Interactions of knowledge systems in shiitake mushroom production: a case study on the Noto Peninsula, Japan

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(1) Title of the paper

Interactions of Knowledge System in Shiitake Mushroom Production

: A Case Study on the Noto Peninsula, Japan

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(4) article type, subject area, and field (see list of "Subject areas and fields" at the end of these instructions)

Original article, Socioeconomics, planning, and management, Forest policy and social sciences,

(5) page count for the text, including abstract and references

8

(6) number(s) of tables and figures

Tables: 7

Figures: 5

(7) any necessary footnotes

We prefer to include acknowledgements for the funding agencies.

<Abstract>

This paper examines the relationships between traditional and modern scientific knowledge for shiitake mushroom production in the Ishikawa Prefecture of Japan. On the Noto Peninsula in Ishikawa Prefecture, the success of a new variety of shiitake, the Noto-Temari brand, boosted the number of farmers, the majority being new to mushroom production. Looking at the production of raw and dried mushrooms of the Noto-Temari brand, the paper assesses the knowledge systems of conventional farmers versus newcomers to mushroom production. In the case of premium quality Noto-Temari brand, the newcomers had a higher rate of production compared to conventional mushroom producers. We apply the knowledge conversion framework deriving from Polanyi (1966) to understand the dynamics of the knowledge system and our case suggests that traditional knowledge and techniques can be productive, but also obstacle to the adoption of new technology. In other words, it is possible that the very knowledge of conventional technology is interfering with the modern knowledge for growing the premium quality Noto-Temari brand.

Keywords

Traditional knowledge, Non-timber forest products, Log cultivation, Shiitake mushrooms, Mushroom farming

<Text>

Shiitake Mushroom Cultivation and Consumption in Japan

The Ishikawa Prefecture in Japan is located in the temperate zone; the humid climate provides appropriate conditions for mushrooms to grow. In recent years, non-timber forest products (NTFPs) account for roughly 50% of the total value of forest-related products, playing a significant role in regional development and employment (Forestry Agency, MAFF, 2010). Farmers and private enterprises co-exist in mushroom production. Changes in methods of production and new research and development in mushroom spawning has significantly influenced changes in the regional economy (Matsuo 2010). Two types, dried and raw, of shiitake (*Lentinula edodes*) are cultivated in different ways (on logs or on mushroom beds using sawdust) and sold on the market. Since the introduction of sawdust cultivation, which generally requires more controlled conditions and is often produced in-house, shiitake mushrooms can be produced and sold year round. In comparison raw, dried shiitake mushrooms can be kept longer and transported longer distances at lower cost because they are lighter. In addition, technological improvements in transportation have enabled the expansion of the commercial distribution of mushrooms to a wider area.

Shiitake cultivation was traditionally a valuable income source in winter for farming households in mountainous and semi-mountainous areas. For these regions, the income from dried shiitake production contributed to stable communities and livelihoods (Furutsuka 2000).

<<Insert Table 1>>

Table 1 shows the tons of production, imports, exports, and consumption of Japanese shiitake. The quantities of dried shiitake produced in Japan have decreased due to rising imports, a lack of logs, and shortage of successors to continue with operations. Imports increased rapidly in the late 1980s, to the extent that imports from China currently account for 96.4% of mushroom consumption in Japan (Matsumoto et al. 2009). Japan's exports of dried shiitake in 2010 had fallen to just 40 tonnes (t), as shown in the table, though they were one of Japan's main agricultural exports before the Second World War (Furutsuka 2000).

As for raw shiitake, with a shift in production methods from logs to sawdust, production volume rose rapidly from the 1960s to the 1980s, although it has been relatively flat in recent years. While the volume of imported shiitake rose rapidly in the 1980s, raw shiitake imports as of 2010 were still only 6.8% of total Japanese consumption of raw shiitake.

Shiitake Mushroom Production in Ishikawa Prefecture

Table 2 shows that raw shiitake production in the Ishikawa Prefecture in 2011 was 828 kg, of which

sawdust cultivated mushrooms accounted for 776 kg, resulting in 94% of total production; dried mushrooms accounted for less than 20 kg. In the last decade, the production of raw shiitake has been stable at 800 to 900 kg annually, while the percentage produced on logs is decreasing compared to the amount produced on sawdust (Table 2). In 2001, cultivation on logs represented more than 30%, while in 2011 it was less than 10%. The shift to sawdust away from log cultivation in Ishikawa Prefecture reflects a national trend, as well.

<<Insert Table 2>>

Ishikawa Prefecture is divided into five regions, with the Minami-Kaga region producing most raw shiitake, which are mostly shipped to Kyoto (Figure 1). The central region is the most productive in log cultivation due to its climate. Historically, the municipality of Tsubata-cho in the central region is known for its mushroom cultivation on logs, with raw shiitake shipped to the nearby city of Kanazawa .

<<Insert Figure 1>>

Introducing Noto-Temari Shiitake Brand in the Oku-Noto Region

The Oku-Noto region consists of four municipalities, Suzu-shi, Wajima-shi, Nonoichi-machi, and Anamizu-machi, and is located in the northern part of the Noto Peninsula. Because of the climatic conditions, farmers in the region naturally gravitated toward shiitake production in winter and rice in summer. The system was stable until around 1975 thanks to relatively high prices for their products. Because the region is relatively far from major consumption markets and due to geographical limitations hindering the shipping of fresh shiitake, the main product was dried shiitake. In fact, at 96.5% in 2001 and 96% in 2011 almost all dried shiitake are produced in the Oku-Noto region in the prefecture (Table 3). Furthermore, the factor that dried shiitake are lighter and less labor-intensive to produce enables the aged population of Oku-Noto region to produce in a relatively competitive manner.

<<Insert Table 3>>

It is in this region where a new brand of shiitake, the Noto-Temari, was introduced. An organization known as the Oku-Noto Shitake Promotion Group (the “Group” hereafter; in original Japanese it is association but it is called “the group” to avoid confusion with agricultural associations) was established in October 2010 with the aim of expanding the production of shiitake, using the Noto 115 variety. They marketed this variety as the Noto-Temari brand. The Group is

composed of the shiitake division of individual agricultural cooperative associations, the forest management division of the Prefecture (Okunoto Agriculture and Forestry Division), the Agriculture and Forestry Division of the Suzu City government, participating municipalities, the Ishikawa Special Forest Products Promotion Association, Maruka Fruits and Vegetables, Japan Kinoko Research Center Foundation, Japan Agriculture (JA) Group at national level, JA-Zen-Noh Ishikawa at prefectural level, and individual JA-affiliated associations at the local level (Figure 2). Researchers affiliated to the Prefecture is supporting the production with practical researches but the efforts are relatively in a recent period (Yashima, 2012; Yashima et al., 2014)

<<Insert Figure 2>>

Noto 115 is the variety and Noto-Temari is the brand. It is a type of shiitake grown from Kinko 115 spores and cultivated in the Ishikawa Prefecture. To foster branding of Noto-Temari, the Group set up strict standards for the mushroom form in terms of diameter, thickness and inward curl and sold only those shiitake that met the criteria. The standards for the Noto-Temari brand of shiitake mushrooms require a pileus (the cap) to be at least 8 cm in diameter, a thickness of at least 3 cm, and an inward curl (*makikomi*) of at least 1 cm. The Noto-Temari Premium brand of shiitake requires a standard thickness of 8cm and inward curl of 8cm. As a result of this standard, the ratio of

Noto-Temari Premium is usually less than 5% of the overall Noto-115 production.

The mushroom (Noto 115) and spores (Kinko 115) were developed by the Japan Kinoko Research Center Foundation, which is a vendor that produces, manages, and sells mushroom spores of many varieties. Therefore, shiitake mushrooms are grown in other parts of Japan using the same spores and branded under other names, such as Takeou (Tottori Pref.) Daibutsu-kun (Nara Pref.), Taketaro (Okayama Pref.), Genki-kun (Ehime Pref.), Hiroshima Jumbo (Hiroshima Pref.), Hitachi-kun (Ibaraki Pref.), and 115GO (Iwate Pref.)

Most brands from other regions, however, have not survived in the market. Management factors enabled the branding and stable supply of Noto-Temari mushrooms through joint selection and joint sales. Through the joint selection system a third party is designated to sort and classify the shiitake mushrooms collected by the JA agricultural cooperative from individual farmers. This system facilitates accurate classification, leads to market credibility about quality, and secures higher prices. In other areas, the standards were less strict or left to farmers to determine, eventually leading to lower quality and price. This joint selection is what makes the Noto-Temari Brand different from the shiitake mushrooms of other regions.

Noto-Temari is has proven to be an exception, having sustained itself as a brand in the market for a relatively long period of time (i.e. at least five years since the establishment of the branding organization). This is in part due to the fact that the Group has also implemented activities

for marketing the brand, such as hosting promotional events, as well as aided farmers in production, such as securing logs for mushroom production and working to improve farmers cultivation skills. Furthermore, as part of the branding process, three agricultural associations (JA Ozora, JA Machinomachi, and JA Suzu City,) trademarked the Noto-Temari brand together.

As the brand value of Noto-Temari grew, the number of new farmers producing them increased in the Oku-Noto region. According to the Group, 29 new farmers started production in the three years from 2010 to 2012. Of those new farmers, six were from another business sector, including four from construction (Table 4). Furthermore, other farmers changed from dried to raw shiitake production of the Noto-Temari brand.

<<Insert Table 4>>

Existing Litarature and Key Terms

Non-timber Forest Products

There exists a large amount of literature for the NFTP, tropical forests and some article refers to traditional knowledge in the context. In context of economic analysis, including impacts to local communities and wider society, Zeidemann et al. (2013) conducted an analysis of benefit distribution of Brazil nuts at different reserves and identified needs to “integrate socioecological heterogeneity” inherited in the NFTPs or Brazilian. Carrasco et al. (2014) identified that current

economic evaluation fails to capture biodiversity values, including those of NFTPs and claims that considering the access or distance to urban areas are critical in matching the demands of beneficiaries and supplies. Rist et al. (2012) reviewed 38 articles to examine the compatibility and conflicts between timber harvesting and NFTPs and identified the lack of attention to NFTPs in certification processes or governances in general.

In a similar vein, Illukpitiya and Yanagida (2010) examined the trade-off between the agricultural and extraction of NFTPs in Sri Lanka wherein they found that NFTP extraction activities "decrease the function of agricultural efficiency, producing a positive externalities in the conversion of forest resources." Jensen (2009) analyzed the value chains of NFTP in the context of Lao People's Democratic Republic and examined where the values were for the case of agarwood and essential oil. Though it was not the objective of the study, certain gaps in the statistics were identified and it was estimated that 80% of the values and 60% of the quantity fall into "illegal harvests" if defined as harvesting without a legal permit or with no customary rights (Jensen, 2009). He et al. (2014) analyzed the mushroom production in Southwest China and points out that both the market and government failed to commercialize NFTPs.

For other non-tropical regions, Kilchling et al. (2009) analyzed the demands for the NFTPs in Swiss urban areas and analyzed the purchase behavior, profiles, and importance of product attributes, such as certificate, price, origin, stores or environmental friendliness. They found that the

local origin and environmental friendliness were important for the consumers and suggested that certificate NFTPs to communicate such attributes will be supportive tool (Kilchling et al., 2009). Bull et al. (2014) focused on Nuxalk First Nations case in Canada and analyzed the utilization of NFTP, such as briquettes and essential oils for improving economic and livelihood standards of the community.

Traditional Knowledge and Knowledge Conversion Model

The traditional knowledge plays a critical role at the landscape level for the management of lands, including common lands (cf. Secretariat on Convention of Biological Diversity, 2011). The traditional knowledge is highly contested concept for human and intellectual property rights, increasingly as related to and biodiversity and genetic resources since the end of the 1990s (cf. von Lewinski, 2008; Izatul and Talaat, 2013). Its use is linked to understand forest ecosystems (cf. Bürgi et al. [2013] for analysis in Switzerland) or adapting to climate change in agricultural biodiversity globally (Koohafkan [2012] on FAO programmes). The one commonly accepted interpretation of the traditional knowledge is that it “comprise both aesthetic and useful elements, as well as literary, artistic or scientific creations” and category of it includes expressions of folklore in the form of music, dance, song, handcrafts, designs, stories and artwork; elements of language; agriculture knowledge; medical knowledge (WIPO, 2001; Leistner 2004; Van Overwalle, 2005). The agriculture

knowledge and related forest knowledge, which is the focus of this paper, is included in the definition. The knowledge is sometimes subdivided in three classes; traditional medical knowledge (TMK), traditional agricultural knowledge and traditional ecological knowledge (TAK) traditional and ecological knowledge (TEK) (WIPO, 2001). Such subdivision is rejected, however, by some scholars that they artificially disaggregate components of a single reality (Cottier and Panizoon, 2004). We agree with such criticism and we will use the term traditional knowledge as it is difficult to distinguish the TAK and TEK. It is conventionally defined as knowledge transmitted through generations, frequently not in a different form compared to conventional scientific knowledge (Curci, 2010). The holders of traditional knowledge share it amongst community members the knowledge may not be in a written form. This complicates the legal and economic evaluation (Van Overwalle, 2005). As result, the statutory legal system established by the government prevailed over the customary law, including those related for the traditional knowledge, developed by the community (Chun, 2014). In existing literature, the length of traditional knowledge is conventionally defined as knowledge transmitted through generations. Yet, it is also pointed out that the content of the traditional knowledge can be new, but the way it is acquired, used and transmitted is based on traditions and has social meaning attached to it (Curci, 2010; Hansen and Vanfleet, 2003). The traditional knowledge in this paper is defined focusing less on trans-generational length but rather at individual basis at one generational timeframe.

We applied a conceptual framework of knowledge conversion by Nonaka and Takeuchi (1995) to the traditional knowledge of mushroom production. Polanyi (1966) divided knowledge into (1) subjective and empirical tacit knowledge and (2) objective, theoretical explicit knowledge. The former is difficult to articulate with formal language and embedded in individual experience, as is the case to explain how to ride a bike (Byosiere, et al. 2010). The latter can be shared and communicated in manuals and can be updated. The old experience mushroom farmers can know how to handle the logs for productions under different seasonal and environmental conditions even if they cannot explain in words as tacit knowledge. The manuals will, alternatively, tell you, as explicit knowledge, when to turn the logs, cut them to what length and at what temperature this should be done. The updates are easier with explicit knowledge. The tacit knowledge is highly efficient amongst the members of strong ties at an informal basis while explicit knowledge is efficient amongst members with weak ties (Byosiere, et al. 2010).

For Noto region, the traditional knowledge of mushroom productions were conventionally transmitted and shared in communities with strong ties (as in dried shiitake) but are rapidly changing to be shared amongst members with weak ties, including newcomers (as in Noto-Temari). At result section, we propose that this knowledge conversion model is relevant both at production phase and at the commercialization phase of the mushrooms.

Analysis of the Production Rate of Noto-Temari

To identify the baseline productivity of the Noto-Temari, we have analyzed the trends in their production amount and productivity for the new and conventional farmers respectively. The overall number was 55 farmers, with 17 conventional and 38 new farmers and the data was provided by the Group. It was not sample survey research but a complete survey meaning that all the available datasets are used for the analysis. Hence, results are presented without applying the statistical analysis. The overall production amounts (p_i) and productivity (y_i) are defined as following formula;

$$p_i = x_{1i} + x_{2i} + x_{3i}$$

$$y_i = \frac{x_{1i} + x_{2i}}{p_i}$$

The "i" indicate the identification of the farmer. The variables with "x" are the productions amounts with different classes and standards. The first x_{1i} indicate the production of the Noto-Temari Premium, the productions with the highest standard, x_{2i} is for the Noto-Temari, x_{3i} is the production of the mushrooms Noto 115. We set two hypotheses for the analysis: a) New farmers will be significantly less in their amount produced and in productivities because they lack the technology and b) Farmers with smaller production amount will be more efficient in

producing higher quality Noto-Temari because they can focus their resources.

The Different Modes of Analysis

We conducted questionnaires, from July to December 2013, to two set of stakeholders: (a) the person in charge of the Oku-Noto Shitake Promotion Group, and (b) mushroom farmers in Oku-Noto. We interviewed eight farmers, three of them new to the business and the others conventional farmers. The main purpose of the survey was to find out who taught the stakeholders mushroom cultivation methods and techniques they used, and how many years they had been cultivating mushrooms. On the basis of the investigation, we analyzed a new skill used in the growing of Noto-Temari, the differences comparing the newer cultivation technique from the conventional one, and how the mushrooms are shipped.

Based on the production data and interviews, we applied a conceptual framework of knowledge conversion by Nonaka and Takeuchi (1995) for analyzing the differences in mushroom production by new and conventional farmers. To date, this knowledge conversion model has been applied to various sectors; in this paper we have apply the framework to the knowledge of production and branding of the Noto-Temari.

Results of the Analysis of Noto-Temari Production

Quantitative Results

The production amount and productivities of the new and conventional farmers are shown in Figure 3. The average of the Noto-Temari Premium is 16.54 for the conventional and 19.42 for the new farmers. The medium is 17 for the conventional and 10 for the new farmers. The new farmers have slightly higher average with higher distribution range. For the production in Noto-Temari, the average is 220 pieces of mushroom, with a medium of 186, for the conventional and 145, with a medium of 107, for the new farmers. A similar trend of slightly higher average with higher distribution range is observed for Noto-Temari. For overall the production, the average is 473, with a medium of 466, for the conventional and 360, with a medium of 221, for the new farmers. The average and medium for conventional are similar because their distributions are equally disperse. The medium of the new farmers are lower indicating that the majority are producing smaller amounts. In summary, the overall trend indicates that the conventional farmers produce higher amounts with the exception of the Noto-Temari Premium.

<<Insert Figure 3>>

The results of productivities are outlined in the Table 5. The average productivity of the Noto-Temari (or the ratio of produced mushrooms of Noto-Temari against Noto 115) are 45.3% for

the conventional and 43.3% for the new farmers. There are no large differences between the two. The conventional farmers have slightly higher productivities. As second step, we will analyze the production scale and productivities. Figure 4 plot the overall production scale in the x-axis and the productivities in the y-axis. In the smaller scale, the distribution is dispersed but tends to converge in the range of 0.4 to 0.5.

<<Insert Table 5>>

<<Insert Figure 4>>

The difference between the new and conventional farmers in productions and productivities are not large. The hypothesis a) for the difference between the new and conventional farmers is in principle rejected. There was a trend that the conventional farmers were slightly higher in production amount and productivities.

For the hypothesis b) for the small scale farmers, the trend was not observed. The productivity of the Noto-Temari was rather random when the scale was smaller, regardless of the conventional and new farmers. The hypothesis (b) is rejected. These results indicated that technique other than dried mushrooms are necessary for the efficient production of the Noto-Temari. We will analyzed the results of the interviews in the following section.

Qualitative Results

One might expect that the farmers of dried shiitake (hereafter “old farmers”) would be superior in craft compared to the newcomers. This was not necessarily the case. The knowledge and technique of producing dried shiitake appeared to interfere with changing styles and absorbing new knowledge systems for producing the Noto-Temari mushrooms. As a result, a significant number of newcomers succeeded in production and met the quality criteria, better than the old farmers in the case of Premium quality Noto-Temari. Interviews with the relevant organization members of the Group and producers revealed that old farmers produced raw shiitake based on their previous experience and intuition. This knowledge is a central focus of this paper and we analyze such knowledge as traditional knowledge obtained in a tacit form as defined in the literature review.

It is the tacit knowledge that the farmers have gathered through their personal experiences, such as production of dried shitake in the post-war period. Tacit knowledge is embedded in the personal contexts and is transmitted frequently on an informal basis. Explicit knowledge, such as farming information gathered by the Japan Kinoko Research Center Foundation, is clearly stated in the manuals. In contexts of mushroom productions, the old famers simplified, leveraged, or skipped processes based on the traditional knowledge to produce Noto-Temari mushrooms. The knowledge included when and how to turn the logs or plant the mushrooms. In Table 6 summarizes

the transmitting of knowledge and techniques for different points of cultivating shiitake mushrooms.

<<Insert Table 6>>

The conventional farmers who have experience in growing dried shiitake tend to apply these protocols in growing raw shiitake based on their experience and intuition, especially when it comes to deciding which process to skip or simplify (based on interviews to farmers, staff members at prefectural extension services). As can be seen in Table 6, the Foundation is a crucial organization developing and producing seed mushroom fungus, providing advice on cultivation techniques for producing raw shiitake. Since it has been involved as the main player in shiitake cultivation in the Oku-Noto region for 40 years, farmers have a high level of trust in it.

We learned, however, that the previous experience and intuition of the old farmers may be interfering with the need to follow standard protocols for producing Noto 115 and Noto-Temari shiitake. Thus, the experience of previous shiitake mushroom producers was not necessarily positively contributing to the production of the new Noto-Temari mushroom. The difference is attributed to differences in attitude towards absorbing new techniques under the supervision of advisors from the Foundation. Because newcomers tend to be more open to new production technology, they more readily accept advice and are able to better follow instructions, enabling them

to meet the quality criteria to produce Noto-Temari and Noto 115. As mentioned, the conventional farmers also received advice from the Foundation. Through the survey, we saw that advisers from the Foundation frequently visit the old farmers and give them advice. Techniques and advice from the Foundation have influenced regional change in mushroom production, as Matsuo (2010) described in *Regional Change of Mushroom Production Areas in Japan.*

This observation implies that the conventional farmers' experience with growing shiitake is working against proper production of Noto-Temari, which requires meeting a specific set of criteria. The successful production of the newcomers, in contrast to the conventional farmers, is an interesting case in terms of how different knowledge systems work. The conventional farmers are also given advice, but the traditional knowledge of dried shiitake production is not necessarily contributing to the new standardized production of Noto-Temari mushrooms. Such knowledge systems can, in fact, interfere with absorbing different production knowledge systems.

The two types of knowledge used for mushroom productions are summarized in Table 7. The "modern" knowledge here indicates the technique of cultivating raw shiitake (i.e., Noto-Temari and Noto 115). The "traditional" technology indicates dried mushrooms and procurement of logs. However, the term "traditional" does not necessarily mean the knowledge is old, outdated, or out of use. For example, the new farmers are rather eager to absorb these "traditional" technologies to produce dried shiitake, because they need to learn the technique for successful production.

Conversely, some conventional farmers under the supervision of the Japan Kinoko Research Center Foundation are not necessarily successful with the production of raw shiitake. Among them, many farmers have decades of experience producing dried mushrooms, and are skilled at log procurement and handling of dried shiitake. It is possible that the very knowledge of conventional technology is interfering with the modern knowledge for growing raw shiitake. Conventional mushroom farmers tend to follow their own experience and intuition, especially on which growing processes to skip or simplify. These omissions potentially impede them from producing products meeting standards for the new Noto 115 and Noto-Temari brands.

<<Insert Table 7>>

Results of the Model Analysis: Factors in the Success of the Noto-Temari Brand

In order to understand the different dimension of the knowledge system, we will apply the framework of “knowledge conversion framework” at four stage by Nonaka and Takeuchi (1996) as described in Figure 5.

<<Insert Figure 5>>

The model proposed by Nonaka and Takeuchi (1995) emphasize that social interactions

enable the two knowledge systems to interact and interchange with each other. The interaction of the tacit and explicit knowledge is defined as knowledge conversion, which is not confined at individual basis but as “social” process. In our case As result of such conversion, human knowledge is created and expanded. For analysis of the mushroom productions, four different phases of knowledge transformation is assumed. At each phase, there are both tacit and explicit knowledge. Depending on matureness of the social processes, ranging from informal dialogue amongst farmers or instructions with manuals, the tacit and explicit knowledge interacts.

Let us go through the process one by one using the example of mushroom production. At the socialization phase at the left upper box, the tacit knowledge is shared. In this phase, knowledge can be the technique for efficient production or know-how of promotion channels and can be personal or expert knowledge. In the following phase of externalization, new forms of productions or promotions are explored based on the tacit knowledge. Through this process, the shared tacit knowledge is expressed in the form of manuals or texts as communicable explicit knowledge. In the case of Noto-Temari, the Group, particularly the JA played a critical role by setting out the clear standards in diameters, thickness and curves for the criteria of Noto-Temari, for the transformation of the production knowledge from tacit to explicit. The third phase is the “combination” of the explicit knowledge by linking the explicit knowledge from different sectors. For Noto-Temari, this was the phases where knowledge were interlinked through production,

collection and retail. In the final phase, these new explicit knowledge will promote more tacit knowledge amongst the producers, or for other stakeholders. In other words, the explicit knowledge is “internalized” and promotes tacit knowledge in the left lower box. If the Noto-Temari enters this new cycle of tacit knowledge, the producers, for example, will be more adaptive to the market needs in quality or timing of their production, based on explicit feed backs from the retailers. The farmers will accumulate experience and feed backs.

To enter such phase, there are two actions required, one at the “socialization” and other at “combination”. For the “socialization” phase, sharing the tacit knowledge amongst new and conventional farmers are potentially beneficial for this knowledge cycle. Current communication is mainly a one-way from the trainer (the Japan Kinoko Research Center or JA) to the producers. For the “combination” phase, there needs to be close communication with the producers, retailers and consumer preferences. The Maruka Fruits and Vegetable Ishikawa Wholesale Market is part of the Group, but this is not sufficient. In other words, the combination phase and their explicit knowledge is not enough, based on the interview results. Through the dynamic exchange of the tacit knowledge amongst the farmers and further exchanges for combination throughout the supply-chain, the cycle of the tacit-explicit knowledge with four different phases will improve.

The interrelationships amongst farmers and information distributers are also critical. By analyzing technology corporations, Byosiere, et al (2010) identified weak ties that are vital when the

focus is on explicit knowledge and strong ties are critical for the tacit knowledge. This is similar to the results that the newcomers were more willing to adopt the techniques and knowledge from the manual source, while experienced farmers tended to rely on their tacit knowledge.

Future Prospects

As we have seen in the review, the analysis of the traditional knowledge and NFTPs and the linkages were in reviewed including those in contexts of tropical forests, where economic pressure, agricultural expansion, population increase and human interventions are increasing and trade-offs with forests conservation were extensively evaluated. In our case, we analyzed mushroom production in the context of underuse and decreasing population. We found that conventional farmers with experience in producing dried mushrooms did not necessarily perform better, implying that different knowledge system interfere with each other. These have significant implications for Satoyama managements and introduction of NFTPs in Japan but also for developmental projects in international contexts It is noted that the introduction of new NFTPs will potentially change the social process of how traditional knowledge is shared and transmitted, as we have seen in the transition and interactions of tacit to explicit knowledge process with Noto-Temari.

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Figure legends

Figure 1. Main Production Areas for Shiitake Mushrooms in Ishikawa Prefecture

Figure 2. Composition of Active Okunoto Log Shiitake-Mushroom Associations

Source: Activating Okunoto Log Shiitake-mushroom Association, Ishikawa Prefecture, JA Ishikawa Branch (2013) "Activating Okunoto Log Shiitake-mushroom Association Activity Report October 2010 -February 2013"

Figure 3. Production amounts of raw shiitake mushroom by the new and conventional farmers (as of year 2013)

* The circle ○ indicated above the boxes in the figures are the outliers.

Figure 4. Relationship between overall production amount and productivity of Noto-Temari (2013)

Figure 5. Four modes of knowledge conversion in Branding Noto-Temari

FIGURES

Figure 1

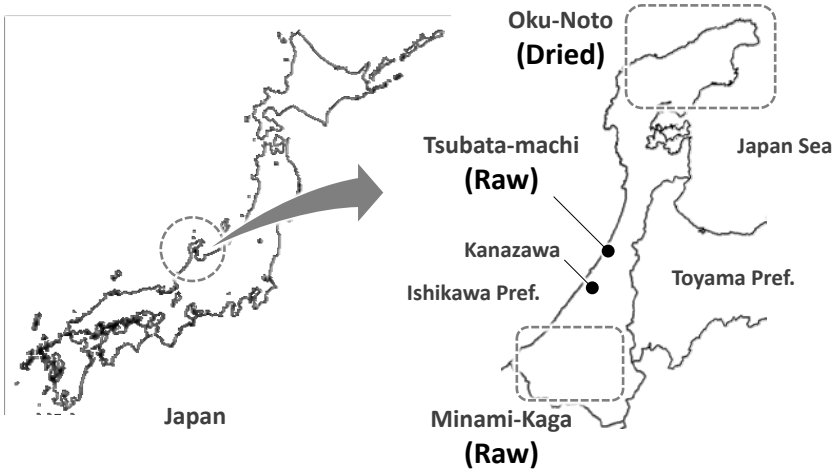


Figure 2.

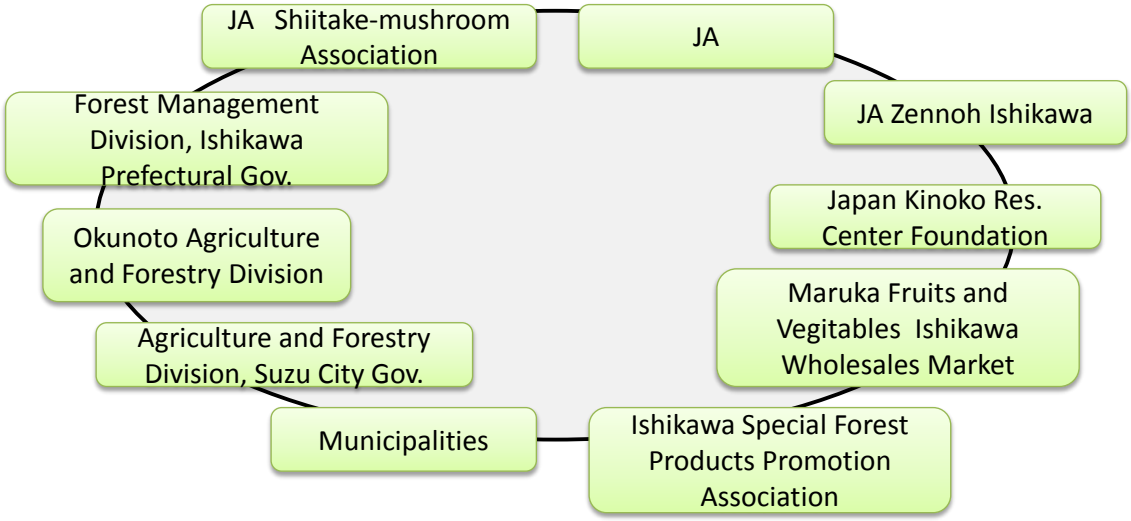
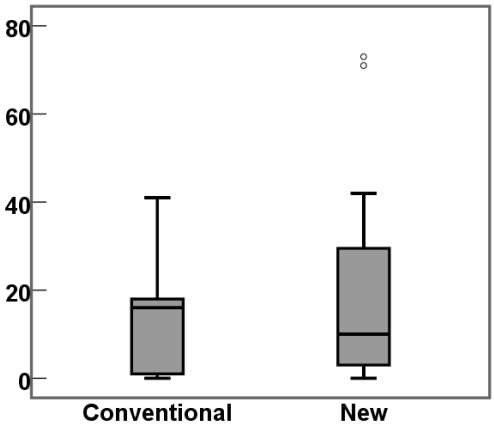
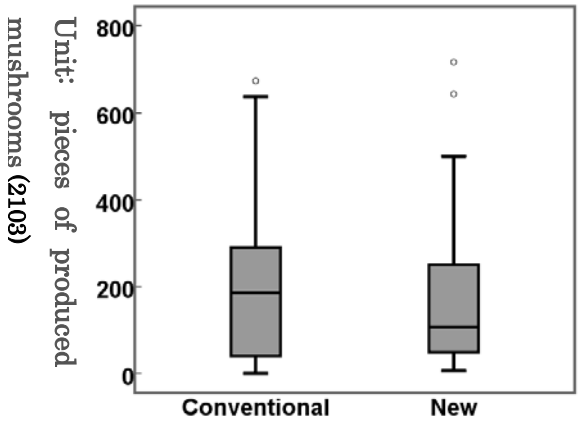

JA Shiitake-mushroom Association
JA
Forest Management Division, Ishikawa Prefectural Gov.
JA Zennoh Ishikawa
Japan Kinoko Res. Center Foundation
Okunoto Agriculture and Forestry Division
Maruka Fruits and Vegitables Ishikawa Wholesales Market
Agriculture and Forestry Division, Suzu City Gov.
Municipalities
Ishikawa Special Forest Products Promotion Association

Figure 3.

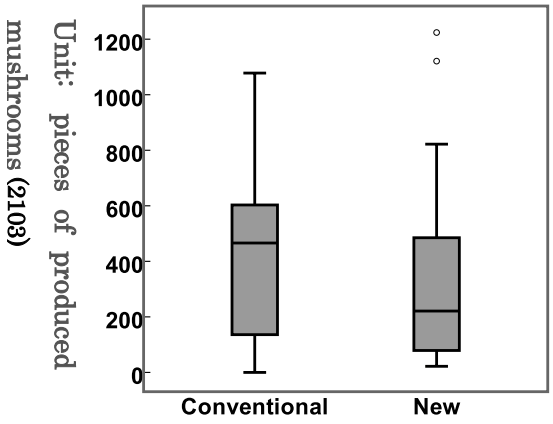


(a) Noto-Temari Premiums

(b) Noto-Temari



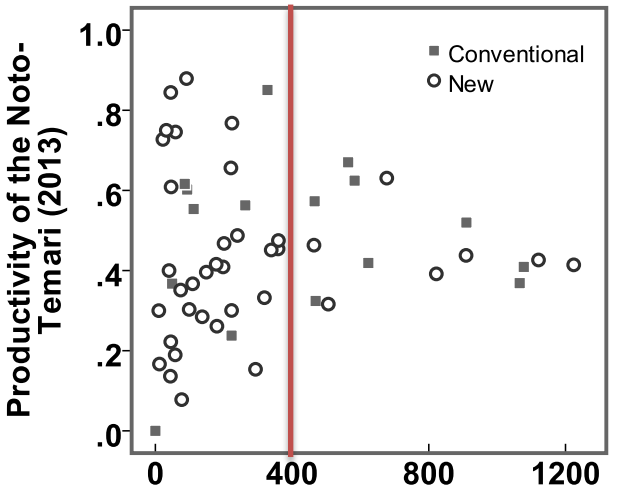
(c) Noto 115



(d) Total

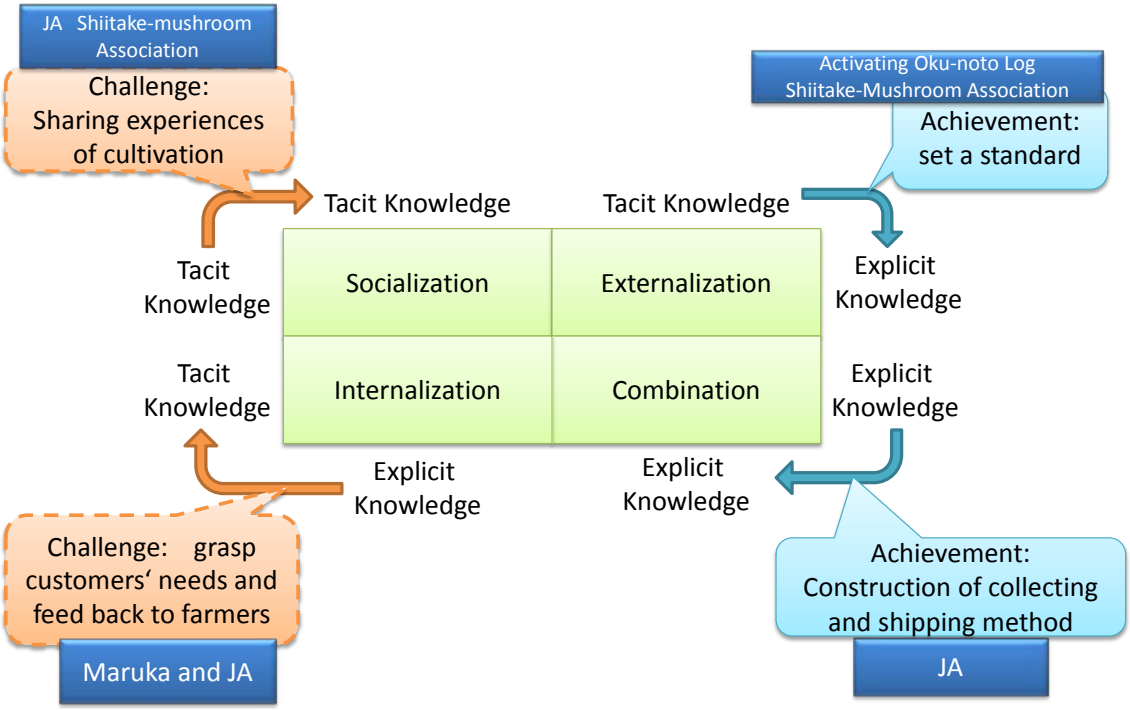
Box-plot representation of the number considered in this study. The median (horizon black line), second and third quartiles are box-plotted. The line outside the box represents 1.5 times the interquartile distance, with points outside considered as outliers (indicate ○).

Figure 4.



(2103)

Figure 5.


JA Shiitake-mushroom Association
Challenge: Sharing experiences of cultivation
Activating Oku-noto Log Shiitake-Mushroom Association
Achievement: set a standard
Tacit Knowledge
Tacit Knowledge
Tacit Knowledge
Socialization
Externalization
Explicit Knowledge
Tacit Knowledge
Internalization
Combination
Explicit Knowledge
Explicit Knowledge
Explicit Knowledge
Challenge: grasp customers' needs and feed back to farmers
Maruka and JA
Achievement: Construction of collecting and shipping method
JA

TABLES

Table 1 Japan's production, imports, exports, and consumption of shiitake mushrooms (Units: Tons)

(1) Dried shiitake					(2) Raw shiitake				
Year	1965	1975	1985	2010	Year	1965	1975	1985	2010
Production	5,371	11,356	12,065	3,516	Production	20,761	58,560	74,706	77,079
Imports	-	93	140	6,127	Imports	-	-	-	5,616
Exports	1,201	2,696	3,330	40	Exports	-	-	-	-
Consumption	4,170	8,753	8,875	9,603	Consumption	20,761	58,560	74,706	82,695

Source: Based on information from Minor Forest Products Managing Office, Forestry Management Improvement Division, Forestry Agency, MAFF (2012)

Table 2 Gross production trends for shiitake mushrooms in Ishikawa Prefecture (Units: Kilograms)

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Raw shiitake	Total: Ishikawa Prefecture	804,000	831,000	786,700	756,300	766,200	819,000	877,900	817,300	852,600	990,170	828,426
	Log cultivation	265,400	231,600	169,400	149,200	110,900	84,400	74,900	79,800	70,000	109,070	52,684
	Sawdust	538,600	599,400	617,300	607,100	655,300	734,600	803,000	737,500	782,600	881,170	775,742
Dried shiitake	Total: Ishikawa Prefecture	46,620	40,080	35,980	30,450	24,870	20,950	15,690	21,240	19,010	16,990	19,579

Source: Based on information from Minor Forest Products Managing Office, Forestry Management Improvement Division, Forestry Agency, MAFF (2012)

Table 3 Gross production of shiitake mushrooms, by region in Ishikawa Prefecture

(Units: Kilograms)

	Raw shiitake									Dried shiitake		
	Total Raw			Log Cultivation			Sawdust Grow					
Year	2001	2006	2011	2001	2006	2011	2001	2006	2011	2001	2006	2011
Minamikaga Forest Management	392,700	259,800	203,257	175,800	58,400	35,158	216,900	201,400	168,099	80	130	78
Ishikawa Forest Management	44,700	121,900	146,989	6,600	2,400	714	38,100	119,500	146,275	20	20	16
Ken'ou Forest Management	105,900	91,900	136,824	56,500	20,400	11,530	49,400	71,500	125,294	610	350	620
Nakanoto Forest Management	72,100	46,300	85,488	900	600	1,948	71,200	45,700	38,540	910	100	84
Okunoto Forest Management	188,600	299,100	255,868	25,600	2,600	3,334	163,000	296,500	252,534	45,000	20,350	18,781
Total: Ishikawa Prefecture	804,000	819,000	828,426	265,400	84,400	52,684	538,600	734,600	730,742	46,620	20,950	19,579

Source: Based on information from Farmland Management Division, Agriculture, Forestry & Fishery Department, Ishikawa Prefecture (2012)

Table 4 Details of new farmers cultivating Noto-Temari (29 persons)

Initial year	Affiliation	Background or description
2010 – 18 persons	JA Aozora – 15 persons	From other industry – 6 persons
2011 – 4 persons	JA Nomachimachi – 5 persons	Farmers under 60 years old* – 12 persons
2012 – 7 persons	JA Suzu City – 9 persons	Retiree from other occupation – 8 persons
		Other – 3 persons

Source: Based on information from Association Promoting Shiitake Mushrooms from Logs in Oku-Noto, Ishikawa Prefecture, and Ishikawa Branch of the National Federation of Agricultural Cooperative Associations (2013)

* The average age of shiitake mushroom farmers in the Oku-Noto area is between 70 and 75 years, so these farmers under 60 are regarded as an important part of the workforce.

Table 5 Productivity of the Noto-Temari by new and conventional farmers (2013)

Farmer	number(n)	average	median	standard deviation	Max	Min
Conventional	17	.4529	.5198	.22576	.85	.00
New	38	.4332	.4117	.20158	.88	.08
Total	55	.4393	.4157	.20743	.88	.00

Table 6 Situation of transmitting knowledges and techniques for producing of shiitake

No.	Type	Person taught the producing techniques of raw shiitake	Point of cultivation	Current adviser for cultivation	logs (valid logs)	Cultivation years (Dried)
1	New	Kinoko Center	Quantity of sprinkled water	Senior farmer Kinoko Center	1,150	2
2	New	Kinoko Center	Supplying bed-log Management in summer	Kinoko Center Workshop	3,000	3
3	Old	JA & Kinoko Center		Kinoko Center	15,000	36 (36)
4	Old	Kinoko Center	Preparing bed-log	Kinoko Center Market	3,000	46 (46) Inherited from his father
5	Old	JA & Kinoko Center	Reserving log Harvesting in optimal timing	None	30,000	40 (40)
6	new	Kinoko Center	Transporting bed-log	Senior farmer	4,000	4
7	Old	Kinoko Center	Inoculation timing	None	12,000	30 (30)
8	Old	-	Covering with bag	None		(28)

Table 7 Technology types and knowledge acquisition of new and conventional farmers

	"Modern" knowledge (Noto-Temari, Noto 115)	"Traditional" knowledge (dried shiitake, logs)
New farmers	Absorb knowledge without resistance	Started with raw shiitake and have difficulty producing dried shiitake
Conventional farmers	Receive knowledge but not necessarily successful	Possess log procurement and dried shiitake technology

It is to be noted that the traditional knowledge (defined in the text) is also relatively new as the dried shiitake mushrooms peaked in its production in post-war period.