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Community-based management of *Tricholoma matsutake* (S. Ito and S. Imai) Singer: a case study of South Korean mountain villages

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Abstract: *Tricholoma matsutake* (S. Ito and S. Imai) Singer commercialisation provides significant economic benefits to rural communities, mainly in China, Japan and South Korea. Recently, a growing body of research has questioned the impact of commercialization on harvesting behavior and the supply of matsutake. One key question arising from this literature is whether or not community-based management (CBM) has a positive impact on matsutake supply. I surveyed nine mountain villages in Gangwon and North Gyeongsang provinces in South Korea. Four villages were found to have begun CBM of matsutake in the mid-1980s to early-1990s. All four villages continued to engage in CBM as of September 2013. Data suggest that CBM has had a positive impact on matsutake supply, although the exact magnitude and explanatory power of CBM is uncertain. Analysis of the nine villages suggests that CBM may not be a feasible strategy in all villages due to existing property rights regimes and that an external catalyst may be required in villages where harvesters do not perceive any economic benefit to CBM.

Keywords: *Tricholoma matsutake*, non-timber forest products, community-based management, South Korea

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1. Introduction

Tricholoma matsutake (S. Ito and S. Imai) Singer is a wild harvested ectomycorrhizal fungus that produces a highly valuable mushroom. The commercialisation of the matsutake mushroom provides significant economic benefits to rural communities, mainly in China, Japan and South Korea (He 2010; Faier 2011; van Gevelt 2013). Recently, a growing body of research focusing on China's Yunnan province has raised questions concerning the effects of commercialisation on harvesting behaviour and matsutake supply (e.g. Yang et al. 2008; Amend et al. 2010; Huber et al. 2010). One key question arising from this literature is whether or not community-based management (CBM) has a positive impact on matsutake supply (e.g. Yeh 2000; Arora 2008; Yang et al. 2009; Menzies and Li 2010).

My study helps answer this question by surveying nine mountain villages in Gangwon and North Gyeongsang provinces in South Korea – a country where matsutake commercialisation has been ongoing since the 1960s. Four villages were found to engage in CBM of matsutake harvested from state-owned forests. CBM of matsutake in each of the villages began in the late 1980s through early 1990s and continues as of September 2013. The impact of CBM on matsutake supply was estimated using qualitative and quantitative data collected from village-leader surveys, household surveys and the Korea Forest Service's geographic information system. Findings suggest that CBM has a positive impact on matsutake yields.

2. Matsutake commercialisation and harvesting pressure

In South Korea, matsutake commercialisation has contributed significantly to the incomes of many mountain village communities since the 1960s (Koo and Park 2004). Matsutake tend to be harvested by mountain villagers from nearby privately-owned or state-owned forests. Owners of private forests harvest matsutake themselves or lease their forests to other harvesters on contracts ranging from 1 to 5 years in duration. For state-owned forests, villagers resident in nearby villages were given *de facto* harvesting rights in exchange for informal duties, such as patrolling forests to prevent forest fires. In the late 1980s, outsiders cited Article 302 of the Civil Act Code and argued that there was no legal basis for harvesting rights for state-owned forests to be solely allocated to nearby mountain village households. The argument was that Article 302 only guaranteed nearby villagers customary harvesting rights for grass and tree products from state-owned forests. As Article 302 did not explicitly mention mushrooms, outsiders began to harvest significant amounts of the lucrative matsutake from state-owned forests (Bae and Kim 2003; Koo pers. com. 2013). In the late 1990s, the Korea Forest Service (KFS) – the government agency responsible for forest ordinances and law – attempted to address the issue by reforming matsutake harvesting rights. Under the currently ongoing system, the KFS issues 1-year leases of matsutake harvesting rights for plots of state-owned forests to villagers in nearby villages through an open tender system. In practice, however, village leaders serve as

intermediaries between the KFS and villagers. Harvesting rights are tendered at the rate of one-tenth of the mean matsutake production value as calculated over a 4-year period by the KFS (Koo and Park 2004; Berch et al. 2007). In addition, the KFS enacted legislation making illegal harvesting of matsutake a prosecutable offense (Bae and Kim 2003).

The matsutake season begins in early September and lasts until late October or early November. Harvesting matsutake is physically intensive work with the majority of harvesters spending at least 20 days a season harvesting in 2009 and making up to four trips per day into the forest (KFS 2010). The economic value of individual mushrooms is judged according to the National Forestry Cooperatives Federation guidelines. Table 1 describes the grading system and uses 5 years of auction data to show the significant differences in price between grades. The main determinant of a matsutake mushroom's grade class is at what point in its fruiting process the mushroom is harvested. Harvested matsutake tend to be sold through a variety of supply channels, including: the regional office of the National Forestry Cooperatives Federation, local agricultural cooperatives, directly to traders or wholesalers, and directly to final consumers.

2.1. Harvesting pressure

Long-term scientific studies on the ecological impact of harvesting matsutake do not exist. Luoma et al. (2006), however, studied the ecological impact of harvesting *Tricholoma magnivelare* (Peck) Redhead – a close relative to matsutake – on yields over a 10-year period in North America. Luoma et al. (2006) found that careful harvesting of *T. magnivelare* had no negative effect on mushroom yields over the 10-year period. However, when harvesting involved raking the soil layer to uncover mushrooms there was a significant decrease in mushroom yields. More generally, Egli et al. (2006) studied the effects of systematic harvesting of wild mushrooms over a 30-year period. Findings suggest that careful systematic harvesting of wild mushrooms had no negative effect on yields. However, trampling of the forest floor reduced the number of fruiting mushrooms.

Table 1: Grading system.

	Characteristics	Mean price per kg (US Dollars)	Minimum price per kg (US Dollars)	Maximum price per kg (US Dollars)
Grade 1	Young mushroom; fully attached veil; more than 8 cm tall	$423	$112	$1106
Grade 2	Veil <1/3 opened; asymmetrically slender stem; 6–8 cm tall	$333	$91	$771
Grade 3a	Veil more than 1/3 opened; <6 cm tall	$255	$71	$579
Grade 3b	Unsorted	$206	$58	$484
Grade 4	Deformed; damaged	$140	$14	$327

Data obtained from NFCF (2008–2012).

Recent literature on matsutake in China suggests that commercialisation has led to the harvesting of immature mushrooms and the trampling of the forest floor. The harvesting of immature mushrooms can have a negative effect on yields for two reasons. Firstly, the harvesting of immature mushrooms may involve raking the soil layer. Assuming that the findings of Luoma et al. (2006) are correct and applicable to matsutake, this may significantly decrease yields. Secondly, harvesting immature mushrooms may reduce genetic diversity and the resilience of matsutake to long-term ecological change. This is because matsutake reproduces through spores which are unable to disperse when mushrooms are young (Amend et al. 2010). As for the trampling of the forest floor, interviews with harvesters by Yang et al. (2008) suggest that this is likely as harvesters tend to spend between 5 and 7 hours each day in the forest searching for mushrooms.

In the more mature matsutake markets of Japan and South Korea, there is almost no explicit mention of matsutake harvesting having any ecological implication (Faier 2011). This is because the majority of research has focused on cultivation and forest management techniques to improve yields (Tsing and Satsuka 2008). There are, however, sustainable harvesting guidelines developed by the research arm of the Korea Forest Service: the Korea Forest Research Institute. These guidelines were developed on the basis of field experiments undertaken in the Korea Forest Service's experimental matsutake forest in Hongcheon, Gangwon province and recommend that mushrooms be harvested 4–5 days after breaking through the soil. During these 4–5 days, mushrooms should be nurtured by covering the mushrooms with soil or a tin can. To harvest, a wooden stick should be inserted into the soil near where the mushroom has emerged and be gently pushed upwards so as not to damage the mycelia. After harvesting, harvesters should cover any gaps in the soil with adjacent soil in order to improve the chance of fruiting in the following year (Koo 2006). The guidelines are disseminated to harvesters at seminars organised to help harvesters maximize their income. A study by the Korea Forest Service (2010) found that 116 out of 350 surveyed harvesters participated in these seminars of which 88 harvesters purported to follow the harvesting guidelines.

3. Community-based management of matsutake

The logic underlying community-based management of natural resources is that communities of resource users are sometimes better placed to sustainably manage a natural resource than other regulatory actors due to, among other factors: a more accurate ability to identify sustainability issues; the ability to allocate resources more efficiently; lower information costs; and local institutions and customary practices that facilitate monitoring and enforcement (e.g. Larson 2003; Armitage 2005). Whether or not CBM is optimal for managing a particular natural resource in a particular community, however, remains uncertain although meta-analysis of case studies, mostly focusing on common-pool resources, has revealed factors that are conducive or not conducive to successful CBM (e.g. Ostrom 1990, 2007;

Agrawal 2001, 2003). Drawing on this literature, Brooks and Tshering (2010) suggest that the characteristics of matsutake are conducive to CBM. In particular, matsutake is a static resource with mushrooms fruiting near human communities in a relatively predictable area. In addition, mushrooms tend to fruit annually, harvesting does not require extensive infrastructure, and the economic value of matsutake tends to be extremely high.

3.1. Examples of community-based management of matsutake

The literature on community-based management of matsutake is thin. In the English language, there are only a handful of case studies of rural communities in Bhutan, China and Japan. Starting with Bhutan, Brooks (2010) and Brooks and Tshering (2010) studied two rural communities that together harvest the majority of Bhutan's matsutake. Brooks (2010) found that there were no institutions or rules governing any aspect of harvesting in both communities. However, in 2000, harvesters from one of the communities attempted to manage the harvesting of matsutake by forcing harvesters to comply with sustainable harvesting guidelines. The village leader and community leaders did not support the initiative and the attempt subsequently failed. Additionally, some harvesters did not agree as they did not want to be monitored in the forest. Brooks (2010) suggests that the lack of CBM in both communities is the result of harvesters not perceiving any need for regulations as harvesters were able to earn sufficiently high levels of income from harvesting individually. Brooks and Tshering (2010) analyse why neither of the two communities undertook CBM and suggest four main reasons: no leadership; the complex ecological dynamics of matsutake; the difficulty of enforcing sustainable harvesting guidelines; and the reluctance of communities to bear the costs of CBM.

Yeh (2000), Arora (2008), Yang et al. (2009) have documented case studies of CBM of matsutake in Yunnan province, China. Matsutake commercialisation is relatively new in China having begun in earnest in 1986 (He 2010). Some villages, however, began experimenting with locally devised guidelines governing the harvesting of matsutake within a decade of commercialisation (Arora 2008). Yeh (2000) found that a number of villages regulate the timing of harvesting and who can harvest. Arora (2008), in a study of two villages, found that the village leaders played a prominent role in CBM. In addition to limiting who can harvest through charging harvesting fees for village-outsiders and arranging forest patrols, rest days were proclaimed by the village leaders in order to allow young mushrooms to mature before being harvested and for harvesters to engage in agriculture and other livelihood activities without fear of losing out on the harvest. Yang et al. (2009) studied eight villages and found two types of CBM regimes: common access with weak enforcement of harvesting rules, and common access with strong enforcement of harvesting rules. An interesting finding was that CBM in three of the villages had shifted from being characterised by strong enforcement of rules to having weak enforcement of rules.

Japan has a long tradition of CBM of matsutake (Hosford et al. 1997). The earliest known record dates back to 1665 with the whole bidding system (Motoyoshi 1989 cited in Saito and Mitsumata 2008). The whole bidding system begins by dividing the village's forests into parcels. The matsutake harvesting rights for each parcel of forested land are auctioned at a village meeting. Once harvesting rights are acquired by a successful bidder, no one is allowed to enter the forest parcel without the bidder's permission. The revenue obtained from the auction process contributes to the village fund and is used for village improvements. What is especially unique about the whole bidding system is that privately-owned forests are included and auctioned along with village-owned forests. Saito and Mitsumata (2008) studied the whole bidding system in three villages in north-central Kyoto Prefecture. Two of the villages had adopted a partial bidding system where some private forests were exempt from the auction process. This was due to the insistence of private forest owners that they should have the right to harvest matsutake from their own land. The third village – where all forested land is communally owned – had a system where some forest parcels were auctioned to individual bidders. For the remaining forest parcels, villagers cooperated and harvested matsutake together.

To the author's knowledge, there are no studies on CBM of matsutake in South Korea published in English and very few studies published in Korean. Bae and Kim (2003) represent the most in-depth Korean study. According to interviews conducted by Bae and Kim (2003) in five villages in North Gyeongsang province, it is possible that CBM for matsutake existed as far back as the Joseon Dynasty (1392–1897) as a result of the government's "Tax on Forest Products for National Needs" programme (Bae 2004). Bae and Kim (2003) detail eligibility requirements, rules for harvesting and punishment mechanisms for the three villages. The eligibility requirements included the length of time that the household has lived in the village, how many months per year the individual resides in the village and the size of land holdings. Harvesting rules included: restricting sales channels, contributing to the harvesting rights rental fee, dividing the forested land into parcels and harvesters into groups, and setting times for the first harvest and the last harvest of the day. Punishment strategies in the three villages included fines, temporary suspension of membership and, as a last resort, expulsion.

4. Methods for data collection and analysis

4.1. Sample villages

Nine mountain villages in Seo township, Yangyang county, Gangwon province and Jaesan township, Bonghwa county, North Gyeongsang province were selected for this study (see Figure 1). Both counties have historically been among the most productive regions in South Korea for matsutake and continue to account for a significant proportion of South Korea's production (KFRI 1999; NFCF 2013). Within the townships, villages were selected on the basis of the number of households.

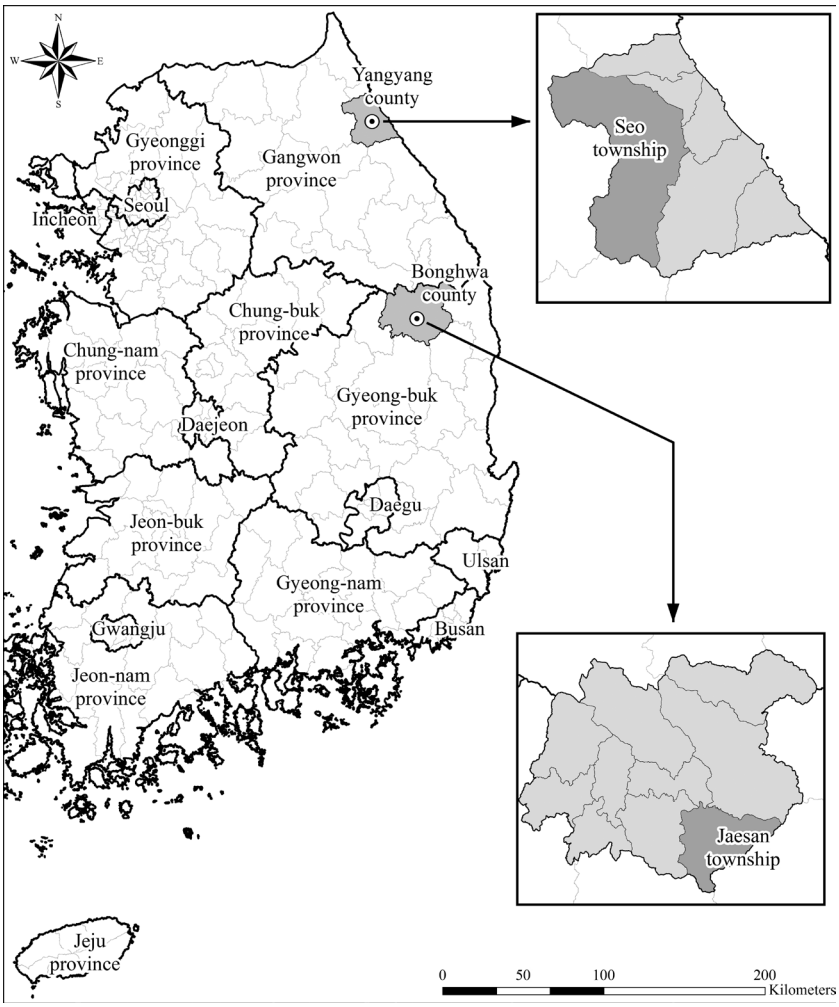

Figure 1: Fieldwork sites.
Data source: Korea Forest Service (2012) Geographic Information System.

4.2. Data collection

Data were collected as part of a larger project focusing on non-timber forest products with a special focus on matsutake. From March to June 2012, village-level and household-level surveys were administered to nine village leaders and 185 households. The household sampling strategy consisted of surveying all occupied households during a period of 3 days spent in each village. The village-leader survey included questions on demographics, infrastructure, and led into an in-depth semi-structured interview focusing on CBM of matsutake. The

household survey included questions on the household, assets and disaggregated income (see van Gevelt 2013). A follow-up phone survey was administered beginning in September 2013 to 59 households that resided in villages before and after CBM. The survey focused on villager perceptions of the impact of CBM on matsutake yields. Lastly, ecological data from the Korea Forest Service's geographic information system were collected to control for ecological variables in the econometric analysis.

4.3. Data analysis

Ideally, the impact of CBM on matsutake supply can be understood through the collection of yield data over a number of years before and after CBM of matsutake began. Due to data limitations, however, this was not possible. Instead, village leaders were asked if yields had increased or decreased after CBM commenced and, if so, by approximately how much. A follow-up survey was administered to 59 households to triangulate the village-leader reports on yield changes. Households were asked whether there was a decrease in yields, no change in yields, a small increase in yields, a medium increase in yields, or a significant increase in yields.

Censored regression analysis was used as another tool to evaluate the impact of CBM on matsutake supply. Starting from the assumption that differences in matsutake yields (using household revenue derived from matsutake as a proxy for yields) between villages that undertake CBM or do not undertake CBM of matsutake should be persistent over time, regression analysis was used to investigate if CBM of matsutake was correlated to higher yields. A tobit regression was run as data is subject to left censoring. The dependent variable is the revenue earned by each household from harvesting matsutake during the 2011 harvest season. The independent variables include: dominant tree species; dominant form of forest ownership; the distance from the village to the nearest large market and cooperative; the number of harvesters in the village; the age of the household head; the gender of the household head; the number of years of education of the household head; household size; the amount of forested land owned or privately rented; the amount of agricultural land owned or privately rented; and whether or not the village engages in CBM of matsutake. The independent variables are drawn from village-leader and household surveys and the Korea Forest Service's geographic information system. The independent variables control for geographical and socio-economic differences that may also explain differences in matsutake revenue. Data analysis was undertaken using STATA 11/IC.

5. Results

5.1. Community-based management of matsutake: origins and operation

Of the nine villages sampled, four villages engaged in CBM of matsutake: Yeongdeok village, Seorim village, Suri village and Dongmyun 2 village. The other five villages did not engage in CBM. CBM of matsutake did not include

harvesting from privately-owned forests and was strictly limited to state-owned forests.

5.2. Yeongdeok village

Yeongdeok village is located at the top of the Taebaek mountain range at an altitude of 530 m. The climate is middle temperate and the forest composition is a mixture of *Pinus denisflora* Siebold and Zucc. (Japanese red pine) and *Quercus mongolica* Fisch. ex Turcz. (Mongolian oak) with an average forest stand age of 44 years. The majority of forests are state-owned. As of June 2012, the village had a population of 38 households. The village is located approximately 15 minutes by bus from the nearest large market and agricultural cooperative.

Yeongdeok village began CBM of matsutake in the late 1980s. According to the current village leader, demand for matsutake peaked in the 1980s. In response, villagers intensified their harvesting and increased competition led to fights between villagers and the harvesting of immature mushrooms. Prior to engaging in CBM, harvesting was undertaken by households or by small groups of households who would share their harvest among themselves. At a regular village meeting in the late 1980s, the issue of matsutake harvesting was raised and villagers unanimously agreed to cooperate and engage in CBM in order to govern harvesting practices. According to the current village leader, matsutake yields increased by approximately 20–30% as a direct result of CBM.

In 2012, 30 households harvested matsutake from state-owned forests. Three plots of state-owned forest were rented by the village from the Korea Forest Service. The 30 households were divided into three teams of ten households and each group was allocated exclusive harvesting rights over one of the forest plots. Teams rotate forest plot every year. Within each group, all households contributed equally to the rental fee of the assigned forest plot and were given the freedom to decide on the specifics of harvesting. The only mandatory condition was that all harvested matsutake were sold to the Yangyang agricultural cooperative. Transportation of daily harvests to the cooperative were organised at the village-level and used village funds. Within each group harvesting income was shared equally among households.

In order to harvest matsutake from state-owned forests, a household had to have enough "village points" and be accepted by majority vote at a village meeting. Village points were accrued through participating in village meetings and other social activities, and helping out in communal tasks. In practice, it takes approximately 2 years for a household to earn enough village points to apply to harvest matsutake. No explicit punishment mechanisms were mentioned despite the village leader and surveyed harvesters being asked multiple times.

5.3. Seorim village

Seorim village is adjacent to Yeongdeok village at the top of the Taebaek mountain range and located at an altitude of 702.57 m. The climate is middle temperate.

The dominant tree species is Mongolian oak and the average forest stand age is 45 years old. The majority of forests are state-owned. As of June 2012, the population was 52 households. The village is approximately 13 minutes by bus from the nearest large market and agricultural cooperative.

Seorim village began CBM of matsutake in the mid-to-late 1980s. Before engaging in CBM, households independently organised themselves into small harvesting groups. Groups would begin harvesting before dawn in order to be able to harvest a sufficient amount of matsutake due to competition with other harvesters and the time it takes for each group to cover a significant amount of mountainous forests. Competition among harvesters meant that villagers tended to harvest immature matsutake instead of allowing the mushroom to mature and to be sold at a higher price. The issue of matsutake harvesting was brought up at a village meeting by a group of households. The villagers unanimously decided to undertake CBM to regulate matsutake harvesting. Interestingly, the main motivation for forming a CPR institution was to allow villagers to devote less time to harvesting. As a result of CBM, the current village leader estimates that yields increased by approximately two-thirds.

In 2012, 25 households harvested matsutake from state-owned forests. Five plots of forested land were rented from the Korea Forest Service and the 25 households were organised into five teams. Each team was allocated a forest stand with groups rotating forest stand annually. Participating households begin harvesting at 7 am. All harvested matsutake is collected from the five groups and transported by the village van to the agricultural cooperative every day. Participating households were paid a wage for their harvesting contributions that was calculated on the basis of the total income obtained from the harvest and the number of days that the harvester participated in harvesting. Wage payments were made at the end of the harvesting season. Similarly to Yeongdeok village, no explicit punishment mechanisms were mentioned by the village leader or surveyed households.

5.4. Suri village

Suri is located at the middle of the Taebaek mountain range at an altitude of 166.23 m. The climate is middle temperate. Forest stands are Japanese red pine dominated and mostly privately owned. The average age of forest stands is 47 years. As of June 2012, Suri consisted of 90 households. It takes approximately 60 minutes by bus to reach the nearest large market and agricultural cooperative.

Suri began CBM of matsutake in the mid-1980s. Before CBM, households or small groups of households competed to harvest matsutake from state-owned forests. Verbal conflict between harvesters was common during this period. It is unclear whether the suggestion of engaging in CBM was brought up by an individual or by a group of individuals. It is also unclear what the exact reason for suggesting cooperation was, although the current village leader believes that the reason was intense competition among harvesters due to an increase in the

demand and price of matsutake in the mid-1980s. The decision to engage in CBM was not unanimously agreed upon as some households argued that cooperating would decrease their harvesting income. The households who did not agree to CBM chose not to harvest from state-owned forests and instead continued to harvest individually from privately-owned or privately-rented forests.

In 2012, 60 households harvested matsutake from state-owned forests. Harvest ing rights were acquired for six plots of state-owned forest. The 60 households were divided into six groups and allocated exclusive harvesting rights over one plot of forested land. Each group was responsible for the harvesting fee for their allocated forest plot and households contributed equally. Groups rotated forest plot annually. Income from the harvested matsutake was shared equally among group members and all harvested matsutake must be sold to the agricultural cooperative. Although it is the responsibility of each group to arrange daily transportation of the harvest, groups cooperated and shared the financial and logistic burden of transportation. In order to be eligible to harvest matsutake from state-owned forests, a household must have been permanently resident in the village for at least 7 years and be approved at a village meeting. When asked about punishment mechanisms, the village leader and surveyed harvesters said that they were not necessary.

According to the village leader, CBM of matsutake did not result in a particularly noticeable change in matsutake yields. Instead, the most visible benefit from CBM was a decrease in competition among harvesters. Another benefit of CBM has been an increased capability to enforce the villagers' collective harvesting rights over state-owned forests. This has reportedly decreased the amount of matsutake harvested illegally by outsiders.

5.5. Dongmyun 2 village

Dongmyun 2 village is the only sampled village from Jaesan township that undertakes CBM of matsutake. Dongmyun 2 village is located at the top of the Sobaek mountain range at an altitude of 525 m. The climate is northern temperate. The surrounding forest stands are Japanese red pine dominated with an average age of 42 years. The majority of forest stands are privately owned. As of June 2012, the village had a population of 83 households. The village is located 40 minutes away by bus from the nearest large market and regional office of the National Forestry Cooperatives Federation.

Dongmyun 2 village began CBM of matsutake in 1994. Prior to 1994, households without privately-owned forests harvested matsutake from state-owned forests individually. Rising demand for matsutake led to intensified competition among harvesters in the mid-to-late 1980s. According to the village leader, increased competition led to unsustainable harvesting pressure which decreased yields, especially as immature mushrooms were harvested. Another serious issue was significant theft of matsutake by outsiders.

Despite these issues, the idea of engaging in CBM did not come from within the village. Instead, a research director from the Korea Forest Service visited

the village in 1994. The research director had previously undertaken research on matsutake yields in the township and was known to the village leader. With the help of the village leader, the research director called a village meeting and strongly urged the villagers to cooperate in harvesting matsutake by stressing the positive impact that cooperation would have on yields and income. Initially, villagers were skeptical as they thought that cooperating would decrease income. Despite this skepticism, the villagers implemented CBM of matsutake with advice from the research director. According to the village leader, total income from matsutake increased by a factor of three almost immediately. Furthermore, villagers were able to cooperate in actively monitoring the forest for harvesting by outsiders which purportedly decreased the amount of illegally harvested matsutake.

In 2012, 50 households harvested matsutake from state-owned forests. Five plots of state-owned forest were rented by the village and the participating households were divided into five groups. Each group was allocated one plot of forested land with groups rotating forest plot annually. Each group was responsible for the harvesting fee for its allocated forest plot and shared both the harvesting fee costs and income equally among group members. When asked about formal rules concerning eligibility for membership and punishment mechanisms, the village leader and surveyed harvesters responded that there were none and that any such rules were unnecessary. A detailed interview with a villager who did not harvest from state-owned forests but instead harvested matsutake from his own private forest said that, in practice, community norms determine who is eligible to harvest matsutake from state-owned forests and dissuade members from disobeying harvesting rules.

5.6. Villages without community-based management of matsutake

5.6.1. Sangpyeong village

Sangpyeong village is located in Seo township at the foot of the Taebaek mountain range with an altitude of 79.29 m. The climate is middle temperate. Forests are dominated by the Japanese red pine and the average forest stand age is 43 years old. All forests are state-owned. As of June 2012, the population was 97 households. The village is approximately 8 minutes by bus from the nearest large market and agricultural cooperative. The Sangpyeong village leader was aware of the results of CBM in the closely located Seorim, Yeongdeok and Suri villages. The village leader, however, said that since all forested land in the village was privately owned, CBM was simply not feasible. This is because each household with privately-owned forest land either harvests matsutake individually or leases the forested land privately to another tenant.

5.6.2. Ohsaek 2 village

Ohsaek 2 village is located within the Seorak mountain national park in Seo township. The village is located at the middle of the Taebaek mountain range at an altitude of 459.06 m. The climate is north temperate. The forests are a mixture

of Japanese red pine and Mongolian oak and the average stand age is 55 years. All forests are state-owned and are designated as protected forests. As of June 2012, there were 120 households in the village. The village is located 20 minutes by bus from the nearest large market and agricultural cooperative. All harvesting of matsutake in Ohsaek 2 village is technically illegal due to the protected status of forests. Despite this, individual households harvest matsutake from state-owned forests either by themselves or with neighbours, family or friends. There is no CBM of matsutake because a formalized institutional structure to harvest matsutake would raise too much awareness of the fact that households harvest matsutake illegally from protected forests.

5.6.3. Kalsan 1 village

Kalsan 1 village is located in Jaesan township at the middle of the Sobaek mountain range at an altitude of 567.99 m. The climate is north temperate. The majority of forests are privately owned and the dominant species is the Japanese red pine. The average stand age is relatively young: 28 years old. As of June 2012, the village consisted of 90 households. The nearest large market and forest cooperative is approximately 35 minutes away by bus. Villagers in Kalsan 1 village were aware of the success of Dongmyun 2 village's CBM efforts. Despite this knowledge, the village leader reported that villagers did not see any reason for CBM as they felt that individual harvesters were able to earn more than enough income from matsutake without needing to cooperate.

5.6.4. Hyeondong 1 village

Hyeondong 1 village is situated at the foot of the Sobaek mountain range in Jaesan township. The village is located at an altitude of 417.43 m and the climate is middle temperate. The majority of forests are privately-owned. The dominant species is Japanese red pine and the average stand age is 37 years old. Hyeondong village serves as the commercial and social hub for Jaesan township's villages. The village is approximately 30 minutes away from the nearest large market and forest cooperative. As of June 2012, the population was 70 households. Similarly to Kalsan 1 village, villagers in Hyeondong 1 village were aware of the success of CBM in Dongmyun 2 village. According to the village leader, however, villagers did not think that cooperating would increase the economic returns from matsutake harvesting and no effort to engage in CBM was made.

5.6.5. Dongmyun 1 village

Dongmyun 1 village is located immediately adjacent to Dongmyun 2 village. Until the late 1960s, Dongmyun 1 and Dongmyun 2 villages were formerly joined as Dongmyun village. As a result, the ecological and forest ownership characteristics of the two villages are similar and residents know each other very well. As of June 2012, Dongmyun 1 village consisted of 70 households. Dongmyun 1 village presents a very curious case considering the proximity of the village to Dongmyun 2 village and the shared history and kinship ties. Villagers in Dongmyun 1 village

observed first-hand the impacts of CBM on matsutake yields in Dongmyun 2 village. Despite this, however, the village leader noted that villagers did not think that engaging in CBM of matsutake would lead to significant economic benefit. It is also important to note that the KFS research officer, who visited Dongmyun 2 village, did not visit Dongmyun 1 village.

5.7. Evaluating the impact of CBM on matsutake yields

Three village leaders recalled significant increases in yields after the village engaged in CBM of matsutake (see Table 2). According to their respective village leaders, Seorim village and Dongmyun 2 village witnessed the most significant increases, followed by a more modest yet significant increase in yields in Yeongdeok village. The village leader of Suri village, however, recalled approximately the same level of yields or only a small increase in yields after CBM began in the village. Harvester perceptions largely corroborate the views of village-leaders although there are a number of discrepancies concerning the magnitude of yield changes (see Table 3). All 59 households surveyed recalled that yields had increased. Overall, 8.48% of surveyed households recalled large increases in yields, 69.49% a medium increase in yields and 22.03% a small increase in yields. For Yeongdeok village and Seorim village, harvester perceptions of yield change are broadly in line with village leader perceptions. For Suri village, not one household recalled no change in yields. Instead 38.1% of sampled households recalled a small increase and 61.9% of households a medium increase in yields. This suggests that the impact of CBM on matsutake yields may be stronger than suggested by the village leader. For Dongmyun 2 village, no surveyed households perceived a large increase in yields. Instead, 85% of respondents recalled a medium increase in yields and 15% of respondents a small increase in yields. This stands in contrast to the perceptions of the village leader, although the 300% increase recalled was in terms of income and not yields. The results from the Tobit regression model are shown in Table 4. Controlling for other potential explanatory variables, the results show that CBM is statistically significant at the 10% significance level. This suggests that CBM is positively correlated to the log of household revenue[1] derived from matsutake (a proxy for matsutake yields).

Table 2: Village-leader perceptions of yield changes after CBM.

	Yield change
Yeongdeok	Increased (20–30%)
Seorim	Increased (67%)
Suri	Same/small increase
Dongmyun 2	Increased (300% proxied by income)

Data obtained from author's surveys (2012).

[1] The logarithm of harvester revenue is used to correct for high skewness and non-normal kurtosis.

Table 3: Harvester perspectives perceptions of yield changes after CBM.

	Yields decreased	No change	Small increase in yields	Medium increase in yields	Large increase in yields
Yeongdeok	0	0	2 (18.18%)	7 (63.64%)	2 (18.18%)
Seorim	0	0	0	4 (57.14%)	3 (42.86%)
Suri	0	0	8 (38.10%)	13 (61.90%)	0
Dongmyun 2	0	0	3 (15%)	17 (85%)	0
Total	0	0	13 (22.03%)	41 (69.49%)	5 (8.48%)

Data obtained from author's surveys (2013).

6. Discussion

Analysis of qualitative and quantitative data indicates that CBM of matsutake has had a positive impact on matsutake yields, although the exact magnitude

Table 4: Regression results.

Variables	Log of matsutake revenue
Broadleaf dominated	0.214
	(0.550)
Mixed species	0.254
	(0.376)
Private ownership	–0.163
	(0.371)
Distance to market/coop	–0.00223
	(0.0103)
Number of harvesters	0.00756
	(0.0106)
Age	–0.0138
	(0.00915)
Gender	–0.453*
	(0.259)
Education	–0.0253
	(0.0262)
Household total	0.0530
	(0.0811)
Forested land	4.19e-05***
	(7.67e-06)
Agricultural land	7.49e-05**
	(3.10e-05)
CBM	0.601*
	(0.305)
Constant	3.519***
	(0.896)
Observations	175

Standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Log likelihood: –253.16696***.
Data obtained from author's surveys (2012) and KFS (2013).

and explanatory power of CBM is uncertain. Villager and household perceptions are, with the partial exception of the village leader in Suri village, unanimous in recalling that CBM has had a positive impact on matsutake yields. The magnitude of the positive impact of CBM on matsutake yields, however, is unclear due to the significant recall time involved in comparing yields before and after CBM. Results from censored regression analysis suggest that CBM is positively correlated at the 10% significance level with higher harvester revenue derived from matsutake (a proxy for matsutake yields). Although the coefficient of CBM is relatively high, it is difficult to ascertain the magnitude of the impact of CBM on matsutake yields due to the relatively small sample size, the difficulty in controlling for all other explanatory variables, and the assumption that differences in harvester revenue (a proxy for yields) for harvesters in villages undertaking CBM and in villages that do not undertake CBM are persistent over time. In addition, CBM provided other benefits to harvesters. These included: increasing the time available for villagers to spend on activities other than harvesting; pooling together resources for the sale of matsutake; and a purported increased ability to protect forests from illegal harvesters

Another encouraging finding is the robustness of CBM in all four villages. CBM in all four villages began when tenure to harvesting rights was issued informally by the KFS. CBM in all four villages adapted to the formalization of harvesting property rights in the late 1990s and continue to function as of September 2013. Additionally, CBM in all four villages has largely operated under the radar of the KFS, with no official forest policies recognizing CBM of matsutake and a significant number of researchers at the KFS and in forestry departments at universities and government research institutions unaware of the existence of CBM of matsutake.

The robustness of CBM is somewhat surprising given that mountain villages have undergone significant change over the past three decades and that there has been a notable decline in traditional forms of cooperation between villagers due to South Korea's economic development and urbanization (Turner et al. 1993; Park 2010). Another interesting finding is that the robustness of CBM and the enforcement of rules seem not to require or rely on overt punishment mechanisms. This finding stands in stark contrast to the findings reported by Bae and Kim (2003) who detailed a set of punishment strategies in their study of villages in Uljin county, North Gyeongsang province. It is possible that, as recounted by a villager who did not participate in the CPR, that informal norms are sufficient and that more formal rules may well have been in place when the CPR were initially formed. This is supported by anthropological studies of Korean villages (e.g. Brandt 1971; Eikemeier 1980; Sorensen 2013).

A reading of the formation of CBM in the four surveyed villages and of explanations concerning the decision not to engage in CBM in the remaining five villages suggest that CBM may not always be a feasible strategy and that an external trigger may be required to kick start CBM in some villages. For example, existing property rights regimes in Sangpyeong village and Ohsaek 2 village

made it effectively impossible to engage in CBM. Specifically, Sangpyeong village was unable to engage in CBM as all matsutake forests were privately-owned and privately harvested or leased. In Ohsaek 2 village, where matsutake were illegally harvested from protected state-owned forests, any attempt to engage in CBM would potentially draw attention from the authorities. In Jaesan township, however, it is notable that none of the four sampled villages internally decided to engage in CBM. Instead, the only CBM example found required the external intervention of a respected actor. In the three villages without CBM, all of which noted the positive impact of CBM on matsutake yields, villagers did not perceive a significant economic benefit to CBM. This suggests that in some cases a respected external actor[2] may be required to push a given community into engaging in CBM of matsutake.

Another variable that may help explain why only three villages internally decided to engage in CBM is the proportion of households who harvest matsutake from state-owned forests (see Table 5). Among the three villages which engaged in CBM without external influence, the average proportion of households harvesting matsutake from state-owned forests was approximately 65% as of 2012. Among the three villages where an explicit reason for not engaging in CBM was the perceived lack of economic benefit to harvesters, the average proportion was 22%. This suggests that matsutake may have been more salient in the villages where CBM did not take place and may help explain why villagers perceived that CBM would not result in significant economic benefits to harvesters.

7. Conclusion

I surveyed nine mountain villages in Gangwon and North Gyeongsang provinces. Four villages began CBM of matsutake in the mid-1980s through early-1990s. In three villages, CBM began internally due to high market demand and increased competition among harvesters. In one village, a respected external actor provided the catalyst for CBM of matsutake. Qualitative and quantitative data suggest that CBM has had a positive impact on matsutake supply, although the magnitude of the impact is uncertain. Notably, all four CPR institutions are robust and have adapted to changes in the larger forest tenure system. Analysis of the five villages that did not operate CBM suggest that there may be barriers prohibiting the undertaking of CBM in certain villages and that an outside catalyst may be required in some cases where villagers do not see an economic benefit in undertaking CBM of matsutake.

[2] It is important to note that since the 1970s, South Korean villagers have been heavily reliant on extension officers and government researchers for technical expertise regarding agricultural and non-timber forest products (Park 1997).

Table 5: Key variables by village.

Village	CPR institution (date)	Trigger/constraint	Dominant tree species	Forest age	Majority forest ownership	Population	Households harvesting matsutake from state-owned forests (% of total population)	Distance to market/ cooperative	Township
Yeongdeok	Yes (1980s)	Internal	Mixed	44	State	38 hh	79%	15 min	Seo
Seorim	Yes (1980s)	Internal	*Q. mongolica*	45	State	52 hh	48%	13 min	Seo
Suri	Yes (1980s)	Internal	*P. denisflora*	47	Private	90 hh	67%	60 min	Seo
Dongmyun 2	Yes (1994)	External	*P. denisflora*	42	Private	83 hh	60%	40 min	Jaesan
Sangpyeong	No	Property rights	*P. denisflora*	43	Private	97 hh	0%	8 min	Seo
Ohsaek 2	No	Property rights	Mixed	55	State	120 hh	9%	20 min	Seo
Kalsan 1	No	No benefit	*P. denisflora*	28	State	90 hh	13%	35 min	Jaesan
Hyeondong 1	No	No benefit	*P. denisflora*	37	Private	126 hh	16%	30 min	Jaesan
Dongmyun 1	No	No benefit	*P. denisflora*	42	Private	70 hh	37%	40 min	Jaesan

Data obtained from author's surveys (2012) and the Korea Forest Service's geographic information system (2012).

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