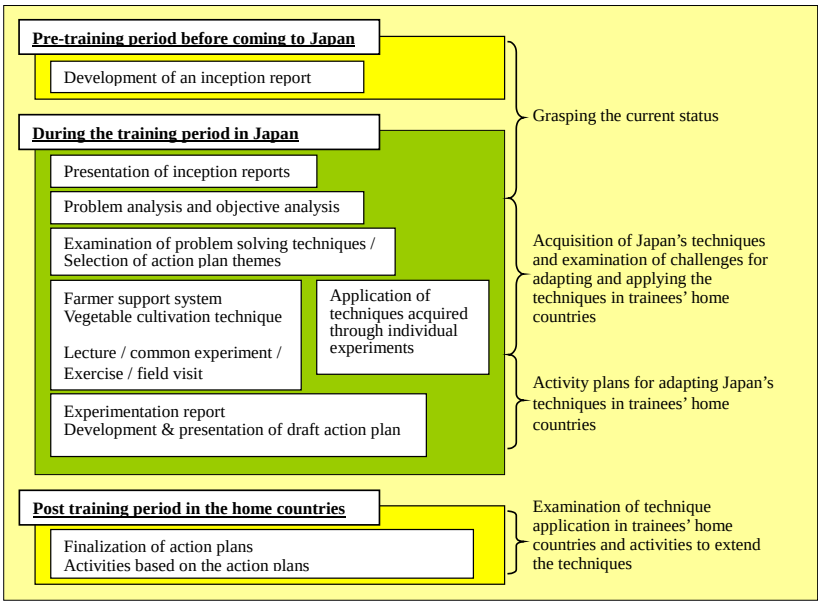
Are Japan's cultivation techniques and the wisdom of creative Japanese farmers applicable?
– Case study of training activities at Tsukuba International Center -

Part 1: Introduction

The objective of the vegetable cultivation technique training course in Tsukuba International Center (TBIC) is to develop human resources that will establish and extend vegetable cultivation techniques in their native countries, acquiring and adapting the comprehensive techniques of vegetable cultivation in Japan. The AAI, through our long years of experience in supporting farming, land use planning and agricultural extension activities in developing countries, believes that experiments and research for appropriate techniques in developing countries and improvement of practical capacity of technicians, who communicate the experiment and research results to farmers at local level, are extremely important. Therefore, we develop training curricula which present Japan's cultivation techniques systematically, including their development processes, and facilitate trainees to be able to acquire as many of the techniques as possible. We also provide many opportunities to be exposed to the techniques of creative farmers, in order for the participants to learn how individual farmers devise and incorporate various techniques in their farming practices in a different environment.

Japan's cultivation techniques, which are the core of the training curriculum, are scientific and rational techniques and skills, as they are results of rigorous research and experimentation at national and prefectural institutions. This means that even though environmental conditions differ from country to country, by appropriately applying basic scientific theories, good results can also be obtained in developing countries. On the other hand, the techniques, wisdom and knowledge of creative farmers are technological systems formed under particular environmental conditions, and they are often dependent on individual skills and capacity. However, it is still hoped that the views and thinking of experienced farmers will provide useful clues for problem solving in developing countries.



Conceptual Diagram of the Vegetable Cultivation Technique Course

If problems in developing countries are merely due to insufficient technology, they can be solved by the transfer of advanced technologies. However, in reality, problems tend to be much more complicated. Issues surrounding agriculture in trainees' home countries differ and therefore one cannot simply apply Japan's techniques and the wisdom thus acquired in the training courses in their own countries. In order to be able to utilise acquired techniques, it is necessary to select techniques that fit in local situations and circumstances and apply and adjust the selected techniques accordingly. In order to make it easier, in our training, we avoid one-way communication about Japan's techniques. Rather, we start with the compilation of an inception report by the trainees, introducing the characteristics of agriculture in their home countries and introducing the structures and activities of their host organisations. The training also includes individual experimentation to find appropriate techniques to solve problems that each trainee's organisations are facing, as well as conducting collective experimentation to enhance trainees' understanding on various cultivation techniques. Furthermore, participants develop action plans to prepare for the application of techniques they have learned in the training in their own countries. Through this series of training, trainees try to acquire techniques and theories that have application in their countries.

We have introduced these efforts several times in AAI News. However, we have not touched upon the details of Japan's techniques that were taught in training courses. JICA's agricultural technique training is provided not only in Japan, but also overseas in the form of development survey projects and technical cooperation projects. From this perspective, it is beneficial to share information from Japan and oversea training activities, likewise the sharing of information between different training activities. Therefore we think that introducing cases in Tsukuba could provide useful clues to various activities overseas. In this series, we will first introduce problems trainees face in their own countries and examples of Japan's techniques that can be applied to tackle and address the problems. In addition, we would also like to introduce local activities by our trainees in their home countries, and examine challenges in extending Japan's techniques overseas.

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Part 2: Introduction of grafting techniques to prevent soil borne disease of tomatoes

In the first part of the series, we introduced basic efforts of training courses at the JICA Tsukuba International Center (TBIC) and approaches to teaching Japan's cultivation techniques to trainees from different countries each with their own unique problems. In the next few volumes, we are going to introduce Japanese techniques which we actually picked up during training courses. In this part, let us introduce an example of a training course in 2007 provided by a trainee from the Philippines, which focused on grafting techniques.

Grafting exercise at TBIC

This trainee was working as an agricultural technologist. Her job was to provide guidance to vegetable and fruit farmers on the introduction of appropriate varieties that are suitable for the local environment, basic cultivation methods, and the introduction of environmentally friendly methods, using biological control or plant extracts, for preventing crop damage by blight and insects. According to the trainee, in the Philippines, although farmers use a large amount of pesticides, the yields remain low. In particular, it was found out that tomatoes were suffering severely from soil borne diseases and measures against wilt diseases were urgently needed. Therefore the following Japanese techniques as countermeasures were introduced and their applicability in the Philippines was investigated.

Observing grafting at a farm

a) Introduction of crop rotation for lowering density of bacteria
b) Introduction of disease resistant breeds
c) Improvement of fertilizer application techniques to move away from over application of nitrogen
d) Grafting using disease resistant stock
e) Disinfection of farming plots

Grafted sapling

As a result of research, it was concluded that the grafting is a useful technique that can be extended to farmers in the Philippines. It was decided that grafting using disease resistant stock plants become the theme of individual experimentations and that confirmation of specific effects and issues for extensions will be sought.

First of all, we tried to make the trainees master Japanese grafting techniques for tomatoes using special grafting clips and tubes which are commonly used in Japan. Then, we introduced how farmers had used to use Japanese paper or thin lead plates (fishing rod weights) before specialized materials were developed, so that the trainees could be provided with information for extension activities after going back to their country and so that they could learn that, with a little bit of innovation, it is possible to work with grafting without specialized materials in the Philippines. We spent time making people understand some key points and tips for grafting. For instance, it is important to adjust seeding timing in order to make the scion and stock plants compatible sizes. It is also important to do the work quickly under shade so that evaporation from the young seedling will be minimized. Efforts were also made to provide the trainees with experience and sound comprehension on how important it is to retain humid environment and adjust temperature during the first 3-4 days from the day of grafting, as well as to adjust lights from the early stage to promote growth. In addition, we ensured that the trainees mastered grafting techniques through seeding, grafting and injection of bacteria with an aim to evaluate stock plants of eggplants and tomatoes which are used to avoid soil borne diseases that are causing an increasing number of problems in the Philippines. Simultaneously, these experiments and exercises were useful for the trainees to confirm the effectiveness of disease control.

The challenges that grafting technique extension work in the Philippines face include how to avoid stocks that have negative influence on fruit quality and harvest volume. This issue involves the question of compatibility between the stocks and scions. Another challenge is to secure suppliers of well performing eggplant stocks. In addition, investigation into the financial burden of grafting and the establishment of technical training methods for grafting and naturalization are also important tasks that need to be tackled. Taking these challenges into consideration, trainees developed an action plan for conducting follow-up experimentations in the Philippines - a project which is also envisaged to serve as a demonstration. Considering local application after returning to home countries, a comparative analysis of the "tube grafting" method which was used in individual experimentation sessions, and the "yobitsugi grafting" method would be required. We are planning to continue to provide information on these techniques as part of our follow up activities.

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Part 3: Should we plant a whole potato or cut a potato before planting?

In Japan, it is common to prepare seed potatoes three weeks prior to planting. First comes the nurturing process; sprouting in an environment that has a low temperature (10 – 20°C) and strong sun light. Then, before planting, seed potatoes are cut into two or four 50g pieces. The potatoes are normally cut through the apical bud to the apical end, however some large scale farmers use smaller 30g uncut seed potatoes that are planted using a machine after sprouting in sun light. Seed potatoes should normally be 40-60g and if a very small seed potato is planted, it may delay the growth and reduce production. However, it is not guaranteed that a large seed potato will yield more crops.

In high yield cultivation techniques, the quality and size of seed potatoes, as well as whether they are cut or uncut seed potatoes, greatly influence the growth and harvest. Therefore, the vegetable cultivation technique courses include experimentations on harvest amounts from cut seed potatoes and small uncut seed potatoes. They also include lectures on potato cultivation, a visit to the National Center for Seeds and Seedlings (NCSS) in Hokkaido to learn about seed potato production and distribution, and a visit to farms employing machine planting. Advantages of using small size uncut seed potatoes are that one can avoid section work, reduce the danger of virus transmission, and one can machine plant them. However, we tell our trainees that, as it is not necessarily easy to produce small size uncut seed potatoes, it is more common to use cut potatoes. We try to assist trainees in how to choose which kinds of seed potatoes are better suited to them, looking at cultivation size, status of machine use and the cost of production including the cost of seed potato production.

In the training course for Tajikistan, which began in 2000 and was held for four consecutive years, we had experiments for summer/autumn potato cultivation using cut seed potatoes. For the trainees from Tajikistan, it was the first time to encounter the section treatment of seed potatoes. The result of the experiment was beyond their expectation, and the trainees were discussing their plans to cultivate potatoes in their country using the newly acquired method. When Mr. Zaitsu of AAI visited Tajikistan in 2002, he received a report from a former trainee. "We used to plant uncut potatoes, but by cutting seed potatoes, we could increase seed potato numbers and increase the planting area."

Potato cultivation training (Nicaragua)

On the other hand, a Nicaraguan trainee who participated in one of the vegetable cultivation technique courses in 2006, reported the low production of potatoes in his work area. He cited three main reasons for the low productivity. These were 1) difficulty in obtaining seed potatoes; 2) the high price of seed potatoes; and 3) the small number of available disease-free seed potatoes. He also reported that uncut seed potatoes are used in his area. They are imported in 20 kg sacks, and the size of the seed potatoes in the sacks varies significantly. There has been no examination conducted to test the productivity of different sizes of the imported seed potatoes. Therefore, he stressed that it was urgent for him to find out how different sizes of seed potatoes influence harvests and an individual experiment was conducted to look into this. In this experiment, we used four different sizes (20g, 40g, 60g and 85g) of uncut seed potatoes, using a variety called 'Dejima'. We compared stem numbers in each treatment plot, the number, weight and total yield of different size categories of crops (<50 g, 50-100g, >100g). The results were that the bigger seed potatoes sprouted faster than others, had more stems, grew more vigorously and yielded more crops. Seed potatoes in the 85g group had the highest yields. Seed potatoes in the 40g group also had satisfactory yields and this proved that small, uncut seed potatoes, with adequate sunlight sprouting treatment, can be used as a viable seed potato. Based on the results of this individual experiment and as an output of the training course, an action plan was formulated to conduct a similar potato cultivation experiment under the local environmental conditions in Nicaragua after his return, and to share the results with local farmers. We expect that the trainee will be able to provide appropriate advice to local farmers based on the results.

As introduced here, trainees continue to experiment in the environmental conditions in their countries and conduct extension activities, based on what they learned and experienced in potato cultivation technique training courses in Japan. This kind of support will be even more effective if we continue to provide advice through strengthening post-training follow-up support in the trainees' home countries.

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Part 4: Pruning effects can be seen even with the determinate type tomatoes

Fruit vegetables such as Cucurbitaceae and Solanaceae require pruning. There are different pruning methods for different vegetables. For tomato plants, lateral branches are removed from the stem to ensure only one main stem. For eggplants, the lateral branches are removed, except for the two branches that grow from the node below the first flower. Leave the two lateral branches and if they become crowded, remove some leaves. For watermelon and other melons, remove the terminal bud at a low node when there are 4 to 5 primary leaves, and leave 2 to 4 vigorous vines that shoot out from the nodes between the stem and primary leaves. The purposes of pruning are to effectively manage pest control, growth and harvest. Pruning also aims to increase the quality of the products and to shorten the harvest period to intensify the farmland productivity. Some of the expected effects of pruning are; 1) avoidance of overshadowing crops due to crowding; 2) improved work efficiency; 3) reduction of pest and disease outbreaks; 4) timely harvest of a large number of uniformed fruits of similar sizes and quality; and 5) effective use of farming plots. The work accompanying pruning includes a) training of vines and fixing of the stem on support poles; b) disbudding exercise to remove small unnecessary lateral buds; c) in case of watermelons, removal of excess fruits, leaving only two well-shaped fruits, after around four fruits are produced on the four lateral vines; and d) other removal of leaves and terminal buds.

I would like to introduce an individual experiment related to pruning methods for tomatoes, which was conducted by a Samoan trainee this year (2008). The trainee is based at the Department of Crops, within the Samoan Ministry of Agriculture. His work entails technology extension using demonstration plots, problem analysis as part of the vegetable cultivation group activities, investigation into counter measures, and development of work plans. His problems at his work area are the low quality of imported seeds, insufficient production of seeds by the Ministry of Agriculture, and insufficient knowledge of pest control. In addition, due to careless crop management, improvement of crop quality is difficult, which impacts negatively on marketing and new market development. The main vegetables cultivated in Samoa are pumpkin, cabbage, cucumber, Chinese cabbage and tomatoes. Among these vegetables, the biggest challenge Samoa faces is how to produce a large fruit tomato that has a high market value. In Samoa, they grow red large fruit and determinate variety of tomatoes. When the seedlings are transplanted, they are fixed to a short support and are left to grow freely. With this method of cultivation, the harvests will vary in sizes and the total harvest does not increase. Therefore, the trainee examined which cultivation techniques in Japan can be applied to his situation, and then conducted an individual experiment to evaluate the effect of limiting fruit numbers and it's training.

He used a red large fruit bearing determinate variety of tomato that is similar to the main variety cultivated in Samoa. They were planted in a plastic covering house as a shelter from rain, with 75 cm space between each plant and 100cm between rows. The number of fruit bearing branches was limited to two, three or four in different sections. The plants in these sections were trained towards the wire at 1.8 m above ground and one section was for plants that were left to grow freely as is commonly done in Samoa. The result was that as the number of fruit bearing branches increased from two to three, the number and amount of harvest increased. However, in the section with plants with four fruit bearing branches, the yield went down. The highest yielding section among the four sections was the one with plants with three fruit bearing branches. Pruning requires additional work such as disbudding and training. It also increases the cost, as training materials are necessary. However, pruning makes pest and weed control and harvest work more efficient, and makes it possible to harvest in a timely manner and reduce dropping and rotting fruits. We are positive that the trainee was convinced that pruning could lead to improvement in fruit quality.

Given the result of the individual experiment, the trainee is thinking of including in the post training action plan in his country, a plan to cultivate high quality and high yield tomatoes applying the pruning technique. In many developing countries, there is still little demand for intensive use of farmland and for improving market values including increasing fruit quality and controlling the harvesting period. Therefore, fruit vegetables are mostly grown on the ground without support or a trellis. It is considered that pruning techniques will attract attention from now on, as they increase work efficiency including timely harvesting, which in turn leads to an increased harvest.


High quality fruits with the three-branch pruning treatment


It is difficult to find fruits when plants are left to grow freely without pruning


Training tomatoes

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Part 5: Supporting efforts to reduce pesticides use

Since 1992, improvement and development of environmentally friendly agricultural technologies has been promoting in Japan, in order to reduce the use of chemical fertilizers and pesticides. A number of technologies are being improved and developed for application, which include weeding by machinery, use of animals for weeding, use of biological pesticides (natural enemies), antagonistic plants, tunnel culture, pheromones and mulching. This has been prompted by the growing interest expressed by consumers in safe agricultural products. Consumers are aware of environmental risks and producer safety issues posed by excessive use of chemical fertilizers and pesticides applied to increase yields. In the vegetable cultivation training courses held in Tsukuba, technologies to reduce pesticides are introduced, in particular, emphasis is placed on the use of natural enemies as a means of preventing insect damage to crops, as this strategy is considered to be an effective technology to reduce use of chemical pesticides and respond to consumers' expectations. However, the technology is quite complicated and it is difficult to teach the trainees to master it. Through the farm visits, the following examples of the use of natural enemies for pesticides reduction have been introduced to the trainees.

Vegetable	Cultivation Methods	Location	Control Methods	Effects on Pesticide Reduction
Eggplant	Green house	Miyazaki	Bring in *Diglyphus* larvae that are parasitic on *Liriomyaza* damaging string beans.	Use of indigenous parasites on *Liriomyza* that damages eggplant leaves, reducing the pest density leading to reduction of pesticide use.
Eggplant	Open-field	Kyoto	Surround eggplant plots with sorghums to attract aphids which in turn attract parasitoid wasps.	The indigenous parasitic wasps that come to sorghums attach themselves to aphids on eggplant. This reduces pest density and use of pesticides.
Cabbage	Open-field	Aichi	Sprinkle sex pheromones around plots and derange communication between pests and disturb coupling, reducing the pest density.	For eradication of low density cabbage moth (*Plutella xylostella* Linnaeus), indigenous spider species (natural enemies) are used. For other pests, chemicals that nurture natural enemies are used, reducing overall use of pesticides.
Paprika	Green house	Ibaraki	1) Special entrances to the green houses that prevent pests flying in, using insect proof nets and yellow lights which insects dislike. 2) Reduction of pest density using traps with sticky tapes, and prediction of outbreaks 3) Mass release of natural enemies available in the marketplace	Prevent entry of pests through seedlings and facility entrance and control initial outbreak of pests with yellow and blue luring tapes. At the same time, observe pest density to judge the timing for natural enemy release. When the density is low, natural enemy is used for control. Once the density starts increasing, use selective pesticides, reducing overall amount of pesticides use.

In all the examples, it is understood that application of non-selective pesticides could actually increase pest numbers. This is called a resurgence phenomenon and the pest density could be higher than a situation without any application of pesticides. While natural enemies are controlling pest density, pesticides should not be used. Once the pest density starts increasing, selective pesticides that do not harm natural enemies are used. When using natural enemies for pest control, appropriate application of pesticides is highly important.

In 2008, a trainee from Mongolia conducted individual experiments on pest control methods that use natural enemies and do not rely solely on pesticides. In Mongolia, cabbage farmers were troubled by pests such as the diamondback moth (*Plutella xylostella*), the small white butterfly (*Pieris rapae*) and the cabbage moth (*Mamestra brassicae*). As a result of repeatedly applying synthetic pyrethroid, a non-selective pesticide, it has become difficult to control the diamondback moths that are reducing crop yields. In the individual experiments of the Mongolian trainee, four different sections were created in a cabbage plot, and cabbage yields and mortality rates of the moth's 3-stage larvae against the five different pesticides used in the experiment were compared. The result shows that the synthetic pyrethroid pesticides when used repeatedly in large quantities kill natural enemies and lead to a resurgence of moths and an outbreak of resistant moths, which in turn make pest control difficult.

In order to control and eliminate pests, it is essential to establish effective preventative measures for pest control and methods that enable accurate judgment in timing and application of appropriate measures. These measures could include some preventative tactics such as growing the right crops in the right areas, rotational cropping, use of low competitive varieties, selective use of pesticides, creation of desirable habitats for natural enemies with the right temperature and humidity and laying banker plants that lure their prey (pests), and appropriate application of fertilizers. Monitoring of pests and natural enemies through plot observation and accumulation of data and data analysis are critical for determining pest control measures. The combination of different techniques is also essential for reducing pesticide use. It is expected that trainees will learn about the importance of integrated pest management (IPM) from our training, and will promote this approach in their own countries.

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Part 6: Conclusion

In this series, we discussed four case studies introducing Japanese cultivation techniques that exhibited a high application potential in developing countries, in vegetable cultivation training courses at JICA Tsukuba. Trainees experienced and evaluated different techniques at first hand as part of individual experiments, in order to solve problems they face in their countries in vegetable cultivation through applying Japanese cultivation techniques. The following table summarizes the contents of the experiments.

Trainees Country	Problems	Possible techniques	Challenges for application
Philippines	Soil borne diseases affecting tomato cultivation	Grafting technique	Impact of grafting on yield and quality of crops. Training on grafting and naturalization techniques. Economic consideration. Secure supply of high quality stock plants.
Nicaragua	Insufficient availability of quality seed potatoes	Systematic production of seed potatoes and distribution system	Establishment of quality management system of imported potatoes. Testing methods to evaluate appropriate size of seed potatoes. Introduction of extension techniques using model plots.
Samoa	Low yield from free growing cultivation of tomatoes	Pruning and vine training techniques	Labor and costs required for pruning and vine training. Development of training methods for determinant variety of tomatoes
Mongolia	Control of difficult and persistent pests	Application of selective pesticides and rotational use of pesticides	Organized research on integrated pest management and introduction of extension techniques using model plots.

In addition to the above, the training courses introduced other techniques to tackle a variety of problems in other trainees' countries. These included use of *neridoko* (soil mixed with compost and water) nursery beds to deal with low rooting problems in tomato seedlings when planting in drylands in Ethiopia, organic fertilizer production from fermentation of chicken droppings to counter animal waste problems in Kenya, and mulching (silver mulch) to control pest problems in organic farms in Nicaragua. Although the trainees had some knowledge of these techniques, they had had little experience in applying them in their work. In the training courses, we first ensured that the trainees mastered the basic vegetable cultivation techniques. Then they learned application of the techniques from the experiences and wisdom of creative Japanese farmers. Based on the newly acquired knowledge, trainees evaluated and examined the applicability of each technique to their countries' natural and agricultural environment. Naturally, there were a number of challenges that are expected in the process of local application.

Some techniques such as grafting, pruning and training, *neridoko* nursery beds and fermentation of chicken droppings, do not really require any special materials or equipment, therefore they are relatively easy to apply in developing countries. On the other hand, techniques such as use of selective pesticides and silver mulching require materials. Some measures even require establishment of a new system, for instance the case of setting up of production system for seed potatoes, which makes it harder to apply in other locales. A common challenge in applying Japan's cultivation techniques in developing countries is the need for re-evaluating the techniques in local environmental conditions and local circumstances surrounding the agricultural scene. One way to overcome this challenge can be found in the technique extension work which used to be seen in Japan. In this extension system, researchers from national or prefectural governments played an active role in introducing cultivation techniques to farmers. Farmers also communicated their own ideas and innovations that were generated in their daily farming activities. This led to the development of new techniques, and by collaborating with extension workers, technique development and extension work were run in a complementary manner.

The expectation of the JICA training courses is for the trainees, who learned Japan's cultivation techniques, to establish applicable techniques in their countries based on acquired knowledge, and to ensure their extension. Considering this, there should be adequate follow-up support to assist the trainees in examining the necessary plans and modifications for successful application in their countries of the techniques acquired in individual experiments. However, without sufficient follow-up, one cannot see the real results of the trainees' activities after returning to their home countries, making it difficult to gauge the impacts of the training. In order to resolve this issue, it is necessary to couple training with follow-up activities. Moreover, as mentioned in previous volumes of AAI News, another possibility is to strengthen the linkage between the training and other JICA schemes such as technical cooperation projects.

There are many cultivation techniques and wisdom accrued by creative Japanese farmers, which use the resources around us effectively, and many of them can be applicable in developing countries. Our company has experience both in implementation of technical training courses in Japan and in various activities in trainees' home countries. Making the full use of our experiences, we would like to continue to provide technical cooperation which is truly useful for the trainees. They have a lot of challenges to overcome in their countries.