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The role of state institutions in non-timber forest product commercialisation: a case study of *Tricholoma matsutake* in South Korea

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SUMMARY

Two major barriers to non-timber forest product (NTFP) commercialization are a thin market structure and ensuring long-term supply. There is a growing literature suggesting potential solutions to address these two issues. The majority of these solutions, however, marginalize the role of state institutions in favour of other institutional arrangements. This study used the example of *Tricholoma matsutake* (S. Ito and S. Imai) Singer commercialisation in South Korea to show that state institutions can play a leading role in addressing the thin market structure and ensuring long-term supply. Specifically, the Korea Forest Service (KFS) and National Forestry Cooperatives Federation (NFCF) addressed the thin market structure through the provision of a supply channel, grading system, price-setting mechanism and guidelines for transportation. In order to help ensure long-term supply, the KFS and NFCF support and undertake forest management activities. This case study shows that state institutions should be seriously considered along with other institutional solutions when tackling barriers to NTFP commercialisation.

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

Rôle des institutions d'état dans la commercialisation des produits forestiers autres que le bois: une étude-cas du *Tricholoma matsutake* en Corée du Sud

T. VAN GEVELT

Deux obstacles majeurs à la commercialisation des produits forestiers autres que le bois (NTFP) sont la structure fragile du marché et l'assurance d'une production durable. Une littérature suggérant des solutions potentielles pour faire face à ces deux questions est actuellement en plein essor. Toutefois, la majorité de ces solutions marginalise le rôle des institutions d'état en faveur d'autres arrangements institutionnels. Cette étude utilise l'exemple de la commercialisation du *Tricholoma matsutake* Singer (S. Ito et S. Imai) en Corée du Sud, pour mettre en évidence que les institutions d'état peuvent jouer un rôle directif pour faire face à la situation fragile du marché et pour assurer une production durable. Plus précisément, le Service forestier coréen (KFS) et la Fédération des coopératives des forêts nationales (NFCF) se sont penchés sur la structure fragile du marché en fournissant un canal d'alimentation, un système de gradation, un mécanisme d'établissement des prix et des suggestions pour une organisation du transport. Afin d'aider à assurer une production durable, le KFS et la NFCF soutiennent et entreprennent des activités de gestion forestière. Cette étude-cas montre que les institutions d'état devraient être considérées sérieusement, à l'instar d'autres solutions institutionnelles, quand il est question de faire face aux entraves à la commercialisation des NTFP.

El rol de las instituciones estatales en la comercialización de productos forestales no-madereros: un estudio de caso del *Tricholoma matsutake* Singer en Corea del Sur

T. VAN GEVELT

Una estrecha estructura de mercado y el asegurar una oferta en el largo plazo constituyen dos grandes barreras para la comercialización de productos forestales no-madereros (PFNM). Existe una creciente literatura que sugiere potenciales soluciones para estos temas. La mayoría de las soluciones, sin embargo, marginan el rol del Estado en favor otros arreglos institucionales. Este estudio usa el ejemplo de la comercialización del *Tricholoma matsutake* (S. Ito y S. Imai) Singer en Corea del Sur para mostrar que las instituciones estatales juegan un rol medular en afrontar el problema de la estrecha estructura del mercado y asegurar la oferta en el largo plazo. Específicamente, el Servicio Forestal Coreano (SFC) y la Federación Nacional de Cooperativas Madereras (FNCFM) afrontan esta estrecha estructura de mercado a través de las provisiones de un canal de suministro, sistema de calificación, mecanismos de fijación de precios y directrices para el transporte. De manera de colaborar en asegurar suministros en el largo plazo, la SFC y la FNCFM apoyan y realizan las actividades de gestión de actividades forestales. Este estudio de caso muestra que las instituciones estatales deberán ser seriamente consideradas junto a otras soluciones institucionales a la hora de abordar las barreras para la comercialización de los PFNM.

INTRODUCTION

Non-timber forest product (NTFP) commercialisation has the potential to provide sustainable economic benefits to rural communities. The extent to which NTFP commercialisation can provide economic benefits is dependent on addressing the thin market structure that is characteristic of many NTFPs and ensuring long-term supply (Arnold and Ruiz-Perez 2001, Belcher *et al.* 2005, Belcher and Schreckenberg 2007, Neumann and Hirsch 2000). There is a growing literature suggesting potential solutions to address the issues of a thin market structure and to ensure long-term supply. The vast majority of these solutions, however, marginalise the role of state institutions in favour of non-state institutions and other actors (e.g. Laird *et al.* 2011, Ros-Tonen and Kusters 2011, Wynberg and Laird 2007). This study uses the example of *Tricholoma matsutake* (S. Ito and S. Imai) Singer commercialisation in South Korea to show that state institutions can play a leading role in addressing the thin market structure and ensuring long-term supply.

Matsutake is a wild harvested ectomycorrhizal fungus that produces a highly valuable fruiting body. In South Korea, matsutake commercialisation has contributed significantly to the incomes of many mountain village communities since the 1960s when the South Korean government designated matsutake an export item in order to earn foreign exchange to support its economic development (Bae and Kim 2003, Koo and Park 2004). The Korea Forest Service¹ (KFS) and National Forestry Cooperatives Federation² (NFCF) played a leading role in overcoming some of the issues caused by a thin market structure. In particular, an official supply channel, grading system, price-setting mechanism and guidelines for transportation were created to structure the market and reduce transaction costs across the value chain.

More recently, the KFS and NFCF have taken leading roles in helping ensure the long-term supply of matsutake by addressing a steady decline in yields due primarily to changes in human-forest interaction. Specifically, the KFS and NFCF research, support and undertake forest management activities for private- and state-owned forests. These forest management activities effectively mimic millennia of human-forest interaction and play an increasingly important role in ensuring the long-term supply of matsutake (Berch *et al.* 2007, Chun 2009, 2010, Koo and Bilek 1998).

THE ROLE OF STATE INSTITUTIONS

A thin market has few sellers and buyers and relatively little trading activity. This tends to lead to high transaction costs throughout the value chain (Neumann and Hirsch 2000).

Historically, state institutions have often played a key role in reducing transaction costs through structuring markets through the provision of formal infrastructure, regulation and information on prices and quality (Eggertson 1990). The importance of state institutions in reducing transaction costs has seen a resurgence with the new institutional economics literature in the 1980s and 1990s and, more recently, numerous historical examples of how state institutions reduced transaction costs in agriculture (e.g. Chang 2009) and industry (e.g. Rodrik 2007).

Markets for NTFPs are generally thin when market demand is niche, and it is difficult to supply a sufficient quantity of high quality NTFPs to meet demand due to the low density of production, yield variation due to climatic and ecological conditions, and the often rapid perishability of NTFPs (Arnold and Ruiz-Perez 2001, Belcher *et al.* 2005). The NTFP literature has recognised the need for transaction costs to be reduced through structuring markets, particularly in order to bulk up supply to sufficiently tradable quantities and to provide information on price trends to upstream actors and ensure quality to downstream actors (e.g. Belcher and Schreckenberg 2007).

With the notable exception of Finland, where state institutions have effectively reduced transaction costs (Richards and Saastamoinen 2010), the intervention of state institutions in NTFP markets has generally increased transaction costs. For example, legislation geared towards ensuring the sustainable supply of NTFPs in Mexico, and parts of Canada and the USA have been widely inappropriate due to a lack of data, relatively poor institutional capacity and a limited understanding of how NTFP markets differ from timber markets (Alexander and McLain 2001, Granich *et al.* 2010, McLain and Jones 2001, Mitchell *et al.* 2010). This has effectively increased transaction costs across the value-chain, particularly for harvesters who are required to navigate overwhelming bureaucratic requirements (Laird *et al.* 2011).

Two more extreme examples of how state institutions increased transaction costs are Cameroon and Orissa, India. In the Cameroonian case, high demand for medicinal plants led the state to implement legislation heavily taxing the commercialization of “green gold”. In addition to almost leading to a collapse of the medicinal plants sector, the introduction of taxation legislation proved difficult for upstream actors to navigate and led to exploitation, mostly in the form of informal taxes (Laird *et al.* 2010; Ndoye and Awono 2010). Another striking example is the nationalisation of the highly valuable *Diospyros melanoxylon* Roxb. (kendu leaf) in Orissa, India in the 1960s and 1970s. Under nationalisation, all harvesters were required to sell their product to the state forest department’s kendu leaf department at a fixed price set by the government. This was supposed to reduce transaction costs by

¹ The Korea Forest Service is a government agency under the auspices of the Ministry for Food, Agriculture, Forestry and Fisheries.

² The National Forestry Cooperatives Federation was founded by the government in 1962 with the remit of: organising reforestation activities and managing forests; providing loans, expertise and extension services for forest and forest product development; and collecting, storing and selling forest products. The NFCF is funded primarily by the state and operates at two levels with 142 regional offices and a federal office based in Seoul. Membership is open to all forest owners (Yoo 1997).

providing a buyer that would guarantee high prices to harvesters and by bulking-up supply. In practice, however, the kendu leaf department had the ability to refrain from purchasing a harvester's product on the premise of not being satisfied with the harvested kendu leaf. Furthermore, harvesters were remunerated at very low rates with the majority of value being captured by the state (Lele *et al.* 2010).

With very good reason, these case studies have led to a cautionary approach to the role of state institutions in NTFP markets: the 'less is more' approach (Laird *et al.* 2011).

As a result, current trends have been to support other actors and non-state institutions and to limit the role of state institutions to providing infrastructure, information and communications technology, and a regulatory framework that allows for actors to engage in the NTFP trade with little interference (Ros-Tonen and Kusters 2011, te Velde *et al.* 2006, Wynberg and Laird 2007). It is important, however, to consider the possibility for state institutions to play a more active and leading role in the NTFP market than what is currently advocated in the literature. Although examples of success cases are few and far between, both Finland and the following example of matsutake in South Korea provide examples where state institutions have been central in overcoming barriers to NTFP commercialization through reducing transaction costs.

Another formidable barrier to successful NTFP commercialisation is ensuring long-term supply. This is particularly important as commercialisation tends to result in an increase in NTFP harvesting in order to meet demand. The exact impact of commercialisation on harvesting behaviour and long-term supply depends on land tenure, the production technology, how harvesting affects regeneration and the history of human-forest interaction (Guariguata *et al.* 2001, Sunderland *et al.* 2011, Ticktin 2004, Ticktin and Shackleton 2011). In cases where long-term supply depends primarily on sustainable harvesting, customary law or bottom-up solutions are often effective in ensuring long-term supply (Laird *et al.* 2011). In some cases, however, ensuring long-term supply may depend on altering the production technology through, for example, engaging in forest management to maintain or improve yields (Belcher *et al.* 2005). Altering the production technology often requires a significant upfront investment in capital and labour with benefits accruing in the future (Koo and Bilek 1998). In these cases, it is likely that harvesters may be unable to meet the costs or are unwilling to undertake large present investments for distant benefit streams. In these cases, state institutions may be able to provide appropriate economic incentives for harvesters to undertake such activities and help ensure long-term supply of the NTFP.

METHODS AND APPROACH

This study can be divided into two sections. The first section investigated how state institutions have taken a leading role in overcoming some of the issues of a thin market structure. This was achieved by using a largely qualitative case-study approach based on fieldwork that was undertaken as part of a

larger research project in Bonghwa county, North Gyeong-sang province from May to September 2012. Specifically, the author and a research assistant participated in harvesting matsutake in Dongmyun 2 village and followed the value chain to Bonghwa (the capital city of the county), where matsutake was sold through the NFCF and directly to wholesalers. During this process, a snowball sampling procedure was used. Informal interviews were undertaken with traders ($n = 2$), wholesalers ($n = 18$) and KFS and NFCF employees ($n = 10$). The author and research assistant also observed the grading process and the auction. Lastly, data on the contribution of matsutake to household revenue in 2011 was collected from 74 harvesting households. A notable limitation of the research method is that the sample size was limited by the need to build relationships between the author and downstream actors.

Five years of data on the daily auction price and the quantity supplied for auction were collected from the NFCF. The data were used to evaluate the efficiency of the auction process as a price-setting mechanism. The hypothesis leading the data analysis was that an efficient price-setting mechanism should result in similar variation of price and quantity supplied. To analyse the data, the study used the Cuddy-Della Valle index, which estimates the variation around a trend line rather than the variation around the mean (Cuddy and Della Valle 1978).

The second section focused on how state institutions help ensure long-term supply through forest management. This was achieved through personal communication with leading scientists and academics at the Korea Forest Research Institute and the College of Forest Science, Kookmin University, an extensive literature review, and an analysis of data collected by the KFS.

ADDRESSING THE THIN MARKET STRUCTURE

Historical background

Historical records concerning matsutake date back hundreds of years in South Korea. The first known record is found in *The Chronicles of the Three Kingdoms* and details that matsutake was offered to King Sung Duk as a gift in 704 AD. A letter in *The Collected Works of Mogeun* (1328–1396) is the next known record of matsutake and recounts the prominent intellectual, Yi Saek, expressing delight at receiving matsutake as a gift (KFRI 1999). *The Annals of the Joseon Dynasty* suggest that matsutake continued to be a highly valued gift and a royal delicacy for the King, the King's court and the elites. In particular, records detail two instances in 1733 and 1768 where the King declared his appreciation of matsutake as a delicacy. Additionally, *The Annals of the Joseon Dynasty* recount that in the years 1419, 1423, 1431, 1483 and 1521 the King commanded that matsutake be given as a gift to envoys from the Ming Dynasty of which Joseon was a tributary state (National Institute of Korean History 1413–1865).

During the Joseon Dynasty (1392–1897), matsutake was demanded by the royal court in significant quantities under the “Tax on Forest Products for National Needs” programme. Under this programme, the King’s office levied specific forest product taxes on counties and prefectures. The specific forest products requested and their quantities were based on the ecology of the region and the region’s population. In turn, the county and prefecture offices forced villagers to harvest the requested forest products, which were then delivered to the King’s office (Bae 2004). In the late Joseon Dynasty, an intricate value chain emerged where middlemen and brokers purchased matsutake from harvesters and were informally responsible for their supply to government offices. Brokers generally received a fixed commission of the sale price and middlemen received an amount that differed from case to case (Bae *et al.* 2002, Chung 2006, Palais 1996).

From the late Joseon Dynasty until 1960, there is no mention of matsutake in South Korean records due to colonisation and the Korean War. By 1960, Japan’s supply of matsutake had declined significantly and demand for imports increased significantly. The South Korean government capitalised on this opportunity and began to export matsutake to Japan in order to earn foreign exchange (Koo and Park 2004). Increasing affluence in South Korea in the 1980s led to domestic demand for matsutake, mainly as a gift to give during chuseok: a major harvest festival that takes place during the matsutake fruiting period. Responding to domestic demand and increasing purchasing power, the government allowed unrestricted domestic consumption in 1996 (Bae and Kim 2003). Exports of matsutake have declined rapidly since due to high levels of domestic demand. Demand for imported matsutake (mostly

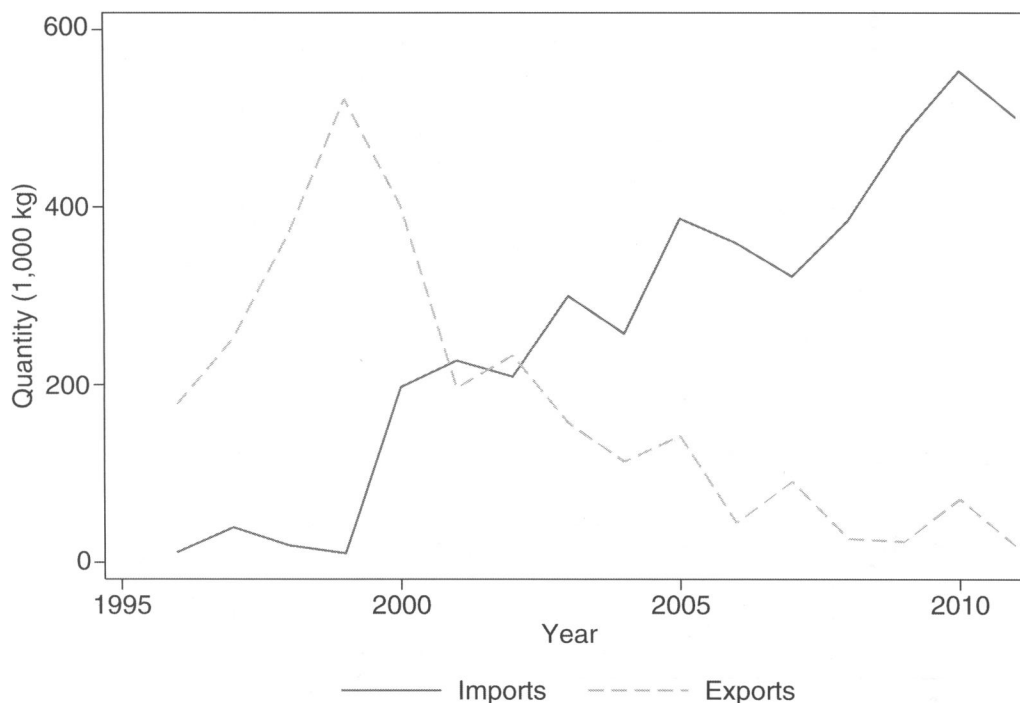
from China) has risen at such a rate that South Korea has moved from being a net exporter to a net importer (see figure 1).

The value chain

The South Korean matsutake value chain consists of harvesting, transporting, sorting, auctioning, marketing, retail and consumption. Harvesting takes place in September through late October or early November depending on climatic conditions. Harvesters are generally villagers who live in the immediate area surrounding matsutake forests (Koo and Park 2004). Forests are privately- or state-owned. In a nation-wide survey of 350 harvesters, 37% of harvesters collected matsutake from private forests and the remaining 63% of harvesters collected matsutake from state-owned forests (KFS 2010). Owners of private forests either harvest themselves or rent their forests to other harvesters. For state-owned forests, villagers living in surrounding areas were allowed to harvest matsutake from the 1960s on the basis of customary rights and in exchange for informal duties, such as patrolling the forest to help prevent forest fires during the dry season. Due to conflict between villagers and intruding outsiders over harvesting rights in the 1990s, the Korea Forest Service implemented a system where harvesting rights for plots of forest are sold to harvesters living in villages with customary rights for an annual fee (Bae and Kim 2003, Berch *et al.* 2007).

Harvesting is physically intensive work as matsutake tend to be found on relatively steep slopes. For privately- and state-owned forests, harvesting tends to be undertaken individually

FIGURE 1 Imports and Exports



Data obtained from NCF (1996–2012)

or in small groups. For some state-owned forests, harvesting is undertaken by large groups organised at the village-level through community-based management institutions. In addition, measures are often taken to ward off potential thieves from harvesting from both privately- and state-owned forests. These often include harvesting at multiple times during the day and, in some cases, camping in the forest at night. The average size of privately-owned forests is 2.9 hectares and the average size of state-owned forests is 18.3 hectares (KFS 2010).

Harvesting requires a practical understanding of matsutake ecology and experience. In particular, it is important that harvesters know when and how to harvest and how to nurture immature matsutake. Being able to locate matsutake largely depends on the experience of the harvester and predicting the annual concentric movements of the matsutake mycelium colonies, which tend to move outwards between 10–20 cm per year subject to soil conditions, the presence of other mycelium colonies and organic litter (KFRI 1999).

Prior to 2007, harvesters were legally limited to two supply channels: selling directly to the regional office of the NFCF or selling to traders who would in turn sell to the NFCF. Since 2007, however, supply channels have been liberalised. In 2009, approximately half of all harvesters continued to use the NFCF supply channel with the remaining harvesters distributing their matsutake through local agricultural cooperatives, traders, wholesalers or using courier services to sell directly to consumers (KFS 2010). In general, harvesters receive remuneration at a rate approximating the daily NFCF auction price. If harvesters bring their matsutake for sale to the regional NFCF office they receive the previous day’s auction price minus a commission fee of two percent. If harvesters sell to traders, they tend to receive 20 000 to 30 000 KRW (USD 17.66 to 26.49) per kilogram less than the daily auction price to allow for traders to earn a small margin per kilogram. Harvesters (and traders) selling directly to wholesalers or to consumers, tend to receive between 20 000 to 40 000 (USD 17.66 to 35.32) per kilogram more than the daily auction price. Survey data collected by the author from 74 harvesting households in Bonghwa county found that the mean revenue derived from matsutake in 2011 was 2 168 510 (USD 1 990.74) with a maximum of

20 000 000 KRW (USD 18 400). As a proportion of household revenue, the mean contribution of matsutake was 5.82% with a maximum contribution of 30%.

Matsutake differ in appearance and, to a lesser degree, aroma and taste depending on when they are harvested and the measures taken to nurture the fruiting body (e.g. covering the fruiting body with soil or a tin can) after it breaks through the soil (Koo 2006). When matsutake was designated an export item by the government, the NFCF implemented a grading system to facilitate the export of matsutake to Japan. Table 1 details the grading system and uses five years of daily auction data from the NFCF to show the significant differences in price between grades. Sorting is undertaken by trained employees at regional offices of the NFCF. Sorting is undertaken every day during the harvest season (including weekends and public holidays) from 10am until 4pm. The sorting process begins with a harvester or trader bringing matsutake to the NFCF. The matsutake are sorted by grade class and the harvester or trader receives payment. The sorted matsutake are divided by grade into plastic boxes of 10 kg in preparation for daily auction.

With the liberalisation of matsutake supply channels in 2007, a substantial proportion of sorting now occurs outside of the NFCF by traders, wholesalers, exporters and importers. Sorting outside of the NFCF continues to follow the transparent grading system of the NFCF and is generally straightforward as both buyers and sellers have a solid understanding of the grading system criteria. The liberalisation of distribution channels has, however, resulted in several instances of deliberately inaccurate sorting (Korea Consumer Newspaper 2010).

During harvest season, the NFCF holds daily auctions at each of its regional offices. Auction participants are wholesalers and are required to fulfill a number of criteria and sign a contractual agreement with the NFCF headquarters in Seoul. As of 2012, the main contractual stipulations are that participants pay a deposit of 10 million KRW (USD 8 820) and agree to pay for their purchased matsutake by cash or check on the day of the auction. Additional requirements are made with a view to maintaining the quality of matsutake during transportation and ensuring that domestic and imported matsutake are not mixed (NFCF 2011).

TABLE 1 *Grading System*

	Characteristics	Mean (KRW)	Minimum (KRW)	Maximum (KRW)
Grade 1	Young mushroom; fully attached veil; more than 8 cm tall	478,467 (USD 423)	127,000 (USD 112)	1,250,000 (USD 1,106)
Grade 2	Veil less than 1/3 opened; asymmetrically slender stem; 6–8 cm tall	376,788 (USD 333)	103,000 (USD 91)	871,885 (USD 771)
Grade 3a	Veil more than 1/3 opened; less than 6 cm tall	288,225 (USD 255)	80,000 (USD 71)	654,750 (USD 579)
Grade 3b	Unsorted	232,566 (USD 206)	66,000 (USD 58)	546,500 (USD 484)
Grade 4	Deformed; damaged	158,008 (USD 140)	15,908 (USD 14)	369,800 (USD 327)

Data obtained from NCF (2008–2012)

The auction is a common-value sealed auction and is presided over by a senior employee of the regional office of the NFCF. At slightly after 4pm each day, the available quantities for auction of each grade are displayed on a whiteboard. By 4:30pm, auction participants must fill out a form detailing the quantity of each grade class they would like to bid for, and their bid price per kilogram. The forms are placed in a sealed box. Auctions across the country all begin at 5:20pm. The highest bid for each grade class is read out along with the name of the bidder. The highest bidder takes the quantity previously written on the form and pays for it at the bid price plus a commission of two percent. The remaining quantity is split between the other auction participants at the same price. Wholesalers proceed to sell their matsutake to retailers and high-end restaurants and hotels at a markup of between 30 000 to 50 000 KRW (USD 17.66 to 44.20) per kilogram.

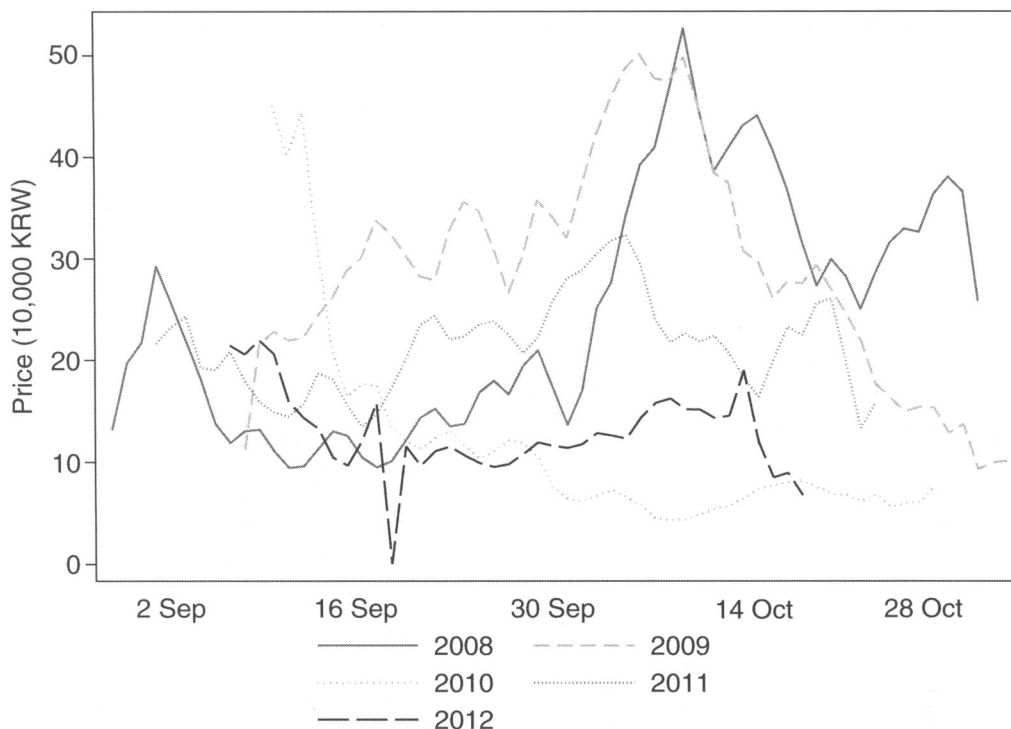
The efficiency of the auction as a price-setting mechanism in the value chain can be evaluated through daily auction data collected from the NFCF. Theoretically, if the price-setting mechanism is efficient then the variability in price should broadly reflect the variability in quantity supplied. Figures 2 and 3 plot daily auction prices and quantities from 2008 to 2012. A superficial look at the data suggests that price exhibits significantly higher variation than quantity supplied. This is largely confirmed by the Cuddy-Della Valle index estimates (see table 2). A comparison of the estimates show that, with the exception of 2012, daily bid prices exhibit far more variation than supply suggesting that the price mechanism is relatively inefficient. Interviews with auction participants and harvesters, however, add another dimension

to evaluating the efficiency of the price-setting mechanism by suggesting that tacit knowledge is the major determinant in setting the daily auction price. In particular, the auction price is affected by yield expectations for the entire harvest season which is informed by observing climatic conditions in the months prior to the harvest season and the previous day's climatic conditions and yield.

Transportation of matsutake must be fast, frequent and ensure freshness. In order to keep matsutake as fresh as possible, refrigeration technology is used. At the lower-end of the value chain, matsutake are packed with dry ice in 1 kg styrofoam boxes. Moving up the value chain, refrigerated containers and trucks are often used. For export, refrigerated containers tend to be sent by airfreight. The NFCF imposes rules on transportation of matsutake that wholesalers who participate in the auction must abide by. These rules tend to also be abided by actors operating outside of the NFCF in order to ensure the quality of their product.

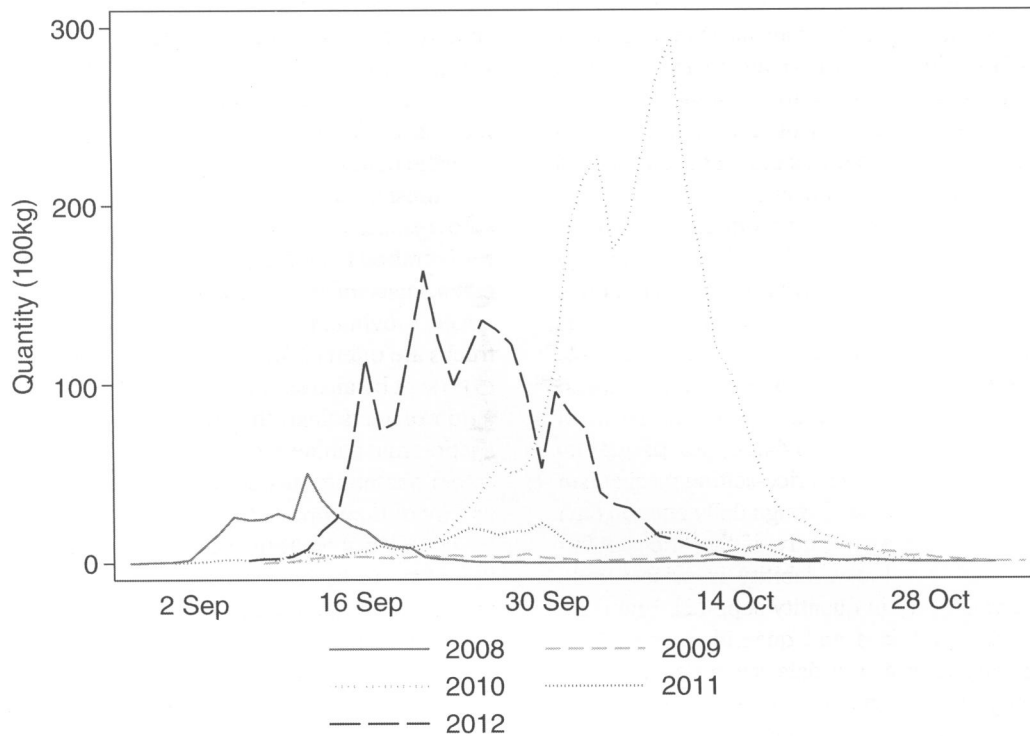
In South Korea, matsutake largely markets itself due to its status as a highly prized delicacy. Retailers, however, take advantage of the fact that matsutake fruits during *chuseok*: a major harvesting festival where gifts are exchanged. *Chuseok* gift sets are packaged by premium retailers, such as department stores and priced with a markup often exceeding 200% of the auction price. The region where matsutake are harvested from allows for price differentiation. Matsutake from, for example, Bonghwa in North Gyeongsang province tend to command a higher retail price than in most other regions due to the unverified perception of a more potent aroma. Some regional offices of the NFCF facilitate regional differentiation

FIGURE 2 Averaged (across all grades) auction prices (2008–2012)



Data obtained from NFCF (2008–2012)

FIGURE 3 Total quantity of auctioned matsutake (2008–2012)



Data obtained from NCF (2008–2012)

through labelling each individual mushroom with a tag denoting the region in which it was harvested. More recently, provincial governments have organised annual matsutake festivals. Festivals last between three days to a week and have stalls that sell fresh and cooked matsutake, as well as derivative products such as alcohol distilled from matsutake and a variety of other non-timber forest products, such as *Panax ginseng* C.A. Mey.

Consumption of South Korean matsutake occurs both domestically and internationally. Domestically, matsutake is often consumed directly by the final consumer or bought as a gift. Lower grade matsutake is often consumed as a seasonal delicacy in common restaurants in townships and secondary cities, and is also commonly consumed by harvesters. In major cities, matsutake tends to be consumed in high-end restaurants.

ENSURING LONG-TERM SUPPLY

The second major barrier to NTFP commercialisation is ensuring long-term supply. For matsutake in South Korea,

ensuring long-term supply is largely dependent on altering the production technology through forest management in order to address changes in human-forest interaction.

Matsutake production technology and yields

In South Korea, matsutake form a mutually beneficial symbiotic relationship exclusively with the *Pinus densiflora* Siebold and Zucc. (Japanese red pine) and are found in Japanese red pine-dominated forest stands that are between 20 to 90 years old (Ogawa 1991 cited in Koo and Bilek 1998). Matsutake yields are highly variable and are suggested to be highest when the forest stand is between 30 to 60 years old and the primordial is afforded optimal climatic conditions for formation: abundant rain in the spring, a relatively dry and hot summer, and a cool and moist autumn; a mid-August 100mm soil temperature of 16 to 19 degrees Celsius; and approximately 500–600 mm of rain during the fruiting period. Soil that is well-drained with granite or gneiss origin, little weathering, acidic and infertile tend to improve yields. Yields tend to be higher when the soil has relatively thin litter and organic layers (Berch *et al.* 2007, Lee 1981, Lee *et al.* 1984).

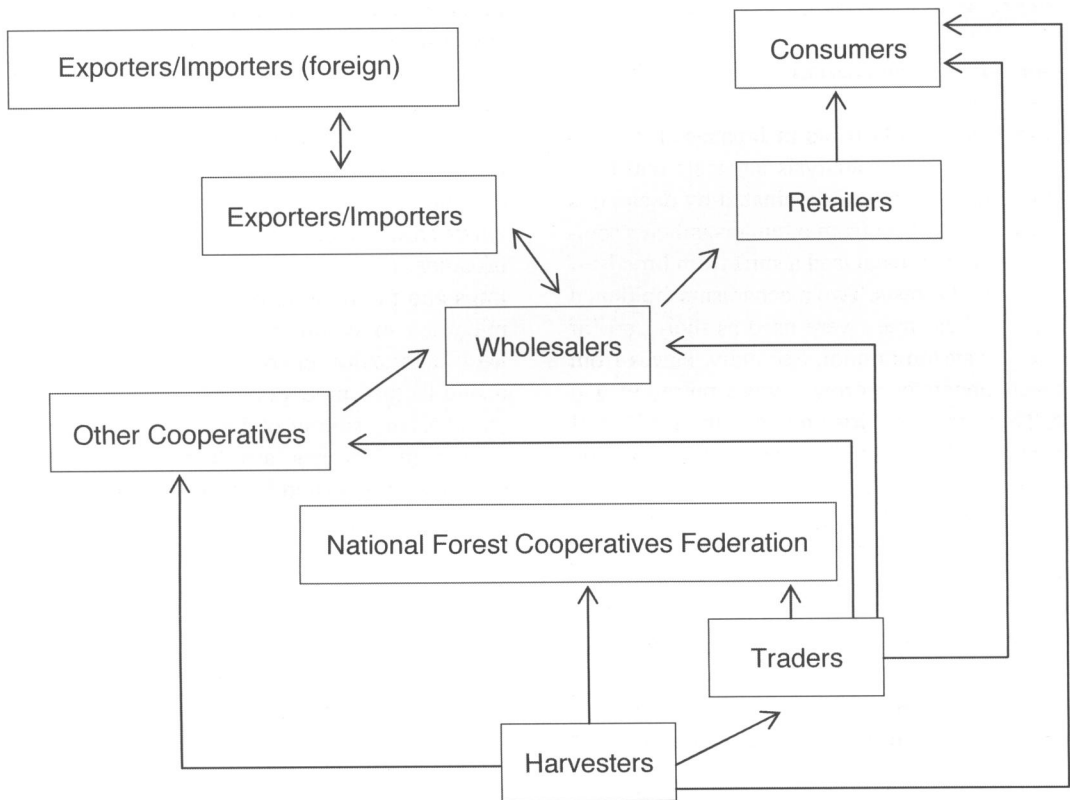
Yield data are available since 1960 (see figure 5). Yields peaked in 1985 and appear to have stabilised in the 1990s and 2000s although the high volatility of annual yields makes it difficult to see a clear trend. Suggested explanations for the decline in yields from 1985 levels include: pine gall midge disease, forest fires, climate change and changes in human-forest interaction. Among these explanations, changes in human-forest interaction arguably pose the greatest threat to

TABLE 2 Cuddy-Della Valle estimates

	2008	2009	2010	2011	2012
Price	31.57	11.66	11.10	11.93	18.99
Quantity	4.78	3.28	5.52	6.14	21.61

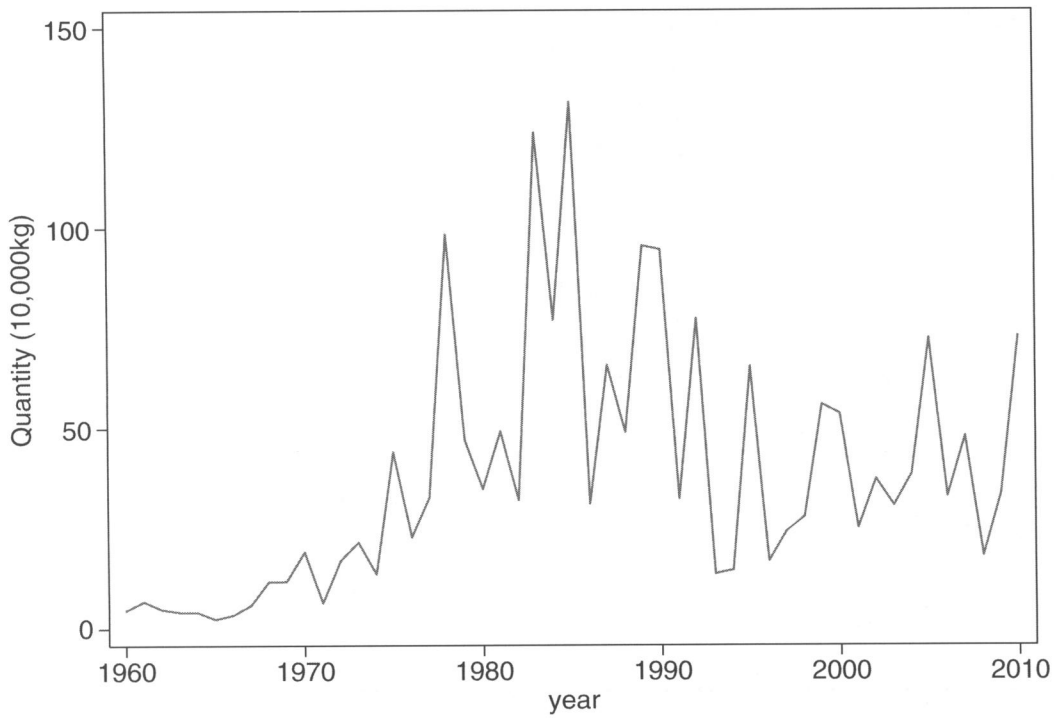
Data obtained from NCF (2008–2012)

FIGURE 4 *The matsutake value chain*



Source: Author's fieldwork (2012)

FIGURE 5 *Matsutake yields*



Data obtained from KFS (1961–2011)

matsutake yields in South Korea (Cha *et al.* 2009, Koo and Bilek 1998, Lee *et al.* 1983, Park *et al.* 1995).

Changes in human-forest interaction

In South Korea, matsutake only fruits in Japanese red pine-dominated forest stands. Pollen analysis suggests that until 599 AD, the Korean peninsula was dominated by deciduous broadleaf forests. The transition from a hunter-gatherer society to an agricultural society catalysed a shift from broadleaf forests to pine dominated forests. Two mechanisms facilitated this shift. Firstly, broadleaf trees were used as fuelwood for the traditional heating system: ondol. Secondly, leaves from broadleaf trees and understory growth were putrefied and used as manure. These two activities reduced the fertility of forested land meaning that only pines could thrive (Chun 2009, 2010).

Over the last half century, South Korea has experienced astounding economic development and an unprecedented rapid transition from agriculture to industry (Chang 2010). This has decreased the rural population and replaced fuelwood with fossil fuels and forest organic matter with commercial fertiliser (Chun 2009, 2010). Figure 6 plots annual usage of fuelwood and forest organic matter from 1960 to 2011. Somewhat surprisingly, the data show that

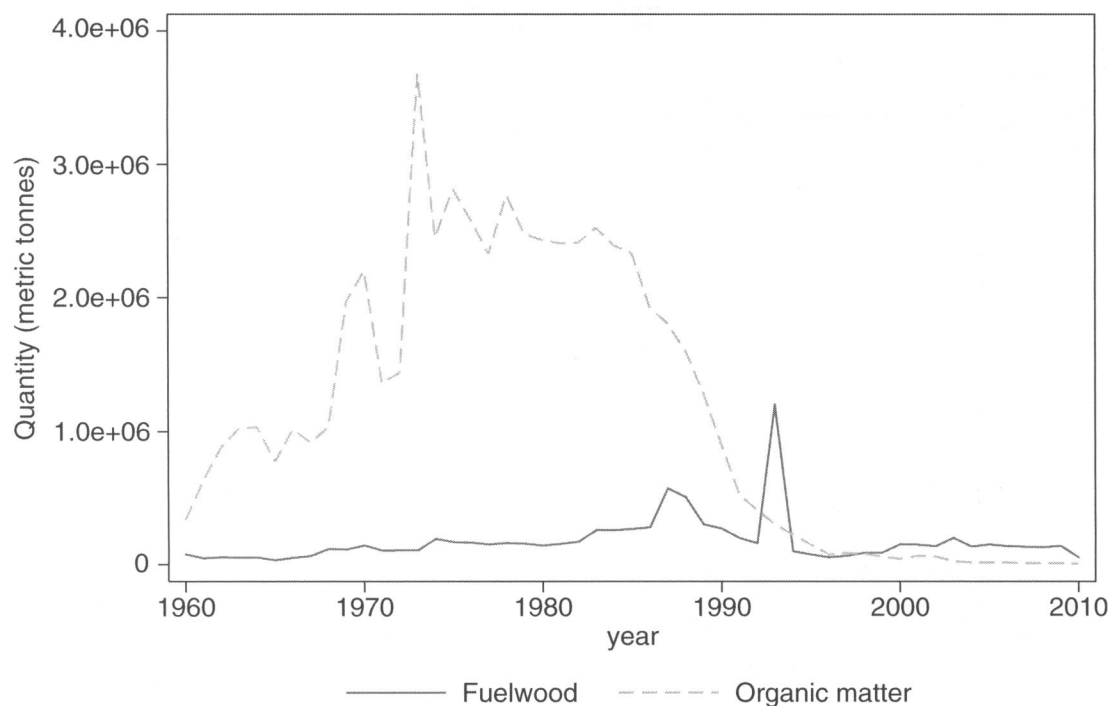
fuelwood has largely remained constant. The use of forest organic matter, however, has decreased significantly since the mid-1980s.

In conjunction with a significant decrease in the proportion of rural households, the substitution of forest organic matter with commercial fertiliser has significantly reduced rural household incentives to remove understory growth and organic litter from the forest. This creates soil conditions that allow shrubs and broadleaf species to thrive. Furthermore, broadleaf trees block out the sunlight required by pine seedlings and the buildup of organic matter encourages saprobe microbes to compete with matsutake (Chun 2009, 2010, Yoshimura 2004 cited in Saito and Mitsumata 2008). The result is that pine dominated forests that are critical for ensuring the supply of matsutake and contributing to rural household incomes are transitioning to being broadleaf dominated³ (Koo and Bilek 1998).

Forest management

Research into forest management techniques to improve matsutake yields dates back to the 1960s when the Kyoto Prefecture Forest Experiment Station in Japan developed the Kyoto method (Saito and Mitsumata 2008). In South Korea, forest management techniques are based on the Kyoto method

FIGURE 6 *Fuelwood and organic matter consumption*



Data obtained from KFS (1961–2011)

³ There is no specific data on the transition of matsutake forests into broadleaf dominated forests. Data are available on the land area of coniferous forests and Japanese red pine forests, which can be cautiously analysed as a proxy for changes in the land area of matsutake forests. The area of coniferous forests has decreased from 3,316,516 ha in 1973 to 2,580,629 ha in 2010. The area of Japanese red pine forests has declined from 1,614,350 ha in 2003 to 1,447,439 ha in 2010 (KFS 1974–2012).

but have been adapted to domestic conditions by the Korea Forest Research Institute – the research arm of the Korea Forest Service. First, forests are surveyed and placed into one of three categories: forests with matsutake; forests adjacent to forests with matsutake; and forests without matsutake. For forests with matsutake and adjacent forests, forest management activities are undertaken. For forests without matsutake, forest management activities are undertaken if the forest is deemed to have the potential to support matsutake (Berch *et al.* 2007).

Forest management activities undertaken in South Korea effectively mimic the human-forest interaction practiced by rural households for millennia. Forest management techniques include: adjusting stem density through thinning and pruning; removing understory growth; and clearing organic matter from the forest floor (Berch *et al.* 2007, Lee *et al.* 2000). The exact set of activities undertaken and their frequency is dependent on the age and species composition of the forest. In general, forest management activities must be continued for at least seven years before any yield improvements are seen (Koo and Bilek 1998). Table 3 shows the schedule for forest management activities.

In practice, forest management for state-owned forests is financed by the Korea Forest Service and undertaken through the extension services of the National Forestry Cooperatives Federation. Part of the forest management costs are paid for by the sale of matsutake harvesting rights to rural households. For privately-owned forests, 40% of the costs are subsidised by the federal government and 20% of the costs are subsidised by the provincial government (Berch *et al.* 2007). In the vast majority of cases, forest management activities for privately-owned forests are undertaken by the NCF's extension services (Koo pers. comm. 2013).

Survey data collected in 2009 by the KFS from 350 private forest owners who harvest matsutake found that only 77 owners were undertaking forest management activities. From the 273 harvesters who were not undertaking forest management, 36% of harvesters expressed an intention to undertake forest

management in the future while 33% of harvesters said that they will not undertake forest management. 31% of harvesters reported that they had never heard about forest management to improve matsutake yields before. Among the 77 harvesters who undertook forest management activities, 40.4% reported that yields had increased. 48.1% stated that there had been no increase in yields and 4.2% that yields had decreased. 7.3% reported no change in yields (KFS 2010). It is likely that the negative responses to forest management on yields are the result of high variability in annual yields disguising the increase in yields (Ka pers. comm. 2012, Koo and Bilek 1998).

DISCUSSION

State institutions have played key roles in both reducing transaction costs across the matsutake value chain and in altering the production technology to help ensure the long-term supply of matsutake in South Korea. Regarding the reduction of transaction costs, search and information costs have been addressed through the provision of regional supply channels where matsutake is sold and bought in sufficient quantities during the entire harvest season. Additionally, the grading system and the price-setting mechanism provide information on price and quality to all actors involved in the value chain. Bargaining and decision costs are reduced through the grading system and price-setting mechanism. Lastly, policing and enforcement costs are somewhat reduced through the legal contract between the NCF and wholesalers.

The success of the KFS and NCF in reducing transaction costs and facilitating trade in matsutake trade is arguably best measured by the longevity of commercialisation, which has been ongoing since the 1960s, and the relatively high revenue that harvesters continue to earn from matsutake. Additionally, there appears to be little discontent among actors concerning the operation of the value chain and the remuneration received by actors across the value chain. Despite this success, it is

TABLE 3 *Forest management guidelines*

	Pine dominated; 16–35 years old	Broadleaf-invaded; 16–35 years old	Pine dominated; 36–50 years old	Broadleaf-invaded; 36–50 years old
Year 1	Thinning; clearing understory; removing organic litter	Thinning; clearing understory; removing organic litter	Pruning; clearing understory; removing organic litter	Thinning; clearing understory; removing organic litter
Year 2	Pruning; clearing understory; removing organic litter	Thinning; pruning; removing organic litter		Pruning; removing organic litter
Year 3		Pruning; clearing understory; removing organic litter	Pruning; clearing understory; removing organic litter	Pruning; clearing understory; removing organic litter
Year 4				Pruning; clearing understory
Year 5			Pruning; clearing understory; removing organic litter	

Source: Adapted from Berch *et al.* (2007)

important to note that the data suggest that the price-setting mechanism is relatively inefficient and appears to function mostly on the tacit knowledge of auction participants. There is much debate about the workings of the price-setting mechanism, especially in relatively thin markets. One stream of thought suggests that prices are not *ex post* equilibrium prices but are instead *ex ante* and formed through tacit knowledge and institutional norms (Hodgson 1988). Following this line of argument, it is possible that the NFCF's price-setting mechanism is a relatively efficient and effective solution.

Regarding the long-term supply of matsutake, it is clear that forest management activities are increasingly necessary to ensure the long-term supply of matsutake in South Korea. Undertaking forest management activities requires significant short-term cost with benefits accruing in the future. For state-owned forests, the KFS completely finances forest management which is undertaken by the extension services of the NFCF. For privately-owned forests, the costs of forest management are heavily subsidised. Despite these subsidies, the majority of sampled harvesters did not undertake forest management. This is partly explained by poor dissemination of information to harvesters, with the KFS' (2010) survey results suggesting that 31% of harvesters had never heard of forest management techniques to improve matsutake yields. Additionally, approximately 60% of surveyed harvesters who undertook forest management stated their belief that yields had not increased or had actually decreased as a result. This viewpoint is likely to be the result of harvesters reporting on short-term observation of yields, which are highly variable, rather than a long-term study of yields (Koo and Bilek 1998). Given these results, it is likely that without better dissemination of information many harvesters will not see the subsidized costs of investing in forest management as a worthwhile investment.

The case of matsutake commercialisation in South Korea has shown how state institutions can play a leading role in addressing thin market structures and helping ensure long-term supply. In addition to highlighting the debate on the efficiency of the price mechanism and the inability of state institutions to provide private forest owners with the necessary incentives to undertake forest management activities, there are a number of contextual caveats regarding matsutake and South Korea which must be considered when considering the case study more generally. Starting with matsutake, demand in both Japan and South Korea is strong and historically rooted. Demand is resilient to shocks and is not subject to fads. Secondly, the regeneration rate of matsutake is relatively rapid and mushrooms can be harvested without damaging the resource base (Brooks and Tshering 2010). Additionally, South Korea is a relatively rare case where the NTFP sector is more economically important than the timber industry which struggles to compete internationally (KFS 1961–2012, Tak *et al.* 2007). As a result, the Korea Forest Service collects detailed data on a range of NTFPs, engages in NTFP-specific research and both drafts and implements NTFP-specific forest legislation. Furthermore, universities and the Korea Forest Service's research arm: the Korea Forest Research Institute, undertake scientific research on NTFPs (Youn 2008). Finally, the Korea Forest Service and National

Forestry Cooperatives Federation have relatively strong institutional capacity and accountability due to their prominent roles in South Korea's nation-wide reforestation efforts beginning in the 1960s (Klock 1995).

CONCLUSION

This study used the example of matsutake commercialisation in South Korea to show that state institutions can play a leading role in addressing the thin market structure that is characteristic of some NTFPs and ensuring long-term supply. Specifically, state institutions reduced transaction costs through the provision of a supply channel, grading system, price-setting mechanism and guidelines for transportation. As for ensuring long-term supply, state institutions research, support and undertake forest management activities. Although broadly successful, issues remain concerning the efficiency of the price-setting mechanism and the inability of state institutions to provide appropriate incentives to private forest owners to undertake forest management.

The findings of this case study provide a welcome example of a broadly successful intervention by state institutions in NTFP commercialisation. Although the success of matsutake commercialisation in South Korea benefitted from the ecological characteristics and market dynamics of matsutake, the role of the NTFP sector in South Korea, and the institutional capacity and accountability of state institutions, it is important to consider the potential of a similar approach in other contexts. For example, the cases of the National Forestry Cooperatives Federation in South Korea and of the Orissa State Forest Department's Kendu Leaf Department in India (Lele *et al.* 2011) share numerous similarities. This suggests that some changes to the intervention by the Orissa State Forest Department, particularly increasing the transparency of the sorting process and price-setting mechanism, may have resulted in similarly, positive outcomes as in South Korea.

In conclusion, this study suggests that an intervention similar to that undertaken by the Korea Forest Service and National Forestry Cooperatives Federation in addressing some of the barriers caused by a thin market structure should be seriously considered and evaluated along with other institutional solutions in other countries. In terms of technical complexity, the approach seen in this case study is relatively straightforward meaning that the extent to which the approach is successful is likely to depend mostly on the accountability and transparency of the system. Regarding ensuring long-term supply, the South Korean approach to matsutake is difficult to replicate, at least in the short run. What is required is a long-term approach which emphasizes both the systematic collection of data and scientific research on NTFPs.

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