takatsuka san.

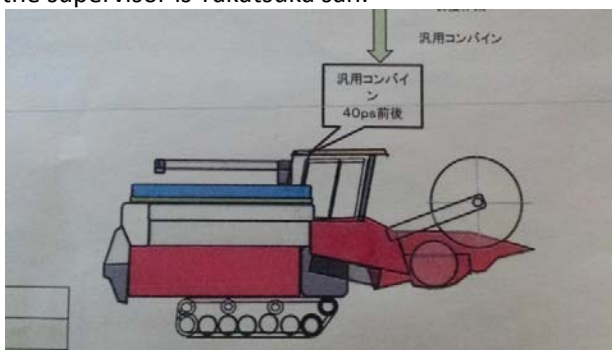


Figure 1. General combine

The machine used to harvest sunflower is a general combine (汎用コンバイン). Takatsuka san has also modified the combine adding pointed tooth protruding from the head part of the machine (header) in order to minimize the head loss. Head loss refers to the harvesting loss occurred when the head of combine fails to cut and gather the crop into the machine. In the case of sunflower, head loss commonly occurs because after flowering the sunflower head would start to drop and face the ground, and this position will be difficult for the combine to cut and collect the sunflower head.



Figure 2. Dropping sunflower head

http://commons.wikimedia.org/wiki/File:Sunflower_head_2011_G1.jpg

The protruding pointed tooth function to support the sunflower head in a way that the head will sit on top of space in between the tooth, giving the header of the combine a higher chance to cut and grab the sunflower head. According to Takatsuka san, the head loss has been minimized effectively from around 30% to around 10-20% with this modification of the header.

Threshing loss

After the sunflower head is collected into the combine, it will undergo a process known as threshing where the seeds are extracted.

Firstly, the sunflower head will be introduced into a rotating threshing drum known as the cylinder (component 6 in figure 3) where the seeds, chaff and smaller debris will be separated from the head through mechanical action. All the extracted material will then be introduced into an air flow generated by fan (component 10). The air flow functions to separate the seeds from the chaff in a way that the seeds would fall and enter through the sieves (components 11 and 12) and chaff would be blown out of the machine. The seeds which enter through the sieves would be collected at the grain auger (component 15) and get transferred to the grain tank (component 16).

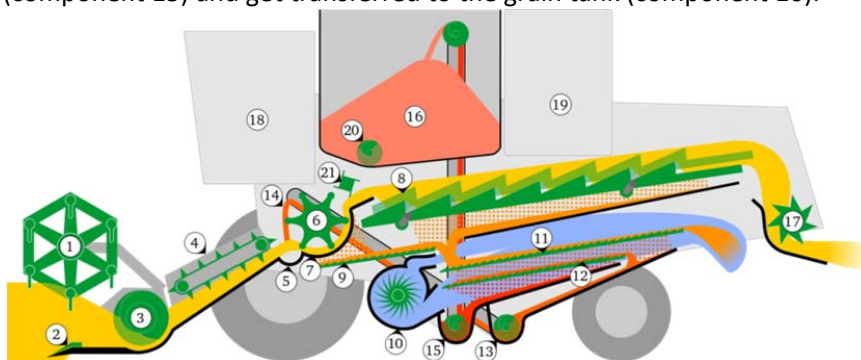


Figure 3. The threshing component inside a combine

http://en.wikipedia.org/wiki/File:Maehdrescher_schema_nummeriert.svg

Threshing loss can happen in this separation process when the seeds are blown out of the machine by the air flow instead of falling through the sieves. This is particularly significant in the case of sunflower seeds because they have a flattened, tear-shape which gives the seed a large surface area susceptible to the wind flow.



Figure 4. Shape of sunflower seed

http://en.wikipedia.org/wiki/File:Sunflower_Seeds_Kaldari.jpg

In the case of Naka City, the amount of sunflower seeds that can be potentially harvested by manual method is estimated to be 4 tons out of 4 hectares of land. But with combine harvesting, only 2.6 tons can be commonly harvested giving a threshing loss of 35%. This represents the most significant loss in the whole production process of sunflower jibura according to Takatsuka san.

Improvement

Minimising head loss - although the protruding tooth modification by Takatsuka san has already effectively reduced head loss, it could be further reduced with the use of a picker header. The advantage of a picker header over simple tooth modification is that it can pick up the dropping sunflower head automatically through mechanical action. The downside of using a picker header modification is high purchase price.



Figure 5. General combine modified with a picker header Figure 6. Sunflower picker header by produced fantini company <http://www.fantiniworld.com/public/images/4062.jpg>

Minimising threshing loss -

1. Wind velocity: the speed and direction of air flow is extremely important because excessive wind will blow the seeds out of the combine and inadequate wind flow on the other hand will result in poor separation of seeds from the chaff. The wind velocity must be carefully adjusted such that precise air flow is created to keep the chaff floating for efficient separation from the seeds (National Sunflower Association).

2. Moisture: moisture is a key factor in the threshing process because the seeds and chaff often stick together with high moisture making the separation process more difficult. Unfortunately, Japan has high rainfall in the summer during which sunflower is produced and harvested. And this is in direct contrast

with other major sunflower producing countries for example United States which has wet weather in the cold season from around September to May. Therefore, the timing of harvesting should be considered but this does not necessarily improve the problem because of Japan's wet weather throughout the whole summer.

3. Plant breeding: altering the shape of sunflower seed seems to be most direct solution because the flattened, tear-shape is a significant factor leading to susceptibility to wind flow and hence threshing loss as mentioned above. However, current researches on sunflower breeding focus mainly on resistance to diseases, oil quality and drought stress tolerance (Vincort 2014). It appears that altering the shape of sunflower seed is not the major trend or under any research efforts. Thus, it is very important to consider the practicality of starting plant breeding as a solution especially in terms of time and cost.

References

Vincort, P. 2014 "Research fields, challenges and opportunities in European oilseed crops breeding", Open Source Biology, vol. 21, no. 6.

National Sunflower Association, <http://www.sunflowernsa.com/growers/harvesting-storage/Default.asp?printable=1>, accessed 6 January 2015.

Vegetable oil extraction

Sunflower oil extraction is the process of separating the oil from the sunflower seeds contents. Common process uses for manufacturing mainly by large oil industries includes cleaning and grinding, pressing, extracting additional oil from solvent, removing solvent traces, refining the oil, packaging the oil, proceeding of by-products or waste(fig7)

Ji-Abura oil extraction

Because of small scale manufacturing of Ji-Abura, its manufacturing process is different from regular vegetable oil manufacturing process. Ji-Abura oil manufacturing is the main step in sunflower oil production in Naka city , which includes seeds drying, seeds separation, oil extraction, filtration, bottling and leftovers(oilcakes) processing, all of those have been completing by Club Core.

Ji-Abura oil extraction process

Seed drying

Seed drying is the first step of oil extraction as the moisture contents directly affect oil quality and shelf ages in oil industry, therefore before separation and extraction the drying is key preparation step. The machine used by Club Core for seeds drying is far infrared dryer (fig1). This type of dryer is very popular in Japan, can dry the most inner part of grains, therefore can avoid the side effects of extra moisture to oil extraction. By doing so the seeds will lost 10 to 20 percent of weight, mostly water content of seeds, but can guarantee high oil quality.

Separation

Even after combine threshing there is still mixed chaffs in dried seeds, so separation is required. The rough separation machine (fig2) separate sunflower seeds from kernels based on gravity and seed size, so the speed of wind during the process is important to get less contaminated seeds. However there is less difference between kernels and seeds thus cause great amount of seed loss during the process. For the oil extraction, the method has been applied is cold press oil extraction instead of chemical extraction, aims to keep high level of vitamin E ,carotene and original flavor in the oil. The cold press is a kind of physical extraction method, through combination of grinding and low heat, extract oil form sunflower seeds. Introduction of heat into oil extraction process leads to degradation of oil flavor and loss of nutrition by evaporation. Therefore by using cold press crude oil extraction method with combination of advanced extraction machine, oil producers can sell their oil in higher price due to its

healthier processing method. The machine used for extraction is 榨油機(fig 3), has all typical part of classical oil mill, additionally it has extra moisture meter and temperature meter, therefore if temperature or moisture exceed the standard level then it end extraction process automatically to ensure lower temperature in whole extraction. Besides, operation of this machine is simple and not labor intensive, so considered as the most promising machine for small scale oil industry.

Filtering or refining

Filtering is the important tool to purifying crude oil, in Club Core this step is done by conventional method, which is that collect oil in one big container and left it as it is for two or three weeks, let contaminated oil sink to the bottom of tank due to the sedimentation then pure oil can be absorbed by suction pump (fig4). The filtering process leads to little yield loss and time consuming, but for the oil production, it is necessary.

Bottling

Bottling is the last step before transporting oil to the local market. For Ji-Abura oil, the bottling also has been done by manually (fig4 & fig5). The bottles used for the Ji-Abura oil packaging are transparent glass bottles in order to magnify customer's appetites and reduce packaging material cost.

The most distinguish difference between commonly used vegetable oil and Ji-Abura oil is that Ji-Abura production process didn't involve in any step which related to harmful chemical substance like Hexane. And comparatively low temperatures during the extraction endowed great taste, nutrition and flavor to the oil. Therefore the unique features of oil extraction should be highlighted in Ji-Abura oil marketing, and sustainable future plan for Ji-Abura oil business.

Issues during extraction process

Drying loss

The total production for drying is the 2.6 ton, got 2.2 ton after drying. The loss for drying is moisture content and for the oil shelf life the moisture content is limited. The loss compare with moisture content of seeds is rescannable.

Separation loss

The total production for separation is the 2.2 ton, got 2.1 ton after drying. Compare with Kernel content of the materials, can be indicated that great amount of seeds blew away with kernels.

Reason: less difference between kernels and seeds on the gravity &size aspect

Extraction and filtering loss

Different type of oil's net production reduced about 10 percent from actual oil capacity rate after extraction, possible reason should be considered. The solution will be added to the final report if there is any.

The oil extractable rate of sunflower seeds is 25~30 percent, according to total amount of raw material after separation, the expected crude oil should be 525~630kg. However after bottling, the total pure oil for selling is 372kg, more than 35percent of crude oil decreased, comparing with decreasing ratio of oil industry during the same process, it is quite considerable loss.

Extraction is unique character of Ji-Abura, so possible improvement can be given to filtering and bottling step.

Possible suggestions to issues:

Possible suggestion to the separation loss.

Idea1: changing sunflower seed size through genetic modification of sunflower or breeding, so that the separation machine can separate seeds efficiently.

Idea2: the sunflower seeds contain high amount of oil than kernels, so the calorimeter based selection machine (if invented) would be possible to reduce the separation loss.

To filtering loss:

1. Better equipment, such as centrifugation machine.

2. Make use of highly contaminated crude oil.

Figures:

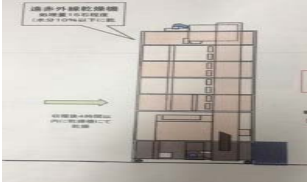


Fig1: far infrared dryer structure outline

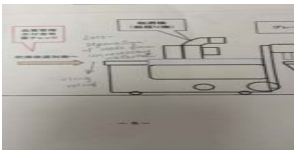


Fig2: structure of separation machine



Fig3: oil extraction machine

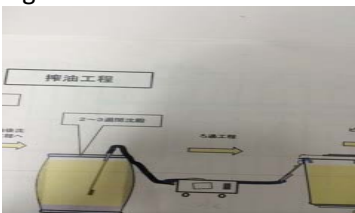


Fig4: Ji-Abura oil filtering principle

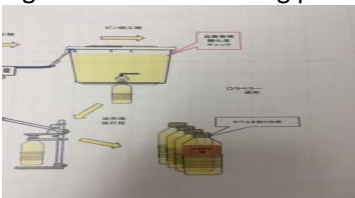


Fig5: bottling principle



Fig6: bottling

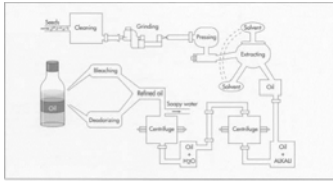


Fig7: manufacturing

Sales, Marketing

Shoukukai

- One of the main tasks of Shoukukai is to promote sunflower in Naka City, with an aim to make it as a symbol of the city to impress the tourists

Package

- A seal is put on each bottle of sunflower oil before it is put onto the market

Sale and Distribution

- Two different sizes of bottles of sunflower oil are produced every year
- 100 1-liter bottles of oil are sold at 2000 yens to restaurants in the city
- Around 2,000 140-gram bottles of sunflower oil are produced and sold at 600 yens to 20 to 25 shops in the city, and the shops then sell them at 1,000 yens to consumers
- The selling price is fixed in order to protect the small shops the city
- All of the bottles of sunflower oil are sold out around 6 months, indicating it is welcomed by the local citizens

Promotion

Sunflower Festival

- Around 40,000 tourists are attracted on the day of festival, half of them are visitors coming outside the city
- No entrance fee is needed for the tourists to participate in the festival
- Booths selling food and drinks made by local raw materials are set up by Shoukukai in the venue of festival
- Around 100 shops are able to make a sales record at around 20 million to 30 million yens on the day of festival
- Total economical effects brought out by the festival are around 40 million to 60 million yens, which are greater than the investment of the sunflower project carried out by Shoukukai

Leaflet



Possible solutions/improvements

Duration and content of festival

- Lengthen the duration of festival, like a week
- Incorporate other activities and elements into sunflower festival in order to enrich the content of the festival
- Parades by local citizens
- Performances of students from local schools

More facilities needed, such as places for accommodation, restaurants and tourist information centers

Mass media

- local newspapers both in Naka city and cities around it like Tokyo, Tsukuba, etc during the festival period
- Leaflets promoting the city and the festival can be made available at main train stations around Naka city. Recommendations are given in the leaflets, such as the routes for travelling around Naka city, souvenirs available in the city, information about the sunflower oil and festival, and even coupons to boost sales

Social Platforms

- Example: Facebook fans page
- Low-cost promotion
- sharing news and information of the city and the festival
- increasing the publicity of the festival