

Title: Hybrid variety creation as a local management tool for vegetable landrace as local commons

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### Abstract

Although there have been huge diversity of vegetable landraces grown in Japan due to its agro-ecological diversity, production of local varieties of vegetable has been decreasing in rural Japan. This is mainly due to modernization of agriculture and change of lifestyle. However collaboration between farmers and breeders has been initiated for regeneration of such varieties using hybrid variety, simultaneously aiming at revitalization of rural livelihood.

In this study, strategy, process and socio-economic impact of the introduction of hybrid (F1) variety of landrace and its seed production was studied to identify the various functions of hybrid in maintaining landraces.

Among the five cases reported for the utilization of F1 seeds for revitalization of local varieties in Nagano Prefecture, Japan, Seiniji-Akane turnip (*Brassica napus* L.) was studied by reviewing the records kept by the producers' group, university, village government and interviewing key persons for the development.

After several years of process to create a variety uniform enough to market, an F1 variety was registered as Seinaiji-Akane. This hybrid variety was created using only gene pool existing within the community and the mother lines are carefully maintained by the village and an entrusted company. By harvesting hybrid seeds and distributing them to growers, the production of Seinaiji-akane was maintained responding to the market demands of pickles factories, but traditional Open Pollinated Varieties have also been cultivated continuously.

Securing uniformity acceptable to market is one strategy to revitalize the use of landraces as local commons. Therefore, hybrid variety creation can be a strong tool for management of landrace gene pool as local commons. Continuation of the production of OP variety simultaneously showed that farmers' perception of OP variety was further strengthened by introduction of hybrid seeds, which in turn also facilitates landrace conservation.

Key words : F1 seeds, genetic resources, landrace, open pollinated variety

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## Introduction

Modernization of agriculture, especially introduction of improved varieties, has led to a serious decrease in diversity of traditional varieties and landraces of crops in the world. Many researchers and research and development organizations recognized the importance of the conservation of such diversity, which is named 'genetic resources' from breeding aspects because these are important materials for further improvement of crop varieties. In this sense, conservation of genetic resources has mainly been carried out at gene banks which are located outside of the locations of original cultivation of those varieties.

Recently, however, *in situ* conservation, which means conservation of traditional varieties and landraces in the place of cultivation<sup>3</sup>, has been emphasized and participatory plant breeding has also been integrated into management of genetic resources. Based on the cases in developing countries, Almekinders and Boef (2000) suggested *in situ* conservation becomes a management rather than conservation when farmers' utilization of genetic resources is given a central position. However, if farmers need to be central actors for genetic resources management, there should be recognizable benefits for participating farmers from their own view points. If the conservation of landraces hinders farmers from maximizing their production from their fields, farmers have little incentive for such conservation and need to be compensated (Ford-Lloyd and Jackson 1985). In this context, mechanism for encouraging sustainable management involving farmers needs to be studied from existing cases for effective, efficient and sustainable conservation of the diversity of traditional varieties and landraces.

From the viewpoints of commons study, FAO recognized the position of genetic resources as follows. Soil, water, and genetic resources constitute the foundation upon which agriculture and world food security is based. Of these, the least understood and most undervalued are plant genetic resources. They are also the resources most dependent upon our care and safeguarding. And they are perhaps the most threatened (FAO 1996). Local management system of soil and water under rapid modernization and industrialization has been recorded and studied. Management of local genetic resources is also intensively studied in developing countries. However, reports on local genetic resources from industrialized nations are rather scarce.

Japan has still relatively abundant local varieties in vegetable crops due to its diversity in topography, climates and rather small scale farming. Especially in Nagano Prefecture, many local varieties have been cultivated locally for a long time. These local varieties have no property right since they have been managed /maintained by local people either collectively or individually with frequent exchange among members. This custom makes landrace seeds as local commons. One of the characters of these kinds of landraces is diversity contained in the population. This diversity is good for continuous harvest for domestic consumption and risk management against pest and disease. At the same time, this diversity works negatively for big scale commercial production. Recently, due to rapid depopulation, ageing and change of diet, production of these landrace

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<sup>3</sup> In the case of natural vegetation, nature reserves and parks are common institutions for such *in situ* conservation.

vegetables has been decreasing. Market standardization including requirement of large lot and responsibility to fulfill the order from dealers has brought severe threats to the sustainability of such small scale landrace production practice.



Fig. 1 An example of a landrace kept by a farmer showing diversity in shape, size and color. (Saga-Onnayama-Daikon)

In order to tackle with these difficult situations and to promote revitalization of these traditional varieties, one of the tools utilized in Nagano Prefecture is introduction of hybrid variety (F1) seed technique to these varieties. This study aimed to record and evaluate such mechanism using a case of developing F1 seed in a radish variety called Seinaiji Akane, a cultivar within a turnip species *Brassica napus* L. from the viewpoints of management of genetic resources as local commons.

#### Materials and Methods (description of the crop and study location)

Seinaiji-Akane is a name of turnip cultivar grown in mountainous areas of south west part of Nagano prefecture. It is one of the five traditional vegetable varieties developed through utilization of hybrid seeds in Nagano Prefecture<sup>4</sup>. This variety was told to be introduced from western Japan near Kyoto in 17-18<sup>th</sup> centuries either by tobacco peddlers or wood craftsmen (called Kiji-shi in Japanese). This variety is quite different from other turnips grown in the surrounding areas, especially its scarlet color (rather than purple) due to different types of anthocyanin. Traditionally, this variety has been cultivated during autumn, harvested in October to December, and pickled using salt, pepper and persimmon peels.

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<sup>4</sup> Other four varieties are all radish species, namely Oyada-Karami Daikon, Ueno Daikon, Nezumi-Daikon and Togakushi Daikon.



Fig.2 (left) A farmer holding Seinaiji-Akane which is kept in the field for producing seeds in the following winter. (right) Pickled turnip roots using traditional recipe.

This study was conducted in Seinaiji village, which is located in Nagano Prefecture, central part of Japan with high altitude between 640 and 1636 m. There exist two main settlements with 736 people at year 2006. There were 69 farm household with 15.2ha of farmland. Traditional livelihood was supported by tobacco production and sericulture, but both of them are not profitable anymore and there are no outstanding economic activities in the village recently. Administratively, Seinaiji village was closed and merged to neighbor village Achi in April 2009.



Fig.3 location of Seinaiji Village

This research was conducted based on mainly two information sources, namely the records kept by the producers' group within a local agricultural cooperative, a university, and village government and interview with key persons in hybrid

seeds development, turnip production, pickles factories and users of both traditional varieties and hybrid seeds.

## Findings

### -History

Seinaiji-Akane is a turnip, but commonly recognized as a kind of radish (Daikon in Japanese) due to its radish-like shape and people call it Akane-Daikon. In the village, this turnip has been eaten as pickles for domestic consumption. According to a villager aged about 80 years old, traditional way of preparation and use is as follows. Turnip is harvested and pickled in November and eaten from spring next year until autumn or even to the following spring. This means the turnip is a good food as preserved diet. Pickling is done with salt and red pepper and vinegar with a little bit of rice bran and persimmon peel as sweetener.

Recently, traditional food has been re-found to be an important part of culture and resources for re-vitalization of rural economy in Japan. In Seinaiji village, a trunk road connecting with neighbor prefecture was opened in year 2000 and the pickles produced in the village were expected to be a good souvenir for passing tourists. The problem was un-uniformity of shape, color and size of roots due to segregation of population. How to conserve gene pool of this crop and utilize them for livelihood was a concern for villagers and village government.

In order to develop crop suitable for bigger scale production of pickles for commercial purpose, supply of uniform materials is a prerequisite. However, wide variation within the population and among sub-populations was recognized by farmers themselves. Another problem to be solved was hard texture of the roots. This is because the turnip was long used for long term preserved food and hard texture population was selected purposively during the long history of cultivation. For commercial production, short term processing period and sales was necessary, therefore soft type roots need to be developed.

At first in 1989, selection of lines from open pollinated populations was tried. The selection criteria were uniformity of shape and softness. However, it was found to be difficult to stabilize the population from composite population. Then, the idea of developing F1 seeds came in. In 1994, the project with objective of developing F1 seeds with characteristics suitable for commercial production started. Village government, farmers, agricultural cooperatives, prefectural agricultural extension service and a breeder from a local university were main actors involved in the project. The budget was mainly born by village government.

In 1995, nine populations chosen from within the village were cultivated for selection of mother lines. For selfing and self-incompatibility test, 144 pair crossing were made in 1996. In 1999, 42 almost pure lines were developed and pre-basic seeds were harvested in 2000. In 2001, First F1 seeds were cultivated for field trials and variety registration was applied in the following year. It was granted on October 24,2005. Property right was jointly kept by village government and the university breeder.

At that time, national policy on vegetable production consisted of (1) Competitiveness, (2) Increasing productivity,(3) Responding consumers' demands, (4) Environmentally sustainable production, (5) Increase in consumption. Utilization of local varieties hardly mentioned. However, 'Certification System for

Traditional Variety' program was launched by Nagano Prefecture government<sup>5</sup> in 2005. This policy tried to maintain varieties and their cultivation methods, and to promote regional economy with heritage food and culture. In order to materialize this policy, it was necessary to find mechanism of maintaining traditional varieties necessary for sustainable use of such local resources. In this context, F1 variety development provided one possible tool for this mechanism.

-Strategy to keep gene pool as local resources

In order to utilize and maintain landrace genetic resources as local commons, devices for hybrid seed production management were necessary during the development and maintenance of this F1 seeds system.

First of all, collaboration between farmers (producers' group) , agricultural cooperative, village office, and a breeder from university was starting point. In this way, farmers' eye and professional breeder's eye were jointly utilized for selection of ideal type roots. Production of seeds was done by producers' group themselves and an entrusted private company. This dual system was considered to provide better security of seed supply at the beginning because the seed company located far from the village did not have enough knowledge about the crop and its growing environment. Since maintenance of mother lines needs professional technique, a private seed company was invited to collaborate with this project introduced by the breeder from the university. During first few years, seeds were produced both by the company and villagers themselves in the village, but later only by the company. The company obtained enough knowledge for seed production of this variety and small scale seed production was laborious for production group members.

In principle, distribution of seeds has been limited to members of producers' group, which makes the genetic resources be maintained within the village as local commons. This producers' group was established within agricultural cooperative for the purpose of better livelihood and production management stability through promotion of production, technique improvement, and obtaining better price for produce for higher income, working closely together with agricultural cooperative, in 1997. However, in order to increase the production of pickles materials, seeds were also distributed to those who promise to sell their products through Agric. Coop. of the village.

There are 21 members in 2012 and member fee is 1,000 yen for a year. For members, who reside in the village, 10ml of F1 seeds are distributed free of charge. When they need more, they can purchase seeds at 200 yen for 10ml. When non-members want to purchase seeds, they can buy them at 300 yen for 5ml. They are requested to use the seeds for domestic use and not for sale through other than agricultural cooperative. In 2011, about 1800ml of seeds were distributed and the two third was for members. F1 seeds were harvested and provided by a private company which was entrusted by the village government for maintenance of mother lines. The production group purchased three litters of seeds in 2011 for 37,800 yen. This amount will serve for three years' demands.

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<sup>5</sup> Local administrative body between municipality and nation.

-Production and sales

Most of the harvest is sold to two local pickles company at the price agreed between companies and the production group. Price for best quality crops is 300 yen per kg for spring harvest and 280 yen for autumn harvest. In spring 2011, 20 producers sold 2,333kg of Seinaiji-Akane to these companies. The amount per farmer varied from 12kg to 399kg. In autumn 2011, 32 producers sold 4,365kg varying from 4kg to 707kg. The very small amount of shipping shows the fact that those producers cultivate the crop mainly for their own use and sell only the surplus not used by them. The system any farmers can participate in the sales through the producers' group is suitable for the community like Seinaiji where most farmers are old and cultivate their land mainly for their domestic consumption.

Table 1. Yearly sales amount of Aeinaiji-Akane (unit:10kg)

Year/season and production place	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Spring	319	216	361	547	616	544	506	239	224	233
Autumn	614	707	667	970	693	451	361	430	281	436
In village	668	623	577	722	903	933	782	471	396	517
Out village	266	299	451	795	406	62	85	198	109	153
Total	934	922	1,028	1,517	1,309	996	867	669	505	670

Notes: In village means shipment from within Seinaiji village. Out village means Shipment from producers living outside of Seinaiji village with F1 seeds Obtained from producers' group.

One of the ideas for effective utilization of produce was to sell the sub-standard crops to a rice wine factory to make alcoholic drink using turnip. This can bring extra income for producers and also wine factory. In this way, farmers can sell all the produce they harvest and obtain small amount of extra income. The alcoholic drink whose name is Akane-chan (Miss Akane) has been sold in the village as a new touristic souvenir.

-Continuation of open pollinated landrace seed production by individual farmers

One important finding was that many farmers still continue to take their own seeds of open pollinated landrace at their own fields. They keep some of the good shape roots based on their own criteria and keep them throughout the winter so that those plants flower in spring and bear seeds. In spring 2012, more than 40 plots were observed throughout the village for seed production. The number of plants per plot varies from 2 to 112. The farmer who keeps 112 plants is one of the leaders for F1 development but still takes his own seeds and distributes the seeds to neighbors. These facts show that farmers in Seinaiji village still want to utilize their own traditional varieties in spite of development of F1 seeds which is suitable for commercial production. Two main reasons mentioned by farmers are, hardness of roots which is more suitable for their traditional way of pickling and different liking of shape and color by different farmers.



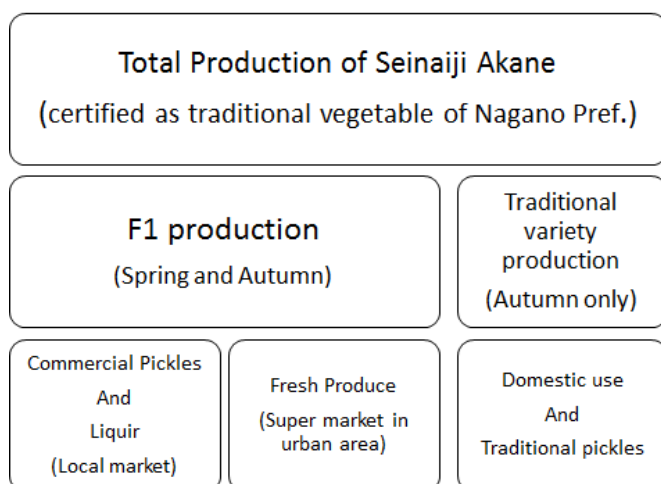


Fig.4 Diversification of use of Seinaiji-Akane after Introduction of F1 seeds

### Discussion

Farmers used to produce their own seeds but most of seeds have been produced by seed companies recently. Ageing of producers, changing of life style and market standardization brought severe threats in seed harvest by farmers by themselves. Responding to the initiatives of highly motivated farmers who were eager to utilize their local varieties, breeders from university decided to develop hybrid varieties to provide farmers with seeds with uniform character for marketing as well as rescue a part of gene pool for conservation of genetic resources before the population of a local variety disappears.

Based on the survey results, the impacts of the hybrid introduction on traditional variety can be summarized as follows. Firstly, hybrid seed users recognize the good character of the open pollinated landrace variety. Uniform crops can be sold to pickles factories at good price (300yen/kg). Factories have secure material supply. From economic point of view, F1 introduction certainly had a positive impact and this can be considered as a good tool for revitalization of not only the local variety but also the livelihood of the community. Although the peak of production was in 2005 and decline was observed thereafter, it needs to be emphasized that continuation of commercial production exists in spite of severe ageing and depopulation.

Secondly, in spite of good characters of F1 seeds, open pollinated varieties are still cultivated continuously. Open pollinated varieties are recognized as good varieties for traditional pickles (not for sale). This is a big social impact from the viewpoint of maintenance of culture. One of the government officer in charge of livelihood improvement mentioned that he was not aware of the diverse aspects of values of Seinaiji-Akane before he became in charge of F1 development project. F1 seeds development brought him an opportunity to recognize the local resources maintained by local people as local commons for a long time in the village. At the same time, even hybrid seed users sometimes found difficulty of cultivating uniform variety because of peak of labor. This means productivity and commercial



value are not necessarily highly prioritized characters for improved variety under circumstances of ageing and depopulated communities.

Apart from such management system, fundamentally important point of hybrid variety development in this case was utilization of only local gene pool. F1 variety is usually developed using genetically distant lines in order to acquire hybrid vigor. However, if distant variety from outside of the original place of cultivation is introduced, very core concept of local commons management may be lost. The fact that this point was clearly recognized and shared by all stakeholders is important fact to understand when we consider hybrid utilization as genetic resources management.

Usually, a local variety is genetically a complex heterogeneous population, especially in cross-pollinated crops like turnip. This character brings a kind of antinomy in terms of sustainability of gene pool. While certain size of population is necessary for the maintenance of varieties' characteristics, uniformity is required for large quantity of sales. If the size of population is getting smaller, the chance of genetic drift and inbreeding depression will become higher. This will eventually leads to loss of local varieties. This study revealed that developing F1 seeds enabled conservation of the part of important local genetic resources of local varieties.

Participation of different stakeholders including farmers, cooperatives, breeders and seed companies is also worth mentioning in these cases. Especially, farmers are invited for choosing samples with ideal phenotype of their local varieties at early stages of selection. This case can be viewed as good integration of breeding into genetic resources management within the context of participatory rural development.

A Japanese rice breeder Suge (1987) wrote that landraces are creatures developed by farmers under very narrow environment such as micro-climate and soil-type of farmers' field plots. The genotypes are adapted to very small areas. Landraces are closely connected with locality, climate and soil, life-style and traditions. These are integral part of local culture and one variety cannot be replaced by another. This statement has been proved in Seinaiji village. People utilize F1 variety as a tool for revitalization of the landrace and community, but they also keep their own landrace for their own use. F1 variety did not and could not replace long existed landrace variety.

For conservation of genetic resources in gene banks, option value is usually recognized, which is willingness to pay for maintaining opportunities for use in the future as breeding materials. This is, in principle, nothing to do with farmers who have developed such genetic resources as landraces. For farmers, use value, which consists of both consumptive and non-consumptive use value at the place of traditional utilization, is important and perceived by local people. When conservation of landrace started from the recognition of such value and adds value to the use of such genetic resources, more chances of conservation and use will be realized. This happened in the case of F1 seeds development in Seinaji-Akane turnip.

Tentative Conclusion and Further Study

Introduction of hybrid seeds can provide the community with a new form of 'traditional variety' or 'landrace'. Some points for successful introduction were found from the case. Management of seed production by local stakeholders is critical for the maintenance of genetic resources as local commons. When local people recognized the value of their landraces, introduction of hybrid seeds does not destroy cultivation of OP variety. This finding supports previous study from Mexico and elsewhere (Brush 1995). In the case of Seinaiji-Akane, introduction of F1 variety rather enhanced the understanding of OP variety as local resources.

Recently, Japan's policy on agriculture and rural development has become to recognize the importance of local production and local consumption for the revitalization of local agriculture. Although this policy does not recognize landraces as local commons, local management of such landraces may be prerequisite for such initiative since production of local crops cannot be carried out without local genetic resources maintained and utilized by local farmers. This initiative can also relate to realization of Farmers' Rights described in the International Treaty on Plant Genetic Resources for Food and Agriculture, which will be ratified by the government of Japan in the near future.

This study is based on the subjective perception of stakeholders and economic impact of the introduction of F1 seeds. More integrated study including assessment of the degree of maintenance of biological(genetic) diversity (or magnitude of gene pool) in both F1 variety and traditional open pollinated landrace populations in the community needs to be carried out to prove the validity of this approach.

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