Asia Techno Farm Initiatives for growing Future Farmers of Asia

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***Abstract*—Humans are now facing the four global issues (Global Tetralemma) related to Population, Food, Energy and Environment. The key point is to find out the cause of these problems and how to solve them. Most of the problems are caused by human activities prioritizing economic promotion. It can be, however, noted that Asia has a high potentiality to play an important role in solving most of the problems in question. In this paper, the hopeful technologies applicable to Asian agrifuture are introduced mainly from the viewpoint of the sustainable development of future Asian society building, by establishing and maintaining a harmonic balance between ecology and economy leading to stable regional peace keeping.**

Keywords- global tetralemma; high-tech agricultural mechanization; Asia Food Project; Future Farmers of Asia growing program; Asian agrifuture;

I. INTRODUCTION

Earth is the only planet on which humans can live a normal life. The global tetralemma refers to the four global issues consisting of population, food, energy and environment. Figure 1 shows this ecological concept. When the population increases, the food production must be increased. To increase the food production, more energy is needed. Energy consumption increases CO_2 production, which jeopardizes the environment. This creates a situation in which we, humans, are facing global problems related to food, energy and environment [1].

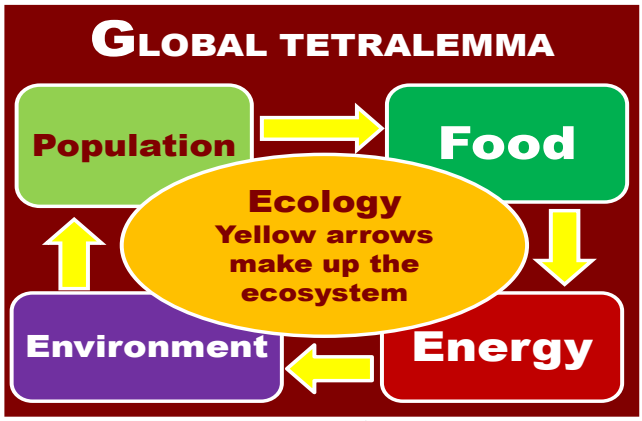

Figure 1. Schematic concept of global tetralemma

Figure 2 shows how economy breaks ecology and produces all the other problems. How to tackle and find the solutions for those problems is one of the main objectives of this paper.

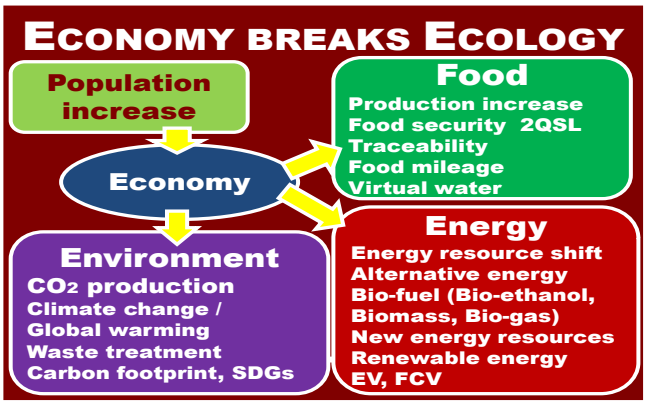

Figure 2. Economy breaks ecology and contributes to other problems

Currently, the world population is 7.8 billion in 2021 and increasing by 80 million per year. Considering this figure carefully, about 140 million people are born and 60 million are dying each year. The difference of 80 million is the population increase per year. As the population grows, more food production is needed. It is said that the population engaged with food production is around 20% of the world population. This simply means that one farmer produces food for 5 persons, including that farmer.

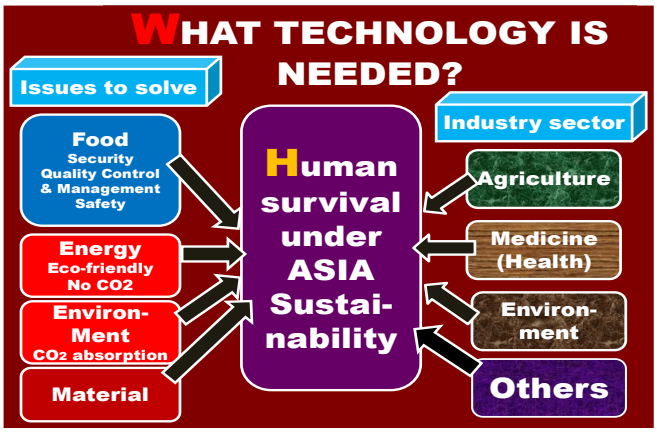

Figure 3. What technology is needed?

Figure 3 shows the relationship between the issues we are facing and the industry sector. We are already facing two emerging global issues related to energy and the environment that we need to solve immediately, however, the final and optimum solution has not been found yet, in spite of many efforts being done by various scientists, researchers and engineers. This is really a competition of the production cost and price of petroleum with the other energy resources in which most of them are eco-friendly or environment friendly ones. Recently, petroleum price has been drastically coming down almost 1/3 compared to ten years ago, due to the new energy resource discovery of shale oil / gas, in which the production cost is very much lower and more competitive. Methane hydrate is another possibility. Japan successfully developed the technology to take it out of the seabed in 2014, however, it is still not cost competitive. It will take a little bit more time to make it for the commercial base production. It may be guessed that the decrease in price of the petroleum may slow down the speed of technology development due to enough production to supply to the market. On the other hand, the mitigation control of CO_2 gas may be delayed, and the global warming issue cannot be improved if this situation is continued. Which one should be chosen, energy or environment, is one of the good examples to think about the real meaning of sustainable development or low carbon society building from the viewpoint of how the harmonic balance can be well maintained under this condition in promoting economy without jeopardizing the environment. The economy always makes us hesitate easily in making a choice. We, humans, already know that the fossil energy should not be chosen due to the cause of the global warming, however, the lower prices of oil entice us.

The author delivered a lecture entitled “Asian Agriculture Growth Strategy” in Prime Minister ABE's doctrine "ABEnomics” as one of the invited keynote speakers at the Agricultural Mechanization Session, of the JSAMFE (Japanese Society of Agricultural Machinery & Food Engineers) annual meeting held at Ryukyu University, Okinawa, Japan, May 17, 2014 [2]. Figure 4 is a schematic diagram showing ASEAN Economic Community should pick up the industrial sector for promoting the economy and how it should be done. It is already known that the ASEAN Economic Community was officially established in December 2015, however, it looks a little bit difficult to know what industrial sector should be set as the main framework of the body to meet and achieve the final goal of the community. In the author's understanding, the goals should be 1) To make ASIA the world's food pantry, enough to supply safe food on demand and 2) To stabilize the economy and maintain the regional peace based on agriculture. The following shows the concept outline of ASEAN Economic Community proposed by the author and how it should be promoted step by step towards the final goal achievement [3].

Most Asian countries are more or less still relying on the economy of the agricultural production. ASEAN member countries are also in similar situation, except some of them. It is already well known that, as mentioned above, the human population is still rapidly increasing at the rate of 80 million per year. It can obviously be guessed that sooner or later, food production must be increased to feed.

Figure 4. Asian Agriculture Growth Strategy

Otherwise, the food issue will become a serious problem later. Asia is fortunately producing a huge amount of bio-resources, especially food resources, however the quality is not well controlled and managed. As far as food production is concerned, the priority should be to secure the safety. It should be noted that there are two kinds of countries in Asia: one kind is resource-oriented countries, and the other kind is technology-oriented countries, called ASEAN, plus three like China, Japan and South Korea. To secure the quality, especially food safety, higher technology is needed and applied. The author's proposal is based on the collaboration and mutual competition among these two types of countries. One needs the resources and the other needs the technologies. Both need them mutually and interactively. The best way is to collaborate and compete to promote a stable economy in Asia. In addition, the following two things should be done on the process of final goal achievement. They are: 1) Technology transfer and 2) Human Resources Development. Both should be desirably promoted in parallel, however, due to some inconvenience of laws and regulations, it is hard to achieve in practice. Which one should be started first? That should be the human resources development, especially focusing on universities. The extension must be followed through the process of technology development and its validation; therefore, it takes time for final technology transfer to extension. Even for the human resources development, it takes time until the effective result could be obtained, therefore the academic mobility program should be started earlier and promoted in the regional area. It is required that highly educated human resources will be absolutely needed by the mature global society. Two stages of goal achievement are shown towards the final one. The first step is to make Asia one of the world food pantries in huge amount of food resources production.

Secondly, the most reliable Asian food brands should be created enough to guarantee both quality and safety. Following the process based on this proposed concept, the Asian economy can be developed and promoted stably, and regional peace keeping can also be maintained. Both resource-oriented and technology-oriented countries can get mutual prosperity to survive together contributing a lot in safe food production and supply to all over the world (Figure 4). The author already tried to propose the project under the title of Asia Food Project consisting of two main parts. They are Asia Techno Farm and FFA growing program, where FFA means Future Farmer of Asia [4][5][6]. These two programs are combined together and the whole framework is explained later in detail as whole involved in Asia Food Project. This paper therefore discusses the following two contents: 1) introduction and application of the various technologies seemed to be required for future Asian agriculture achievement and 2) Asia Food Project proposal consisting of two programs, named Asia Techno Farm and FFA (Future Farmer of Asia) growing program, which is one of the human resources development program.

II. SMART AGRICULTURE

The Ministry of Agriculture, Forestry and Fisheries of The Government of Japan defines smart agriculture as "New agriculture that enables hyper labor saving and high-quality products production by utilizing cutting-edge technologies such as robotic technology and ICT (Information & Communication Technology)". According to the Ministry, the materialization of smart agriculture can achieve hyper labor saving and large-scale farming production by automatic control of agricultural machinery, high-yield, high-quality products production that makes full use of sensing technology and large data, and heavy labor by using robot technology. It can be expected to have more merits such as CO_2 mitigation and labor saving, simplification of agricultural operation by combining know-how with data and assisting operating function and providing important and necessary information to consumers by providing final products information (traceability) [7].

A. Precision Agriculture

Precision Agriculture has variable rate control function for reducing loss and saving materials and energy. The concept of this farming system is similar to the TOYOTA car manufacturing system named “Kanban (or Kaizen)" system mainly consisting of the three conditions listed below.

1) Car manufacturing company provide the required information on which part, how many sets amount, and by when parts must be prepared should be informed to the related parts supply manufacturing company in advance based on the production schedule every day.
2) Parts supply company supplies the ordered parts just enough amounts required for one day manufacturing plan.
3) The parts supply company is strictly requested to bring them by the time when appointed without any delay

In actual farming, three conditions of “What”, “How many or How much” and “When” must be decided from time to time knowing the data provided by GIS is specifically matched with site by site [8][9].

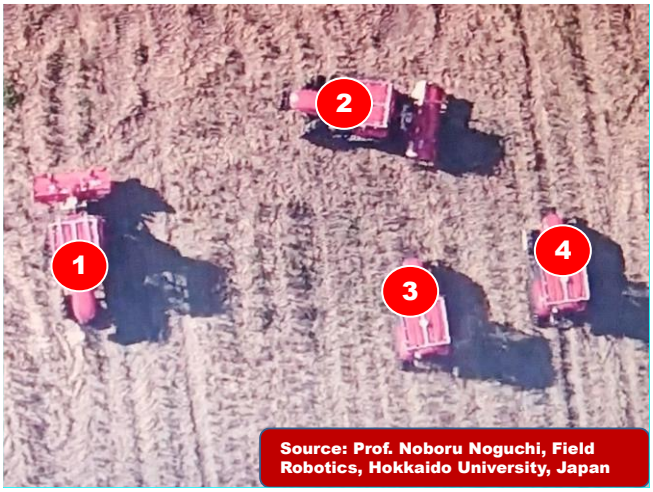

Figure 5. Farm tractor group guidance driving control

Figure 5 shows a group guidance control consisting of four vehicles (tractors in this case). Tractor No. 1 is leading the other three. At the corner or headland of the farm field, the leading vehicle (tractor) starts to turn left. The other three are waiting for the leading one until it to completes the turning and gets in the new path keeping suitable interval and space. In this case the four tractors were used for demonstration running test, however the total number of the vehicles to be controlled is not the problem. Even the bigger group consisting of more number of the vehicles can be controlled in the same way.

Figure 6. Truck group guidance driving control

Figure 6 shows the group guidance driving test consisting of three trucks in this case demonstrated under

the leadership of the Ministry of Land, Infrastructure, Transport and Tourism [10]. The merits are as follows: 1) The benefits are: 1) Aging drivers and a shortage of long-distance truck drivers due to heavy labor within a set limited time, 2) Air resistance can be reduced and fuel consumption can be reduced since the distance between vehicles can be kept short during platooning driving.

Communication and information technology has become more familiar and easier due to the dramatic spread of its technology due to the relaxation of GPS for civilian use, which was initially developed for military purposes. Smart phone is a typical example, and we are now in an era where we can hardly feel the distance of the national sense of the world. The era of IoT (Internet of Things) that connects various information devices to the Internet is really coming.

Until now, unmanned driving technology for automobiles has been the goal of car companies, and the development deadline was initially set to the time of the Olympic Games 2020, but it has been significantly delayed due to the COVID-19 disaster. In the field of agricultural machinery and mechanization, unmanned operation of mobile vehicles such as tractors and combines has already been achieved at the laboratory level. Of course, agricultural machinery has an extremely slow running speed compared to automobiles, traffic is light on agricultural land, and the conditions are relatively good and better, which made it possible to develop technology ahead of automobiles, but in addition to being small scale in agriculture. Since it is a declining industry, it has been considered difficult to be accepted and spread out even if it is commercialized in terms of cost.

B. Robotics

There are two kinds of robots. One is something like an industrial robot set and used to complete the work for the post-harvest products, such as selection, weighing, grading, sorting, packaging etc. in a specially prepared building or facility. The other is a mobile vehicle uch as tractor, combine and transplanter doing the original operation while moving, such as tillage, fertilizer application etc. The location of the robotic machine is autonomously guided by the GPS signal provided from the satellite. The optimal operation can be done under the variable rate control based on the final decision derived from the data collected and provided by GIS continuously from time to time while moving. A laser scanner is mounted in front of the vehicle (tractor, in this case) to detect the obstacle and it functions to stop the machine immediately. The other direct contact type sensor is also mounted for a double check in safety. Three way motions of the vehicle, namely pitching, yawing, and rolling, reduces accuracy. It is also possible to control the automatic guidance operation of a group of vehicles consisting of multiple vehicles while maintaining a master-slave relationship [11]. Figure 7 shows a comparison between agricultural and industrial robots function by some major items. It can be seen from this that there is a fundamental difference in the handling of artificially designed and manipulated agricultural products from the ones grown in the natural environment between two kinds of robots.

Difference between Industrial and Agricultural Robots

No.	Item	Agricultural robot	Industrial robot
1	Robot motion	Move to work Search, Find, Identify, Off road	Stay and wait for the work
2	Objective work	Non standardized Size, Color, Shape, Maturity Hardness, Location	Standardized Designated set position
3	Operation	Autonomous	Program based
4	Function	Learning	Teaching
5	Structure	More complicated	Comparatively simple

Figure 7. Difference between agricultural & industrial robots

The biggest difference between agricultural robots and industrial robots is that industrial robots handle the artificially designed standardized (normalized) products, while agricultural robots handle non-standard products. Non-standard products are different in color, shape, size, weight, ripeness, fruit hardness, etc. for each solid. The harvesting robot makes a decision as to whether or not to harvest by collating this information with preset standard code. Agricultural robot needs to know where the fruit is hanging in what part of position of the fruit tree. Robot has to check each fruit to see if it should be harvested and only fruits that meet the conditions will be harvested. More number of sensor and hardware should be mounted on the agricultural robot to get more information to make the final decision whether the target fruit should be harvested or not. Fruit harvesting robot should take action first in the orchard even for the recognition and identification of which is fruit or not by use of the light reflectance expressed in wave length information in case the fruit is hanging on the tree with leaves. Harvesting robot is mostly used in green factory to harvest vegetables for fresh market use due to comparatively uniform and stable growing under suitable conditions with environment controlled.

C. Green Factory

This type of farming is different from the conventional one using soil, mainly focusing on the mass production of fresh market crops such as lettuce, mini-tomatoes etc., which is similar to the industrial crop cultivation under completely controlled conditions of the environment. This is basically managed on hydroponic system, therefore water is normally used for fertilizing and circulated for saving. Disease infection is tightly controlled. Workers are strictly forced to wear special work clothes, masks and caps, in addition to special boots and gloves. The environment is similar to the clean room of semi-conductor industry plants.

They are also strictly forced to take air showers when getting in and out of the factory. Since vast agricultural land and soil are not required, the completely different kinds of industries which are originally unrelated to agriculture are increasing to join looking for business opportunities because this type of farming uses normally hydroponic system instead of soil. Osaka Prefectural University is leading in this area [12].

Figure 8. Various types of Green Factory

Figure 9 shows the advantages of green factories in terms of materials and costs including future business prospects.

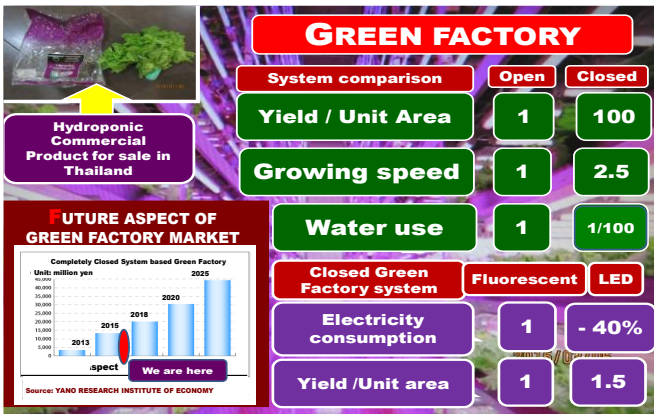

Figure 9. Green Factory, present and future.

D. Drone

Recently, the number of possibilities of drone application to the agricultural sector has grown up rapidly. One of the most important merits of applying drone is to get a wide, bird eye view photo, which enables to find how the crops are growing. Farmers can find what and how they can / should do from the image sent to their device, such as a smart phone. They can make decision regarding how much fertilizer should be applied from the green color image (NDVI, Normalized Difference Vegetation Index).

$$NDVI = (NIR - RED) / (NIR + RED)$$

where NIR–reflection in the near-infrared spectrum
RED–reflection in the red range of the spectrum

According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities. This index defines values from -1.0 to 1.0, basically representing greens, where negative values are mainly formed from clouds, water and snow, and values close to zero are primarily formed from rocks and bare soil. Very small values (0.1 or less) of the NDVI function correspond to empty areas of rocks, sand or snow. Moderate values (from 0.2 to 0.3) represent shrubs and meadows, while large values (from 0.6 to 0.8) indicate temperate and tropical forests. Crop Monitoring successfully utilizes this scale to show farmers which parts of their fields have dense, moderate, or sparse vegetation at any given moment. Simply put, NDVI is a measure of the state of plant health based on how the plant reflects light at certain frequencies (some waves are absorbed, and others are reflected). Chlorophyll (a health indicator) strongly absorbs visible light, and the cellular structure of the leaves strongly reflect near-infrared light. When the plant becomes dehydrated, sick, afflicted with disease, etc., the spongy layer deteriorates, and the plant absorbs more of the near-infrared light, rather than reflecting it. Thus, observing NIR changes compared to red light provides an accurate indication of the presence of chlorophyll, which correlates with plant health. Drone can be used for many other ways, such as seed broadcasting, fertilizer and chemicals application. In these cases, the payload is the problem, namely, how much it can carry and fly. More applications are under consideration; however, the challenges are security, privacy, various regulation and the standards. Hackers can break into seemingly safe remote-controlled engines and networks that control brakes and steering.

III. TECHNOLOGY APPLICATION IN AGRICULTURE

A. Nano Technology

Carbon Nano Fiber is famous and well known for its light weight and strength. It is already used for aviation and car industry. Recently, the bio-based Cellulose Nano Fiber is attracting a lot of interest. It is a newly developed material by Professor Hiroyuki Yano, Humanosphere Research Institute, Kyoto University, Japan from bio-resources equipped with unique physical properties, namely, 5 times stronger and 1/5 lighter than metal, in addition to higher heat resistance. The Cellulose Nano Fiber may take the application area and replace CNF (Carbon Nano Fiber) in the future. In addition, it costs 1/6 of the cost of carbon nano fiber. Cellulose Nano Fiber can be produced not only from trees, but also from various popularly known cellulose materials such as wood, rice straw, cassava and potato.

Various Nano Bubble water provides other hopeful possibilities, such as

- Oxygen Nano Bubbles
- Ozone Nano Bubbles

・Nitrogen Nano Bubbles

Hopefully Applicable industrial sector is shown below.

・Food safety – Vegetable sterilization

・Aquaculture (Fishery) – Oyster sterilization

・Dentistry – Periodontology / Periodontics

・Medical science - Cancer cell control

Oxygen nano bubble water has higher effect of promoting plant growth and shortening the total growth period. Ozone nano bubble water functions effectively for sterilization for various bacteria and fungi. In case of washing out the chemicals attached to agricultural products, 80% are removed by using ozone nano bubble water, whereas only 20% can be removed at one time with ordinary water. Tooth paste water using ozone nano bubble water has been commercialized. Periodontal bacteria in the mouth can be sterilized just by gargling without brushing your teeth.

B. Plasma Technology

Plasma technology can be used to treat waste and change to energy because under high temperature treatment hydrogen can be produced. On the other hand, if the plasma treatment was done under low temperature, waste oil can be changed into fuel. According to the news currently televised, it is said that around 4,000 workers are working everyday at Fukusima nuclear power plant, however it will take 40 years more to remove the debris left in the reactor. The use of plasma is promising for treating highly radioactive debris.

C. Pattern / Face Recognition

The combined technology of image processing, pattern recognition and Artificial Intelligence (AI) is getting popularly applied to recognize and identify the individual person quickly. This technology can be used even for the individual livestock management. Two kinds of memory can be found and considered: one is a tag attached to a part of the body like ear, and the other is the chip type to be embedded in the body. The pedometer, the route traveled, the distance, etc. are automatically recorded and sent to the data center for recording. These data can be used for observing the health status of individual livestock and managing the amount of food to feed.

The net pattern of melons is unique and original to each individual and resembles a human fingerprint. By recording and memorizing this net pattern as an image, the historical background of the melon can be known such as the place and when it was harvested and how it came from the production site. This is one of the areas called Agribiometrics or Bioinformatics.

IV. ROJECTS AND BUSINESS

In this section, some of the ongoing projects and businesses model in commercial base are listed.

A. Blue fin tuna, Kinki University

Blue fin tuna is one of the most popular big thick fishes served at higher class restaurants in Japan. However, to meet the customers demand, fishermen must live away from home for months in remote pelagic fisheries. Sometimes the weather is unseasonable, and they encounter storms and typhoons in case. Some of them will also encounter a fatal accident. If they do not have to live away from home for fishing, it will make them more relaxed and even their family will feel more at ease. Fisheries should be changed from going away and fish for months to keeping put and growing fish. The Kinki University, succeeded in the cultivation of blue fin tuna to grow from the stage of egg up to the final stage for shipment. Currently, blue fin tuna cultivated in this way is delivered to large cities and rural areas and is also served in the cafeteria even on the university campus [13].

B. Osaka Prefectural University

Osaka Prefectural University is one of the first universities in Japan to succeed in researching and commercializing a Green (plant) factory. Just like Kinki University mentioned above, it can be said that this university has demonstrated the industrialization of agricultural products production. The cultivation shelves lined up in an environmentally controlled building are fully covered with LEDs (Light Emission Diodes) of various colors, and the workers working inside seem to be working in the clean room of a semiconductor manufacturing plant, and they are nervous about bringing in pathogens from the outside. Harvested lettuce and other fresh vegetables are delivered not only to university cafeterias, but also to large cities and regions on order. One of the important factors to keep in mind is that producers have a clear and reliable relationship with consumers.

C. EUGLENA Project

This is a joint venture project already launched few years ago. The author does not know how much they have been successful up to now, however, this business model is one of the few successfully launched examples the author knows about. The main product is an algae. Euglena has many characteristic features, but it is noteworthy that it absorbs a large amount of carbon dioxide. Electric power plants discharge a large amount of carbon dioxide, which can be absorbed by Euglena to promote its own growth. The produced Euglena can be sold as a raw material or resource for food, feed and fertilizer, while also contributing to jet plane fuel as bio-fuel. The problem with business operations is that they need technology to produce a large amount of Euglena in a short period of time, and the company founders have also proven this technology. Since it is a bio-based fuel, it contributes a lot to a low carbon and de-carbonized society building from the viewpoint of carbon neutralal concept [14].

Euglena, which efficiently produces polysaccharides, is promising for health foods, cosmetics, bioplastics, biofuel raw materials, and carbon dioxide treatment, but it should be more productive for industrial use. Selection of Euglena strains is required.

Euglena production sufficient to meet the demand basically depends on the expansion of the culture space, but

in order to improve productivity, it is necessary to identify the shape and size of the produced Euglena.

For the purpose of increasing the processing capacity, a method of flowing Euglena in a flow path at high speed and taking an image with a high-speed camera, and an optical observation method using light scattering such as fluorescence imaging, Raman scattering and Mie scattering have been developed [15]. These methods required complex optical systems, and the equipment itself was large and costly. If electrical shape identification becomes possible, complicated optical systems will be eliminated and hyper-compact shape identification device consisting of electrodes and a small circuit board can be realized.

Conventionally, it has been known that there is a correlation between the average diameter of cells between electrodes and across nanopores and impedance characteristics, but it is not suitable for shape measurement of elongated cells such as Euglena. An inclined electrode is added between the normal electrodes, and the position information in the flow path of the target that has entered the electric field is the amplitude of the signal, the magnitude is the signal width, and the shape is the deviation between the rising and falling edges of the signal wave, that is, the eccentricity. As the result of measurement as (Tilt index), information on the cell shape can be obtained only by measuring the electrical impedance. This method of measuring electrical impedance using a device with a tilted electrode made it possible to accurately measure the size and shape of Euglena at a high speed of 1,000 cells per second. By widely applying this method to algae other than Euglena, it is possible to develop useful substances from algae, whose use is expected to expand in the future, from research to commercial-based industrialization.

Figure 10 shows the schematic flow of Euglena cultivation and its various utilizations. The huge amount of carbon dioxide is produced at the electric generation power company, therefore this massive amount of CO_2 can be received by EUGLENA Co. Ltd. and used for growing / cultivating Euglena, because Euglena can be grown up by the absorption of CO_2. Euglena can be used for producing many products such as bio-fuel available for cars and jet plane. In case of application to cars, ISUZU, a famous diesel engine mounted car manufacturer in Japan already has the partnership with EUGLENA Co. Ltd. to produce bio-fuel for diesel engine in which the registered trade name is DEUSEL. This is now being used for public transportation bus and other type of cars. As for the case of bio jet fuel, HONDA business jet had a successful demonstration test flight [16].

EUGLENA Co. Ltd. and HITACHI PLANT Co. Ltd. are jointly working to supply the bio jet-fuel and related plant depending on which product is targeting, bio jet fuel or residue supply for animal feed, organic fertilizer production etc. JX Nisseki Petroleum Co. Ltd plays a role of refining bio-fuel for final product.

Figure 11 shows the difference of the CO_2 absorption capacity between Euglena and various kinds of tree. It can be obviously found from this comparison data that Euglena absorbs 30 times more than cedar and cypress trees. In addition it shows that Euglena can be usefully available for covering the four global issues. Euglena can be categorized as one of the important key resources from this point of view. The author understands that key resource may be defined as the useful important resource to cover the most of four global issues (tetralemma). Most of the agricultural crops are therefore categorized as key resources, however the conditions should be carefully considered to avoid or not to bring in unnecessary problems that conflict with each other among the issues.

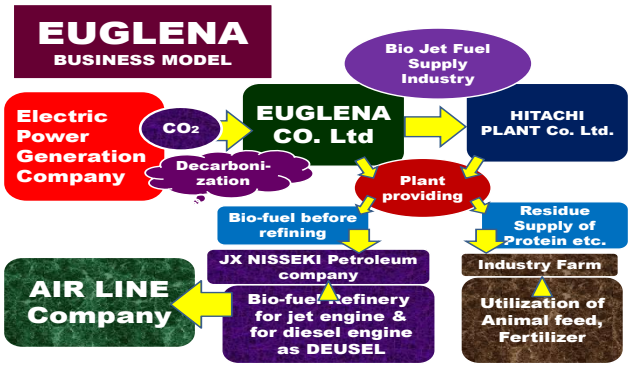

Figure 10. EUGLENA Co. Ltd. business model going on commercial base

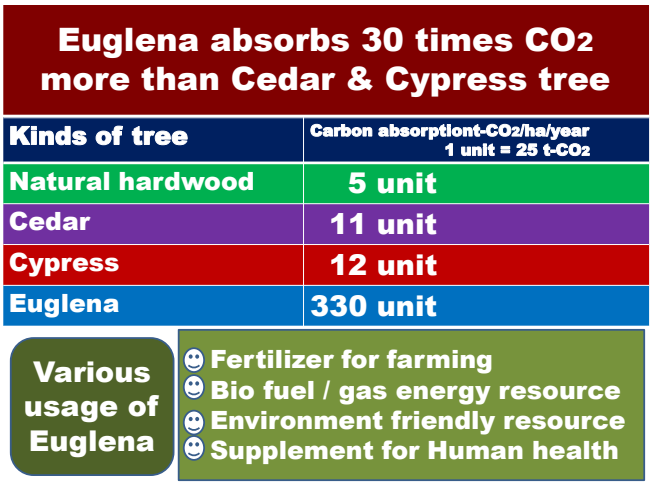

Figure 11. Euglena CO_2 absorption comparison to some of the other trees

D. Good Harvest Plan

This is also a business model proposed by TOYOTA. It is a contract-type business model for small-scale farmers or farmers who have no successor, but own farmland.

The farmer will contact the contracted center and request the dispatch of machine together with driver to carry out the necessary operations timely. The center will respond to the request by dispatching an appropriate driver according to the type of farming operation. The main operation is tillage,

transplanting and harvesting, but the farmer is the owner of the farmland, however, does not physically work directly on farm. The number of such contractor-type farmers is increasing in Japan due to no successors. Agriculture in the high-tech and information era has the potential to significantly increase the entry of industries from completely different original sectors that are not closely related to an original agriculture [17].

This plan is now going under trial for future extension and now being accepted by hundreds of aged farmers who have no next generation successors in some regional area.

In this system, they have one private sector company expressed above as the center or organization to take care of those aged farmers' farmlands not in use and left abandoned for them which is a similar organization to the Farmers Cooperatives. Famers those who are mentioned above have their farmlands, but they can't work physically any more due to aging. However they have no need to sell them. Farmland is one of the precious properties for them. In the future those farmlands may be happily purchased with higher price by the local government in case of new city/rural area development plan is officially announced. This is the reason why most of the aged farmers insist to keep and own the farmland in spite of no successors.

On the other hand, the completely new or originally different industry from agriculture and the related sector would like to join and expand the new market in agricultural sector business. Not only TOYOTA, but also the other industries which are originally different from agricultural sector are actively trying to find and actively join the IT, Information Technology and IoT, Internet of Things based new agriculture business. This is one of the characteristic, but common trends and examples of industries how they can do it easily without owning any farmlands. It can be obviously found from this background that:

1) Any different kind of industry from agriculture can join the agricultural sector business without owning any farmlands, but IT and IoT instead.
2) They can provide the technology and farm management system for whole season farming and production based on the contract.
3) Aging issue of farmers and next era successor growing and development may be solved, however the agriculture promotion must be also achieved along the right way targeting the highly motivated future farmer resource development equipped with higher education

The following shows the framework structure and function of Good harvest plan proposed by TOYOTA.

Farmers can contact and request the company / organization to send the professional operator with machine to complete the requested operation. Of course the farmers pay the equal amount of fee to the company. They have a contract in the beginning of the season. This is one of the contract based farming. Crop can be grown up and managed from the beginning up to the end of the cultivation. Even while the crop is growing, the farmers can monitor and know how their crops are growing through the photo taken by drone and think what they should do. This is one of the examples to see how IT, Information Technology and IoT, Internet of Things make any other various industries to join and find new business opportunity even though they are completely different from the original farmers.

E. Animal Factory

This is an animal version factory of a plant factory. The target livestock are dairy, beef cattle, pig farming, and poultry farming, but unlike growing in a limited space, this is a project to give time to walk around freely in a wide space and to carry out breeding management of livestock with high quality meat. Individual livestock animal management such as beef cattle, daily cow etc. using small device and equipment incorporating information and communication technology is extremely needed. The necessary information is sent as data from sensors attached to dairy cows and beef cattle grazing in the pasture to the central center and used for individual health management.

One micro chip memory or the ID tag is embedded or clipped to each individual livestock animal. It has not only the memory function, but also the one as the sensor for gathering and sending the data as the signal to the central data acquisition station too. While the herd of animals are released in the pasture outside the stable, they walk around freely here and there looking for eating grasses. The embedded micro chip can be used so as to play a role of ID (Identification Card) and sensors, therefore, all the biographical data such as the place of birth, how old it is now, how it was grown up by whom (livestock animal producer) after it was born are installed in there. In addition, the various dynamic health data can be gathered and sent as the telemetry signal to the central data station. Those data are heart pulse, momentum calculated by use of the data obtained from the small sensor similar to the pedometer function, body temperature to find and know the abnormal health condition such as fever, total walking distance and its motion trajectory which can be calculated and processed from GPS signal. On the way back to the stables, the weight of each individual animal can be measured by guiding and passing livestock one by one to the place where the load sensor to measure the weight is buried. The exact three dimensional shape data (weight, length, width) of individual livestock animal can be automatically measured too.

All the gathered data are stored in both of the memories installed in the embedded memory chip and the device set at the central data acquisition station. Those data can be also used in traceability system to ensure the safety and security of food.

F. Beef Traceability

It was already mentioned above how important the mutual liability between producer and consumer. Food

security has four important keywords such as 2QSL consisting of Quantity, Quality, Safety and Liability. One of the most important problems, but difficult one to negotiate, is the mutual liability issue. No matter how famous and well-known companies are, if they do not manage well, they will disperse false information. They can cheat the place of the production, fake the contents of the product, rewrite the expiration date, and do embarrassing acts without hesitation. The other three conditions except mutual liability are relatively easy to clear and satisfy. This is because there is no problem as far as the standard code level is cleared.

As already mentioned above, all the data related to the individual animals are stored in the memory and uploaded on the website / homepage normally prepared by the producer side such as farmers and shops, therefore any consumers, as well as customers seeking beef, can obtain all the information about where the beef in front of them was produced and how it was brought to this place. Standard code varies slightly sometimes depending on the locality and the shop. Barcode and QR code (registered trade number: 4075066) which is the abbreviated expression of Quick Response developed by DENSO Corporation Ltd, Japan is normally mounted on the package of final products. The consumers can obtain the information easily and make the final judge and decision whether to buy or not. The shops and producers should know the standard, because they must be responsible for the product safety especially for food products because it leads to the fatal problem. Even in car manufacturing industry, the product liability is the first priority to consider as well. One of the most important and difficult issues to control is the mutual liability between producers (shops and farmers) and consumers. Some of the shops put the fake label for the purpose of cheating the consumers intentionally caused by the poor management. Once this happened even accidentally, it takes longer time to get the trust and same level of liability as they had before. The issue of product liability should be seriously considered with first priority always. This is because those accidents lead to fatal injuries and even fatal accidents.

The meaning of food security consists of four factors expressed simply with 2QSL. This abbreviated representation shows the capital letter of the four factors of 2Q (Quantity and Quality), Safety and Liability.

Of these four factors, the most difficult to control is 4. There is no problem if the other three meet the set standard values, but it is difficult to express mutual trust between humans numerically, and the level varies from person to person even in case of satisfactory level mutually. Only one of the ways at this moment to secure the safety and to deepen the mutual liability is to accumulate the mutual trust honestly. The name value is also created in this way. Therefore, once the act of losing trust was done, it is difficult to reestablish mutual trust. With the rapid increase of human population in the world, food issue must be one of the most serious issues.

Even now, about 1 billion people in the world are facing food conditions that are insufficient both quantitatively and nutritionally. Traceability is one of the issues that should be considered immediately from the viewpoint of food distribution including the food crisis. It is necessary to ensure sufficient food supply to be reliable more than sufficient production, supply and safety. The author would like to emphasize here the importance of food safety and security in order to make Asia, a resource oriented country, the world's food pantry. The author strongly hopes that by introducing here what kind of situation the effective technology for that is currently in, it will lead to the further importance and solution of the problem.

The reason why the author would like to emphasize the importance of food issue can be summarized again as follows.

1) Food production should be increased due to the rapid increase of human population
2) Asia has a lot of potentiality to make it possible however there are some problems in safety and quality control of the final food products
3) Safe and reliable food must be supplied always
4) Traceability can provide more transparent information related to food safety and liability quickly and exactly.

G. International Collaborations

Asia can be qualified as a world food pantry in production and supply, however, farmers are still working in poor conditions due to various problems such as family labor and low income mainly caused by small scale farming. The ASEAN community based international collaboration is really needed in technology transfer and human resources development. Technology oriented countries should join and actively invest in Asia for further economic promotion and regional peace keeping. The author is making a proposal named FFA (Future Farmers of Asia).

V. PROJECT PROPOSAL

A. Asia Food Project

Asia is one of the huge agricultural production regions and most of the member countries belonging to the ASEAN Economic Community (AEC) are more or less dependent on the individual national economy obtained from agriculture. The agricultural production is extremely high in Asia as a whole, producing an amount comparable to that of the world food pantry, however each farmer has the following characteristics. Most of these characteristics are problematic in reducing the attractiveness of the agricultural industry, this is, their recognition as unattractive industry, and constantly relying on subsidies and support from the central government, which encourages young generation people to leave agriculture and succeeds. The factors that hinder the promotion of agriculture itself are listed as follows.

1) Small-scale farming, 2) Family labor, 3) Low income, 4) Hard work, 5) Aging, 6) Working poor

Figure 12 shows the Asia Food Project scheme and concept. As already explained in Figure 4, this project consists of the collaboration between two types of country groups: one is ASEAN community, which is a resource-oriented country group, will provide resources, and the other group is ASEAN plus 3, which is a technology-oriented country will provide technology. Then both groups will work to create and develop good cooperative and competitive relationships with each other. Technology-oriented countries send experts to this project. Experts should be carefully selected and registered referring to the program contents.

Firstly, the project has to push up Asia to the world's food pantry that enables massive production and supply at a level enough to respond to the world's food supply and demand in a timely manner. Once that goal is achieved, the next step will be a development and creation of the reliable Asian food brand product that can guarantee safety and liability between producer and consumer. As a result, both of the stable agriculture and economy promotion can be achieved, and the sustainable stability of regional peace keeping in Asia can be maintained. In the way of process, technology transfer and human resource development will be carried out in parallel. The main purpose of establishing a community is to deter war between community member countries. Cooperation and competition are necessary for mutual encouragement and prosperity. If the spirit of collaboration and competition among member countries disappears, the interdependence will be increased, which will hinder the operation of the community. This spirit is also necessary to prevent excessive dependence on other countries. If the two promotions of agriculture and economy can be stably managed and maintained, the development of the community will be well promoted, and the mutual prosperity of both technology-oriented and resource-oriented countries will be achieved, and the win-win relationship will be built up as a result.

Figure 12. Asia Food Project scheme

It can be therefore summarized and concluded from the discussion mentioned above that the ultimate goal is the sustainable development under coexistence and co-prosperity of Asian countries. In the process of reaching the final goal, the project has to make Asia the world food pantry firstly and to develop Asian brand food products secondly that can pave safety and security for economic promotion and stable maintenance of regional peace keeping. In the process of reaching this level, technology transfer and human resources development will be carried out in parallel in Asia Techno Farm Initiatives program.

Figure 13 shows the framework of Asia Techno Farm program consisting of three bodies: 1) University, 2) Government and 3) Industry. Those three have their own roles to play jointly to make the program fruitful and successful. They are explained as shown below.

① University

One of the universities offered the project (program) should be approved and appointed as the Asia Food Project organizer to be responsible even for taking care of Asia Techno Farm program management and operation. University farm or experiment station should be provided to be used as the demonstration site, research experiment site and practical cultivation site for growing FFA (Future Farmers of Asia program). FFA program participants are requested to experience the practical rice cultivation for one season from planting to harvesting taking about four months

② Government

The relevant government ministries and agencies will investigate the project proposal applied and submitted by the universities carefully and make a decision to issue the budget allocation, and notify the approved university of the examination result of project application. Some additional comment and advices may be added if they have.

③ Industry

In promoting the project and program, the participation and cooperation by the related industries should be requested, especially for machine trouble shooting and maintenance with the spare parts supply. The related industries are strongly requested to join and provide equipments, and one staff for covering the above mentioned correspondence to various things. Industries are also requested to provide the secondhand equipments as the teaching materials in case. It is desirable if one staff is resident and is always on standby to prepare for problems. Special benefits should be considered instead for the cooperating companies.

The main purpose of the Asia Techno Farm Program is to train farmers who can lead the next-era agriculture using advanced technology. Agricultural income is limited on a small scale, and it is unlikely that it will be able to compete with big scale agriculture in the world market.

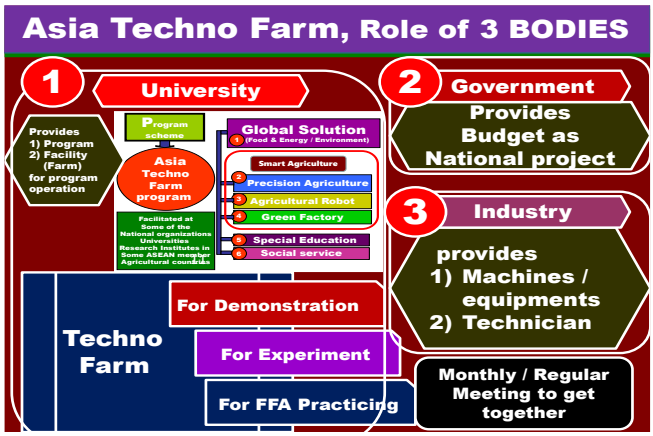

Figure 13. Asia Techno Farm Initiative program

This program focuses on precision agriculture, robotics, and green (plant) factories. It is important to train next-generation farmers in consideration of large-scale farming. Participants are not necessarily limited to Thailand, but considering the acceptance of applicants from ASEAN countries. The mutual collaboration among the member countries of the ASEAN Economic Community can be promoted. English is the common official language aiming to configure a human resources network not only in Asia, but also worldwide toward the future from the viewpoints of internationalization and globalization.

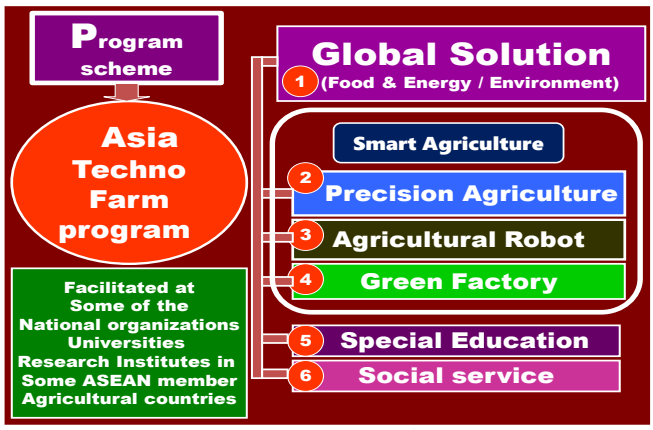

Figure 14. Further detailed program contents of Asia Techno Farm project

The initial goal can be therefore achieved by promoting agricultural mechanization equipped with highly advanced technology considering the farming scale shift from small scale to larger scale due to the upper limit of production from small-scale farming. This is however not to provide the part-time job for small scale farmers to increase the low income, but to achieve the goals shown below fostering large-scale high-tech based farming.

1) Make Asia the world food pantry
2) Create Asian food brand with originality
3) Promote economy and agriculture through the above two processes in addition to maintain the stability of regional peace.

Asia Techno Farm program has several fields and functions as shown in Figure 14. Smart agriculture consisting of three main technologies (precision agriculture, robotics and green factory) are already mentioned, therefore the other three divisions are explained here.

①Global solution

Lectures on global issues are provided and given not only related to agriculture, but also the others such as food, energy, environment caused by poverty and hunger, food residue, agricultural waste, disaster, waste management & treatment, haze issue, ocean pollution due to abandoned plastics, flooding & land slide, release of heavy metals, mass spraying of chemicals (pesticides and herbicides) etc.

⑤Special education

This division is prepared for teaching the additional technique something like the ways how to connect smart phone to the various equipment and sense, measure, monitor, process the signal and gathered data. The skills of regular and final report assembly and presentation material making are taught. Formerly as far as concerned with the training program of machine design for example, the black smith skill was taught first and ends at the level of learning how to use CAD, however, the era changed completely and it is still changing due to new technology innovation day by day. More compact, faster, big data processing capacity handy device development can make it possible. These are now being applied to new era agriculture. The era has come in which even amateurs who has no experience can join and start agricultural business, but some training program should be prepared to educate even the young ones to make them familiar with actual application of knowledge and skill usage for farming. In the information era, advanced knowledge of technology and skills are acquired and it is certain that even amateurs who have nothing to do with agriculture can join the agricultural business. It is however necessary to invest the necessary amount of the capital. In addition, it is really difficult and impossible to provide the technology and financial support to all farmers individually, therefore here introduces one idea on how to change and improve the current situation of Asian agriculture and proposes concrete countermeasures.

1) Most of the farmers can't work physically on farm due to aging. In case of Japan the average age of a farmer is about 65 years old. This background is also an example of the participation of the IT industry such as Good Harvest Plan in the agricultural sector. By the way, who will get more benefit in this case, farmers or industry? For further promotion of agriculture, next era farmers should be grown up, who must be highly interested and motivated to be a farmer equipped with pride and dignity to the profession as the farmer.

2) High technology is developed and innovated day by day, however they don't know how to apply and use them for farming. Even in case of high tech equipment such as smart phone connectable to many of things through internet.. It looks extremely hard for aged farmers to learn and use them on farming, who can't work physically any more.
3) In addition, they require the investment, however, they don't have any extra money to buy those high tech mounted machine and equipment due to low income
4) The new project should be therefore proposed focusing on youth motivation and considering the above mentioned troublesome situation

The Future Farmers of Asia Initiative project proposed here is mainly aiming at the trainer training / development, who can be qualified as the leader enough to transfer those high technologies and apply them to actual farming. The support to all individual farmers should be separately considered because of the reason as shown below.

1) It takes longer time and difficult to consider and take care of all aged farmers.
2) The issue of farmland ownership involves many complicated problems legally under different conditions of individual farmers
3) The highly motivated young generation should be targeted for growing FFA. They are already familiar with those high-tech equipments and devices on a daily basis
4) The target under consideration is neither an individual farmer nor an individual country. That is to train and grow technical leaders first in the region of ASEAN Economic Community.
5) The regional agriculture and economy should be promoted for regional peace keeping by making Asia the world's food pantry as already mentioned before.
The poverty is one of the obstacle factors for regional peace keeping.
6) Agricultural promotion can't be achieved by supporting individual farmers only. By promoting the economy centered on agriculture in the regional community, it is possible to promote cooperation and competition among the participating countries and maintain and stabilize agriculture, economy and regional peace.

Aged farmer has difficulty to follow the high-technology based agriculture, however, the young generation can do it easily with pleasure. On the other hand, in this division, additional curriculum is offered for the farmers especially small scale farmers who would like to actively to change the job from agriculture to the other industry. Active recommendation and guidance to those farmers is also one of the ways of income increase for them. In addition the full-time farmer will get more opportunities to have their farmlands for large scale farming. Reducing the population of small scale farmers makes opportunities for full-time farmers to buy those farmlands for farming scale expansion. Guidance and future possibility on how they should do are advised including the problems to encounter and overcome, the way for negotiation etc. Farmers are however not forced to change the job and the decision making depends on their own will. Only in case they have strong intention to scale-up or change the job from agriculture to some other sector, they are advised and guided.

The statement mentioned above may be misunderstood too. Further description is therefore added here as follows. The situation is different depending on the countries even in Asia. Especially in Thailand the farmers (farmland owner) are not allowed to leave the farmland left abandoned without cultivating any crops. If they do so, they are imposed to pay tax and fine, however, the government controls rice farmers not to grow rice due to the over-production of rice in Japan. The farmers are forced to submit the cultivation plan not to cultivate rice in the beginning of the fiscal year, but they are allowed to cultivate rice just for the purpose of farmland conservation, not to get income from rice production. Farmers are not allowed to harvest rice for this purpose. It should be cut away and treated as "not food", but just for maintaining the land as paddy field. Certain amount of subsidy had been paid instead to cover the income reduction due to this cooperation to the production control. The government officer come to visit farmer and inspect the site one month before the harvest season how the farmer treated rice giving the question of "Was rice treated suitably as "Not rice for food". The purpose of policy enforcement is to keep the income of farmers as the original because overproduction of rice lowers the price of rice. In order to keep farmers' income high, rice production is curtailed, and the government will cover the income that is reduced by production control with taxes. The market principle does not work under this circumstance. Not only that, in addition to criticism from taxpayers for how to use the taxes they paid, farmers' pride in the profession of agriculture and declining motivation have resulted in a situation where the future successors do not grow. Basically, long-term production control policy cannot be continued for a long time by private companies. It is a stupid policy that can be done only by the government using public subsidy funds (tax).

In general, it is common sense not to take production control policy in the situation of overproduction, but to respond by expanding consumption, developing new products, and new markets development. The production control policy has been continued over than a half century, therefore, most of the rice farmers were spiritually discouraged and they have no more hopes to grow next era successors. Almost more than 400 thousand hectares of paddy fields are not cultivated and left abandoned in Japan even though the country is very small and the food self-sufficiency is less than 40 %. The full-time farmers are only 15%. The rest of 85% of the farmers are now part-time farmers. Full-time farmers are increasing their farming scale

by contracting to rent the farmland of small-scale farmers who have difficulty in continuing agriculture due to the aging population and lack of successors. However, since the agricultural land is not accumulated and scattered all over the place, the transportation of machines and the delivery of the agricultural land to the leased agricultural land are problems.

Part-time farmers look mostly satisfied enough because they can get the regular salary monthly from the part-time job, even though they are not paid so much higher, but they can purchase the machine to take care of their farmland maintenance enough. The increase of part-time farmer by providing the part-time job makes the small scale, low income farmer rich enough to buy the machine of their own for taking care of their family such as the education of their children. Most of the part-time farmers are satisfied well with such a daily life, therefore they have no need to sell their farmland and change the job. This situation was caused by the governmental production policy implementation. It can be clearly found from this act that it is important and necessary to support farmers and make them rich financially, however no good results couldn't be brought as expected. No promotion of agriculture couldn't be achieved even they became rich in economy even in the future as far as the same situation is continued. The main point of this paper is not to repeat the same thing again as we learned from this policy enforcement and show the direction which way we should lead and guide the Asian agriculture and grow the Future Farmers of Asia. Fortunately Asia has a lots of natural resources (including food resources) and higher potentiality to produce and supply to all over the world. It is extremely important from the food issue viewpoint due to the world population increase that we should take action immediately to achieve the final goal to transfer the technology which is competitive in the world and to grow human resources (FFA) equipped with higher education.

Japan is well known as one of the technology oriented countries, however, agriculture is not an attractive job and profession for young generation.

The author believes Asia has higher possibility in agriculture, and cooperation and competition between technology oriented and resource oriented countries can maximize its potential towards the future. Time is limited and sooner is better to be ready for taking action to the upcoming food issue caused by the rapid human population growth.

⑥Social service

After the successful completion of the program, the official certificate should be issued. This is the division to take care of those matters. Required documents for official approval, certification and authentication can be prepared and issued if needed.

C. Future Farmer of Asia growing Program

Figure 15 shows the FFA growing program scheme and content. As already mentioned, Asia is one of the huge agricultural production regions in the world. A big amount of food resource is grown up, however, the quality of them is not highly controlled. The value can be added more if it could be controlled in addition to food security. The most important point to keep in mind is to promote the regional agriculture and economy, not to increase the farmer's income.

The summarized content of the FFA growing program is shown in Figure 15. The total length of the training is set around six months including the one month orientation and final wrap-up. Participants are normally accepted not only from Thailand, but also from ASEAN member countries. Acceptance of trainees (participants) from ASEAN member countries basically requires a letter of acceptance from the host country's national government. The cost of acceptance will be borne by the recipient. The target crop of the program is mainly rice since rice is a typical staple food crop, and more than 90% of the world's production is cultivated in Asia. In Thailand, rice can be possibly cultivated two to three times a year, therefore, the stable production and supply can be possible. Even Data collection in rice cultivation tests can be also possible at any time of the year. This is also one of the characteristic merits of rice cultivation in tropical region.

Figure 15. Future Farmers of Asia growing program scheme

Participants are requested to cultivate rice for one season. The purpose is to learn practical skills how to grow it as one season experience. Bi-weekly or monthly report submission is also requested with short time presentation should be done at the regular meeting. Lecturers are invited for delivering the lectures during three to four days per one time invitation. The lecturer has to stay about one week per one time invitation. The rest of two to three days should be spent together with the participants to visit site and discuss on the related topics. This is a valuable opportunity even for the lecturer to know more Asian agriculture and to deepen friendship with trainees. The total number of lecturers will

be around 20 or so. The ratio of the invited lecturers from outside Thailand to inside will be around 60% to 40% or so. Further discussion should be done on this matter referring to the curriculum. The lecturers may be invited from university, research institute, industry, in which they are working actively as the professional, expert, engineer, specialist etc.

D. Workshop holding

Figure 16. Workshop on Precision Agriculture for Thailand 4.0

The workshop on precision agriculture and agricultural machinery industry for Thailand 4.0 was organized and held by Ministry of Science and Technology, on September 19-20, 2017 as shown in Figure 16. The author was requested to contact and arrange the invited speakers. The field demonstration was also conducted by the participated industries using their products

E. Similar training programs in the past

Figure 17. Joint Group training program by JICA and NPO

JICA, Japan International Cooperation Agency, the Government of Japan initiated the group training program focusing on two courses: 1) Rice mechanization and 2) Machine design. Around 15 participants were accepted based on bilateral agreements between partner and host countries. Participants stay almost six months at the accommodation provided by the host country. They were requested to join the lectures and field training of rice cultivation for practical experience and skill-up. Study tour program to visit the various organizations such as university, national research institute & experiment station, government organization related to the course requirement. Two to three days home stay program at Japanese rice farmer was also involved to know not only rice mechanization, but also the daily life of rice farmer. For home stay program at local farmers, the official support was obtained by the city government and agricultural cooperatives.

F. Hopeful possibility for hyper-low cost rice production

There are two planting ways in existing rice farming, however the acceptance ratio of these two planting methods varies depending on the following factors such as climate, locality, labor force hiring costs, and technical liability. In Japan, almost 90% of rice is transplanted, whilst in Thailand the ratio of transplanting to direct sowing is 50% to 50%. The reason why the transplanting is more widely accepted than direct sowing is that the following problems have not been solved yet in direct sowing. They are 1) bird attack to the seed sowed at the ground surface of paddy field, 2) lodging problem by strong wind while growing, because the sowed seed is uncovered with soil and exposed, and 3) weed control. Seed coating by CaO2, calcium peroxide is to provide oxygen to promote germination and improve its percentage under submerged condition in the soil.

Figure 18 shows the coated seed with CaO2, which produces oxygen reacting with water. The ferrite, Fe2O3 can be also used as coating aids for precision seed sowing, because the ferrite coated seed can be used for seed detecting by use of magnetic sensor, therefore the number of seed can be counted per unit time and area. Seed population density sowed per unit area can be easily calculated while the operation is going on and monitored for the planting machine driver to see. It looks that the coating technology has higher potentiality in future as follows. The main purpose of coating using CaO2 shown here is to provide oxygen for promoting the germination and increasing its percentage. The coating with Ferrite (Fe2O3) has the other merits such as additional weight increase of seed to penetrate into the soil, precision sowing by sensing, counting and monitoring the number of seed for the machine driver to know how many seeds are being sowed etc. If the other functional aids like herbicides, pesticides, fertilizer etc. could be possibly coated, the rice cultivation process will be drastically simplified. The direct sowing of those coated seeds by drone will be one of the near future hopeful technologies.

The problem of direct sowing of rice is 1) weed control, 2) bird attack and 3) lodging in order of importance. Just only

two weeks after seed sowing is the most important duration for the farmers to be nervous wondering if the seed is germinated and sprouted enough

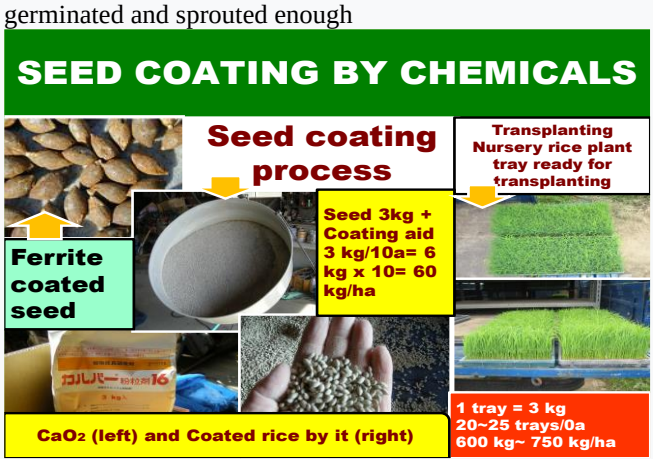

Figure18. Coated rice with chemicals, CaO2

Figure 19 shows the rice combine equipped with direct de-husking function under harvesting operation, which can de-husk the rough rice directly as soon as the rice is harvested and threshed.

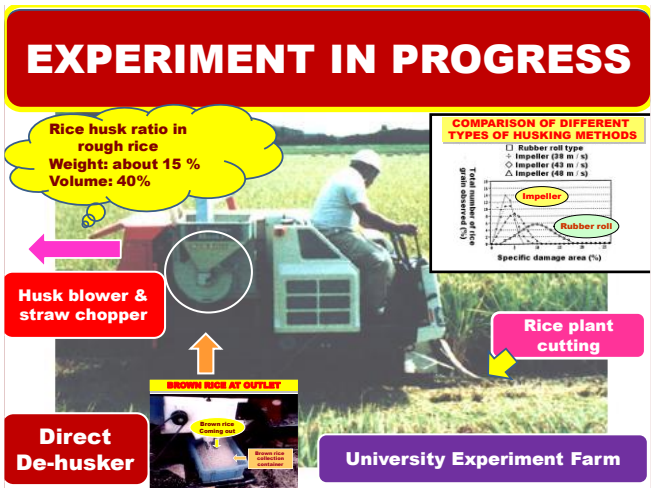

Figure 19. Combine de-husker under harvesting operation

A series of three operations consisting of harvesting, threshing and de-husking can be done in one pass operation simultaneously even high moisture rice. This research was conducted and reported long time ago by the author, however the commercial product is not coming out yet due to the small injury on to the brown rice caused by the impact of impeller rotating at high peripheral speed of 32m/s. The impeller type de-husker is coming to see often at exhibitions mainly focusing on the compactness, maintenance free and simple mechanism and structure as the rice de-husker.

In the future, the possibility of extending these two technologies is extremely high due to the simplification of agricultural operation processes, energy saving, labor saving, and ease of material handling [18].

In the past, the indicators of machine development for agricultural mechanization were 1) energy saving, 2) automation, and 3) safety. There are some overlaps among these three indicators, but basically it starts with mechanizing the basic agricultural operation that is the principle. The general process is to reduce the number of operation process, simplify, perform simultaneous or serial operation, and improve accuracy by automation, and the technology described here is one of the possibilities. In order for technology to be installed in a commercialized machine, it will not be put into practical use or commercialized at once unless some related technologies surrounding it are in the same level of situation and environment. As we already know, it is important to identify problems and investigate their causes. Needless to say, the social needs of the technology are also one of the major factors for technological development, commercialization, and dissemination.

VI. CONCLUSION

Global tetralemma is a common issue not only in Asia, but also in the world, and these issues must be resolved urgently. Asia is qualified as a world food pantry capable of producing and supplying huge amounts of food. Although the production is however large, the quality of the products is not well controlled. From the perspective viewpoint of food security due to the rapid increase in the world population, technology-oriented countries should actively invest in Asia through technology transfer and human resource development. A collaboration in which technology-oriented countries provide technology and resource-oriented countries provide resources is effective in solving mutual common problems. In other words, avoidance of food crisis, escape from hunger and poverty, and promotion of regional economy bring regional peace keeping and its stability. Agricultural policy is not about providing farmers with financial support to increase their income. It is more important to have a policy to strengthen the agriculture rather than supporting farmers. If such a policy is continued, there can be no promotion of agriculture. In Japan, a rice production control policy was implemented for half a century, but, as a result of that, agriculture has declined significantly rather than being promoted. Although the aging of farmers will come sooner or later, looking down on the agriculture industry has brought about a serious situation where young successors are not interested in continuing in that sector. Given that industry is production-based, production control is not an option. Rather, the basic principle is to focus on developing new markets and increasing consumption. Food is an indispensable resource for human survival, and the prosperity of agriculture-based Asia is important and necessary not only for Asia, but also for the world. Rice cultivation system consists of basically three operation processes such as planting, managing rice plant while growing and harvesting. The existing rice

cultivation system can be reconsidered for further improvement to cost down by the replacement of planting method from transplantng to direct sowing and the introduction of combine harvester equipped with rice de-husking functional mechanism that enables the threshing of high-moisture rough rice. This combine has the function of processing the three operations of rice harvesting, threshing, and rice hulling at the harvesting stage, further facilitates material handling and saves labor. There can be seen a high possibility that the shift to a system that aims to save energy and achieve hyper-low cost production of rice is high.

Due to the preference of consumers who dislike brown rice with tiny damage and injury caused in the hulling process of high-moisture rough rice, it has not yet been commercialized. It should be hurry to set and clarify the criteria for the damage rate standard code of brown rice. From this point of view, the machine equipped with this de-husking function has been focusing on the production and utilization of processed rice for a while and still some more time will be needed to be ready for the acceptance environment [19].

IT, Information Technology and IoT, Internet of Things based high-tech agriculture provides the opportunity for many various kinds of industries to join and invest in agriculture. Regional community-based agriculture should be promoted in Asia instead of small scale farming.

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