

Understanding the supply chain of paper mulberry bark in Lao PDR using causal mapping

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Study as part of the research project: "Spatial trade-off analyses for site-sensitive development interventions in upland systems of Southeast Asia"

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Summary

This study is part of the socio-economic component of the CIAT/BOKU project "Spatial trade-off analysis for site-sensitive development interventions in the upland systems in Southeast Asia". The project aims to identify, deliver and implement site-specific intervention strategies for the rural upland areas of Oudomxay province, Lao PDR. One of the goals of the project is to understand under which conditions the extraction of non-timber forest products (NTFP) from wild sources can shift to the cultivation of these resources. This study focuses on paper mulberry bark, an NTFP that can be easily domesticated and grown by farmers.

This study uses causal mapping to examine the factors shaping the supply chain of paper mulberry bark. The supply chain is seen as a network of six functional groups (farmers, district traders, Lao exporters, Thai manufacturers, government extension staff and consultants) each involved in a specific activity within the supply chain. Members of each functional group were asked individually which factors they believe influence the supply chain, how these factors are linked, and which changes could lead to an improvement of the supply chain. The results of the interviews were used to build causal maps for each functional group as well as one aggregated causal map.

The causal maps offer a graphical representation of how each functional group perceives the opportunities and constrains affecting the supply of paper mulberry bark. The causal maps also allow to identify the differences between the perceptions and priorities of each functional group as well as the reasons why various potentials for improvement have not been realised so far. One of the main challenges that until now have not been tackled is the development of clear quality criteria and a price premium linked to bark quality. Only once farmers can be sure to benefit from producing high quality bark will they be willing to invest land and labour to plant and cultivate paper mulberry trees.

Aggregating the functional groups' maps allowed to obtain a systemic understanding of the dominant interactions between factors influencing the paper mulberry bark supply chain. This aggregated map shows the main options for improvement: to increase the area planted with paper mulberry; to provide an incentive to improve bark quality; to negotiate prices; to organise village marketing groups; to establish contracts (both formal and informal); to increase the amount of bark supplied and to improve the information flow within the supply chain.

These results confirm that a systemic understanding of the factors influencing supply chains is necessary to be able to identify and implement measures for effective change. Even though functional groups emphasise different factors, their description of the factors influencing the supply chain complement each other. The causal maps are a useful tool to understand the perceptions and the causal links, i.e. the specific logic of each level of the supply chain. By comparing the maps, differences in perceptions and understanding of the supply chain can be identified, thus pointing out where information transfer and discussion between stakeholders are necessary to reach a shared understanding of the supply chain. Once a shared understanding has been reached, a common goal can be formulated by the stakeholders. Such a shared goal may allow to improve the management along the supply chain by coordinating the actions of the stakeholders.

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1 Introduction

1.1 Background information on Lao PDR

1.1.1 Socio-economic context

The Lao People's Democratic Republic is a mountainous, land-locked country (see Fig. 1) with only 10% of its total area suitable for permanent agriculture. Subsistence agriculture (mostly rice farming) accounts for half of the gross domestic product (GDP) and provides 76% of total employment (FAO, 2005). The annual per capita agricultural productivity in Lao PDR is US$ 542, which is lower than that of its neighbours: US$ 2,615 in Thailand, US$ 2,033 in Vietnam and US$ 1,300 in Cambodia (Lao Consulting Group, 2004).

Figure 1: Map of the Lao People's Democratic Republic

The staple food is glutinous rice ('sticky rice'), which occupies about 78% of the cultivated area in Lao PDR (FAO, 2005). Rice is farmed in monoculture or mixed with other crops (Seidenberg et al., 2003). In the uplands, **shifting cultivation** is still wide-spread. It is a semi-permanent type of agriculture that is based on slash and burn of secondary forest in a rotational period of 10 to 20 years before the field is cleared out again (Eggertz, 1996). Shifting cultivation practices are known to be sustainable as long as these long fallow periods are

maintained. However, due to population growth there is a trend to shorten fallow periods leading these systems to collapse (Roder et al., 1997; Seidenberg et al., 2003). Thus, the international community and the Lao PDR government perceive this old system, based on a semi-nomadic life, as no longer sustainable and aim at reducing shifting cultivation (Evrard and Goudineau, 2004). The Lao PDR government is thus implementing programmes to allocate land and to relocate villages so as to promote agricultural sedentarisation (GoI, 1999).

The **uplands of Lao PDR** are characterised by remoteness and poor farming conditions.The poverty rate reaches half of the population (World Bank, 2006). However, poverty is not related to hunger since there are still natural resources to be exploited. Also, upland farmers do not perceive their self-sufficient farming systems as a signal of poverty. For them poverty is caused by external factors, e.g. weather, war, resettlement, poorly implemented development projects and livestock diseases. Upland livelihoods are based on subsistence farming, i.e. rice production for home consumption as well as harvesting of timber and non-timber forest products (NTFP) (Raintree and Soydara, 2002). However, these natural resources are quickly being lost through over-use as well as deforestation (ADB, 2001; Raintree and Soydara, 2001; Seidenberg et al., 2003). Thus, following the programmes by the Lao PDR government and international agencies, farmers are changing their livelihoods by learning how to produce crops on small plots, sell them for cash and use the income to purchase rice.

1.1.2 Rural development policy

The Lao PDR **agriculture and forestry policy** aims to reduce the practice of shifting cultivation and to promote the conversion to cash and tree crops (NAFRI, 2000; Jones, 2002; MAF-NAFES, 2004). Developing markets is seen as a key element in this strategy. Government and service providers (e.g. international cooperation agencies, extension officers, business services) believe that improving market linkages and the development of small agro-enterprises can contribute to diversify incomes, build financial assets and offer gainful employment for rural upland dwellers (Kerridge and Peters, 2002; Khamhung, 2005; Thomas, 2005). However, when moving from a self-sufficiency system to a market-orientated system, actors face a range of obstacles, e.g. difficult market access (transportation, communication, roads), lack of technical support to learn about new agricultural and forestry systems, poor market information, and the failure to finance the required change (Kerridge and Peters, 2002; Raintree, 2003; Khamhung, 2005). Thus, the process of market-driven development remains a challenge, not least due to market distortions through government regulations, poor capacity to ensure compliance and high transaction cost for business registration, export licenses and other administrative processes (OCISP, 2002; Lao Consulting Group, 2004).

To address these problems three national rural development programmes have been implemented: the land allocation programme; the village relocation programme and the programme to reduce shifting cultivation (Lao Consulting Group, 2002).

The **land and forest allocation programme** aims at ensuring that each parcel of land has clear "ownership" so as to encourage farmers to invest in permanent agriculture and forestry plantings. The Lao PDR government believes that land allocation can also help control deforestation and reduce shifting cultivation (GoI, 1999). Traditionally, the customary land tenure system in Lao PDR was regulated by informal agreements between households and the village headman. Land use rights were acquired by bringing unclaimed land into cultivation (Seidenberg, 2003). However as a consequence of population increase, the movement of people to different locations, the reduction of land

availability, the government policies to develop sedentary forms of agriculture and land allocation lead to changes in the land tenure system (Lao Consulting Group, 2002:10). In Lao PDR all land is the property of the national community (Land Law 1996, Art. 3). However the government can issue land titles that give the holder permanent land use rights. The land titles can be transferred, leased or used as collateral. The government usually issues a temporary land certificate that gives the holder a three-year land use right. After these three years, the holder of a temporary land certificate can apply for a long-term use right (Land Law 1996, Art. 18 and 22). Forest land is divided into five categories: protection forests, conservation forests, production forests, rehabilitation forests and degraded forests (Forest Law 1996, Art. 16-21). The Forest Law (Art. 25) also defines that natural resources must be managed at the community level: NTFP harvesting must be carried-out under the specific regulations of each village. Furthermore it states that upland dwellers can collect NTFP from production forests and degraded forests.

The Lao PDR government is also implementing the **re-location programme** that plans to resettle 60% of the 1.5 million people engaged in shifting cultivation over the course of 10 years (Evrard and Goudineau, 2004). This policy was conceived as a way of facilitate the implementation of a rural development policy by providing the villagers with services and infrastructure such as roads, schools, sanitation and agricultural extension (GoI, 1999; Lao Consulting Group, 2002; Evrard and Goudineau, 2004). But the main problem of this program is that people that are re-located to a new village do not have the customary rights that the people living there have. They thus tend be allocated land that is far from the village or of lower fertility (Lao Consulting Group, 2002). Also, the increased demand for land can lead to social tensions between new and old settlers.

The objective of the **programme to reduce shifting cultivation** is to eliminate shifting cultivation by adopting permanent land use systems and is thus linked to the land allocation programme. It aims to convert rural livelihoods to include permanent occupations such as animal husbandry, fish production, commercial tree planting and production of cash crops (Lao Consulting Group, 2002:13). To reduce dependence on shifting cultivation and poppy production, the Lao PDR government also promotes market integration of NTFP (Anonth, 2005; Thomas, 2005).

1.1.3 Role of NTFP in the uplands

Livelihoods in Lao PDR are highly dependent on forest products (Foppes and Ketphanh, 2000; Vantomme et al., 2002). Some authors associate this importance of NTFP with the low population density in Lao PDR combined with a high forest cover rate (Foppes and Ketphanh, 2000; Vantomme et al., 2002). NTFP are important to the livelihoods of Laotians since they are used as food, medicine, spices, essential oils, resins, gums, latexes, tannins, dyes, fuelwood and as materials for furniture and house construction (Raintree and Soydara, 2001; Helberg, 2005). Some NTFP are also sold to buy rice (see Fig. 2) (Raintree, 2003:2; Yokorama, 2004).

NTFP are especially important to alleviate hunger during difficult periods, e.g. following a poor rice harvest, and by the poorest members of society, who usually have more access to the foress than to other resources (Helberg, 2005). Three strategies for the use of NTFP have been distinguished (Angelsen and Wunder, 2003; Ruiz-Perez et al., 2004; Belcher et al., 2005):

- as a safety net or subsistence strategy: the poorer forest dwellers harvest NTFP to reduce their vulnerability when other income options have failed or do not exist.

- as a gap-filling strategy: forest dwellers harvest NTFP as a supplementary income-generating activity.
- as a specialised strategy: when forest dwellers are well integrated into the cash economy and use NTFP resources as an important cash source. In this strategy, production tends to be managed intensively (cultivation and intensified forest management) by specialised producers.

Figure 2: NTFP sold on a market in Xay

Belcher et al. (2005) argue that independently of the type of strategy that forest people use, NTFP serve to supplement other income sources and NTFP often cover only a small proportion of the household income needs. This diversification of income sources allows to spread the risk through different activities and results in a balanced distribution of revenues and labour throughout the year (Belcher et al., 2005).

However, farmers are finding it increasingly difficult to access NTFP due to the destruction of natural habitats, overuse and unsustainable harvesting techniques (Helberg, 2005). The sustainable use of NTFP is also hindered by a **legal framework** that is fragmentary and partly contradictory. The forest law distinguishes between the traditional/customary and the commercial use of NTFP. For commercial use of NTFP, quotas are specified by product and set annually at the national level. However there are no clear criteria to determine the size of the yearly quota, or how the quota is to be allocated to each province (Enfield et al., 1998). At the local level, to sell non-restricted NTFP, a village-level association has to be formed and the association has to sign management contracts with the provincial agriculture and forestry extension office (PAFEO) (Helberg, 2005). However, there are no standard criteria for the extension staff to evaluate the sustainability of the proposed management plan and they do not have the resources necessary to guide and monitor the implementation of the management plans (Enfield et al., 1998). In the provinces, companies interested in trading NTFP have to apply for a quota at the provincial agriculture and forestry extension office. Thus, the quota provision tends to be based less on an assessment of environment resources but rather on the demand of traders

(Helberg, 2005). NTFP traders also need to pay a range of taxes and royalties, involving paper work and visits to different offices. Another item that is not well defined and thus leaves additional room for the discretionary powers of government officials are the exceptions to NTFP harvesting laws for 'traditional use' and for 'economic necessity' mentioned in Article 30 of the forestry law. Article 30 posits that the harvest of any type of NTFP is acceptable if it is justified on the basis of economic necessity and traditional use (Raintree and Soydara, 2001; OCISP, 2003). These unclear legal guidelines have lead Larsen (2000) to suggested that quotas and taxes should be abolished since they do not effectively stop illegal trade, while potentially being an incentive for illegal rent-seeking behaviour by government officials (see also Vernon, 2006).

In Lao PDR, the **NTFP economy** represented 2.5% of annual exports in 1998 (Raintree and Soydara, 2001; Vantomme et al., 2002). NTFP provided 50 to 55% of cash income of rural villages (Foppes and Ketphanh, 2000; Raintree and Soydara, 2001; Helberg, 2005). Of the total export value of NTFP in 1998, 70% were medicinal plants (e.g. Cardamon *Amomum spp.*), followed by 15% for fibre products (e.g. paper mulberry *Broussonetia papyrifera* L), 8% resin (e.g. dammar resin, oleoresin, benzoin), 6% edible products (e.g. different types of nuts, fern, roots, fruits) and 2% raw material to produce incense (e.g. *Boehmeria malabarica* Webb.) (Vantomme et al., 2002). The problem of trading NTFP thus does not seem to be the lack of demand but the lack of supply due to diminishing resources and inconsistent product quality (Helberg, 2005). Cultivation could solve this problem but only few NTFP are cultivated in Lao PDR. These are mostly developments at the district level or provincial level rather than a national trend. There are instances of domestication of paper mulberry in Luang Prabang and Sayabury (Forsen et al., 2001; Aubertin, 2004); of cardamom in Phongsaly province (Ducourtieux, 2006) and of bitter bamboo in Oudomxay (Soydara and Ketphanh, 2000). For all the other NTFP, which are gathered from the wild, their availability is declining resulting in low cash income and contributing to rice insufficiency (Raintree and Soydara, 2001).

NTFP are thus important for local livelihoods, but their availability has decreased calling attention to the need to better manage the existing NTFP resources. Depletion of NTFP is linked to market demand and the lack of other products to sell for cash. Key factors necessary for the cultivation of NTFP include secure land and resources, the presence of infrastructure, as well as access to technical information. A better understanding of NTFP supply chains may enable to establish development plans to improve the livelihoods of the people living from NTFP.

1.2 Commercialisation of NTFP

1.2.1 Sustainability of NTFP extraction

NTFP are all biotic forest products other than timber, i.e. the term encompasses all goods of biological origin other than wood that are extracted from a forest. The 1980s has seen a development movement concerned with the question of how to control deforestation while reducing rural poverty and increasing income generation (Wollenberg and Ingles, 1998; Belcher, 1998; Belcher, 2003; Belcher et al., 2005). Environmentalists and social activists argued that the extraction of NTFP could provide an environmentally sustainable livelihood (Stoian, 2001; Belcher et al., 2005). The idea that extraction of NTFP would be more sustainable than timber products was disseminated (Homma, 2000). This view assumes that people living from extracting resources from the forests make informed management decisions based on the dynamics of the different NTFP and their markets. Extraction is seen as a process of multiple-product

forest management so that there is a diversification of income sources (Stoian, 2001: 5). It was assumed that NTFP are one of the few resources accessible to the rural poor and thus their commercialisation would lead to economic benefits for the rural poor; and that the commercialisation of NTFP by rural dwellers would be an incentive to conserve the forest (Belcher et al., 2005: 1436).

However, in the late 1990s sceptics started to raise their doubts about the assumptions underlying the 'conservation by commercialisation' hypothesis. The main driver was the failure of the NTFP 'extractive reserves' in the Amazon forest (Stoian, 2001). But other concerns were also raised, especially related to the open-access nature of forests (Neumann and Hirsch, 2000: 19; Belcher and Kusters, 2004: 7). Also, there were case-studies showing that privately owned land brought higher economic benefits for rural dwellers (Belcher and Kusters, 2004: 7; Ruiz-Perez et al., 2004). Indeed, the absence of entry barriers that make NTFP available to the poor, also allows new entrants and leads to the dissipation of rents (Belcher and Kusters, 2004).

It was also noted that although NTFP are important, they rarely provide the means for socio-economic advancement (Angelsen and Wunder, 2003). One of the reasons why it is difficult for the poorer to move beyond the stage of wild collection is because people dependent on open-access resources are unable to exclude competitors. In areas with limited alternatives it is difficult to control overexploitation, resulting in lower prices and in the inability to produce surplus (see Fig. 3).

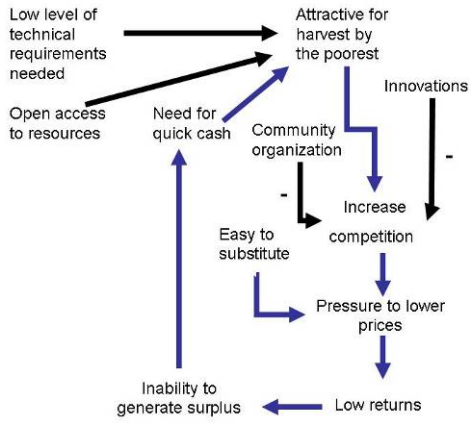


Figure 3: The downward cycle of the poverty trap

Source: own representation, based on Marshall et al. (2003), te Velde (2005) and Schreckenberg et al. (2006)

In addition, NTFP extraction areas tend to be remote, lacking transportation infrastructure, market access, property rights, education, proper health care, capital and know-how (Angelsen and Wunder, 2003; Belcher et al,. 2005). This reduces the capacity of the poor to move beyond their current situation, which was called the poverty-trap (Angelsen and Wunder, 2003).

The poverty-trap might be broken if the degree of innovation (Schreckenberg et al., 2006) and community organisation (Marshall et al., 2003; te Velde, 2005; Schreckenberg et al., 2006) allow to overcome the problem of competition between extractors. Community organisation could result in increased bargaining power for extractors (Belcher, 1998), while innovations (e.g.

technologies and know-how) can allow better management of NTFP resources (Belcher, 1998).

1.2.2 The dynamics of NTFP commercialisation

Following the above mentioned critiques, the **evolutionary view** gained importance. It argues that extractivism is a primitive stage of humanity, an activity that tends to disappear and be replaced by agricultural activities (Allegretti, 1995 cited in Stoian, 2001). This view rejects the long-term viability of NTFP extraction. Instead it views extraction as 'buying time' until better opportunities are available (Homma, 2000). Apologists of this view explain that when the market is growing and the extractive sector is not able to cope with demand, domestication spreads if technologically possible. Furthermore, they argue that if domestication cannot satisfy demand, then substitution by other synthetic or non-synthetic products often occurs (Homma, 2000: 3). Empirical evidence from the Amazon shows this type of evolution for many extracted products, e.g. guarana, rosewood, cocoa or rubber.

The dynamics related to NTFP extraction are explained in **Homma's model** (see Fig. 4). This model is often cited to predict how the NTFP resource base changes over time (Neumann and Hirsch, 2000: 63; Stoian, 2001; Marshall et al., 2003). Homma explained that there is typically four phases in the evolution of extractive activities: expansion, stabilisation, decline and cultivation.

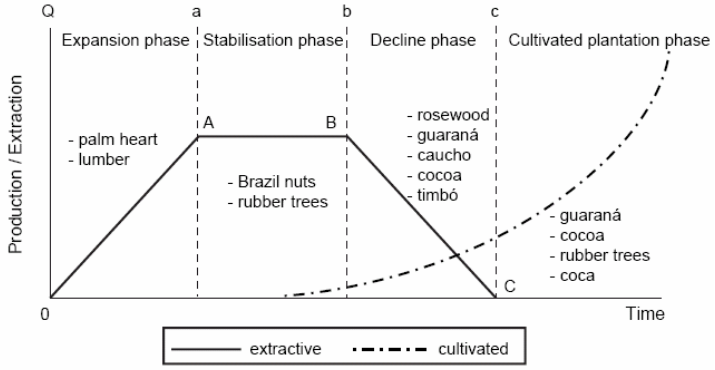


Figure 4: Homma's model of the dynamics of extraction and cultivation of NTFP
Source: Homma (1995)

The expansion phase is characterized by market growth and the increase of supply. The stabilisation phase is the point where demand equals supply, and is close to the maximum extraction capacity. Unable to meet growing demand, extraction gives place to cultivation. Extraction declines while cultivation starts growing. The last phase starts when the product is no longer extracted (Homma, 1995). Agricultural expansion, the existence of new economic alternatives, the development of substitutes, the increase of population density and the degradation/depletion of natural resources are all factors that induce the decline of extraction (Homma, 2000). With the decline of extraction, domestication is a possible scenario, however if domestication is unprofitable, then it might result in industrial substitution or geographic relocation of extraction (Homma, 1995).

Many macro-economic factors are responsible for the growth of extraction such as policies related to extraction of NTFP; heavy migration and high population

density (Homma, 1995). In the situation of high market demand extraction rates are higher than natural regeneration, leading to a decrease of natural reserves. Thus, in the context of: a) lacking industrial substitutes; b) availability of the necessary technology for production and processing; c) favourable prices for participants, and d) profitability in relation to other business opportunities, there are higher chances that domestication will occur. Domestication also has better chances of success if the land is private, there is a well-defined and respected set of rules and laws for local management, there is a well-defined distribution of benefits at village level and there is local knowledge about the product (Neumann and Hirsch, 2000). However, if there is high demand but production costs are high and supply is too low to meet growing market demand, then industrial substitutes emerge or the extraction is geographically relocated (Homma, 1996).

Although some authors (e.g. Neumann and Hirsch, 2000: 63; Marshall et al., 2003) have criticised Homma's model as being over-simplistic, it is still used to justify the support currently given by development agencies to supporting the shift from extraction to management or cultivation of NTFP.

Still, there are authors who criticise domestication since it can lead to the displacement of the poorest (Dove, 1994; Stoian, 2001; Belcher and Kusters, 2004; Ruiz-Perez et al., 2004). Others point out that that domestication often takes the form of plantations and monocultures, requiring a highly specialised technical knowledge, an intensive use of chemicals and mechanical inputs. This has lead Michon and de Foresta (1998) to suggest the integration of NTFP into a multi-strata or multi-species system taking advantage of the local agroforestry knowledge.

1.2.3 Characteristics of supply chains in developing countries

Supply chains of agricultural products in developing countries are characterised as being long, fragmented and as involving multiple small-holder producers delivering produce to collectors (Batt, 2004; Wheatley, 2004; Woods, 2004). They are also characterised by high transaction costs and risks since actors with little power face high costs in accessing information and enforcing property rights (Dorward, 2002). This leads supply chain stakeholders to fear opportunism by other supply chain members and avoid investment (Gow and Swinnen, 1998; Brennan, 2004).

Under certain conditions contracts can reduce this opportunism (Brennan, 2004). But contracts might not work if the litigation system takes too long, if it is expensive, or if it is difficult to check if the terms of the contract are being fulfilled (Brennan, 2004). Given that the legal system in developing countries is often lacking, trust and social capital play an important role in reducing risk and facilitating exchange (Batt, 2004; Best et al. 2005; Minh Chau et al., 2005). Blecher (1998: 80) notes that for most NTFP, competitive market mechanisms are less important than formal and informal market contracts and personal relationships. Thus, long-term personal arrangements are more important than spot sales for raw material trading and price competition is often less important than hierarchical forces.

Poor **market integration** is often linked to systems where producers are involved in subsistence systems and where goods have a low monetary value. Poor market integration is also linked to lack of infrastructure such as storage facilities, energy and roads (see Fig. 5). This increases costs to reach markets and reduces margins for supply chain stakeholders. The stakeholders lack technical knowledge, market information and resources to meet quality standards and formal market specifications (Bienabe and Sautier, 2005).

Three strategies currently used by development organisations to improve supply chains are:

- To improve competitiveness by establishing strong horizontal linkages at producer level (e.g. cooperatives) to increase their bargaining power and by providing technical support to increase both the supply and the quality (Belcher, 1998; Larsen, 2000; Morries, 2002; Marshall, 2003; Best et al., 2005; Gotschi et al., 2006). This allows to capture higher margins from unprocessed commodities (Gibbon, 2001).
- To diversify production through selection of higher-value crops or livestock (Best et al., 2005).
- To promote local processing (Gibbon, 2001).

All the three forms of improvement are subject to different degrees of public action to ensure that the socio-political environment supports and secures a long-term provision of raw material, communication, infrastructure, export finance, workforce training and international marketing of the produce.

Figure 5: Poor road facilities and lack of transport make the trade of NTFP difficult

The literature on supply chains also draws attention to the problem of decisions being taken while ignoring the **interdependency** between different levels of the supply chain, i.e. by decoupling their functional and geographic components (Thomas and Griffin, 1996; Ketchen and Hult, 2006). Thus, the coordination between these components needs to be increased (Thomas and Griffin, 1996; Simatupang et al., 2002). Supply chain coordination enhances barriers to entry, reduces costs for supply chain stakeholders, reduces risks through institutional measures established by stakeholders (private and public) and increases speed and sales (Gibbon, 2001). Coordination is linked to alignment, i.e. ensuring that the interests of all participants in the supply chain are consistent. Alignment is thus an attribute of a competitive supply chain (Ketchen and Hult, 2006). Incentives for change must be given in a way that all parties' interests are aligned. Indeed, if stakeholders have to decide between actions that will benefit them but are detrimental for the supply chain, they will do it (Narayanan and Raman, 2004). The latter is especially important in context of developing countries where information asymmetry is common and where there are higher advantages to hide information or actions (Brennan, 2004).

2 The study

2.1 The province of Oudomxay

Oudomxay is a province located in the North of Lao PRD. It has a border with China's Yunnan province. Oudomxay was selected by CIAT to implement a development project to improve supply chains of NTFP. It was selected because it is a remote and impoverished province, which is currently seeing rapid change into market integration due to its location close to China, Vietnam and Thailand (CIAT, 2005; Thongmanivong and Fujita, 2006).

Oudomxay has a very low proportion of undisturbed natural forest, but there is secondary forest (fallows) in varying stages of maturity. The vegetation classification map from the National Office for Forestry Inventory (NOFIP) indicates 12% mature forest and 48% fallow-forest (wood and shrubland). The population growth in Oudomxay province was 12% between 2002 and 2005 (National Census, 2005; OCISP 2002). Overall, the province has a low population density with an average of 15 inhabitants per km^2. This results in high costs for transportation and communication (OCISP, 2002). Only 46% of Oudomxay villages have road access, 7% have electricity, 4% access to water supply and 52% of the villages have a primary school (PAFO, 2005).

Oudomxay has a complex ethnic composition: 58% of the population is Lao Theung (to which the Khamu group belongs); 23% is Lao Loum and 19% Lao Soung (OCISP, 2002). The villages under study are Khamu and are situated on mountain ranges. The Khamu ethnic group is the most affected by the policies that aim at stopping shifting cultivation (ADB, 2001). The integration into the market economy has changed the way farmers use NTFP. Farmers now trade more, start to be organised in village marketing groups to negotiate with traders, manage NTFP resources collectively and in some cases domesticate NTFP. These changes have been supported by the government extension staff and development organisations (Thongmanivong and Fujita, 2006).

The export value of NTFP-trade from Oudomxay to China, Thailand and Vietnam was about US$ 80,000 in 2002/03. However, total trade is likely to be higher, since much of the trade is not registered in the official reports (OCISP, 2003). The table 1 shows the official numbers for exports of NTFP in the year 2002/03.

Table 1: Registered exports of NTFP from Oudomxay in 2002/03

NTFP	Latin name	Quantity (t)	Average value (Lao Kip/kg*)
Broom grass	*Thysanolaena latifolia*	242	1,035
Sapan	*Boehmeria malabarica*	214	1,426
Paper mulberry bark	*Broussonetia papyrifera*	42.5	1,706
Rattan canes	*Calamus spp*	15.6	1,989
Aloeswood resin	*Aquilaria crassna*	4.2	6,125
Cardamon	*Amomum spp*	1.5	8,000

Source: OCISP (2003); *10,000 Lao Kip ≈ 1 US$

2.2 The supply chain of paper mulberry bark

The supply chain of paper mulberry bark was selected to analyse the factors influencing the supply chain of a NTFP. Paper mulberry (*Broussonetia papyrifera* (L.) Vent.) was selected as a case study because it is a NTFP widely available in the fallows of Oudomxay and because recent market studies showed growing

demand for this bark (CIAT, 2006; Aubertin, 2004). In 2006 paper mulberry bark was one of the best available market option for farmers since: a) it does not require cash investment; b) it can provide a steady bi-annual income after the first year; c) it is easy to grow and there is local knowledge about how to care for it; d) it can be grown in mixed cropping systems; e) the leaves can be used to feed animals; f) it can improve the soil structure after rice; g) the debarked stems can be used for firewood or fencing (OCISP, 2003).

Paper mulberry is native to Lao PDR. It is a pioneer shrubby tree that sprouts naturally in the fallow fields after the harvest of upland rice (Aubertin, 2004). Farmers in Oudomxay collect mulberry bark from the upland fallows even though it is easy to cultivate, as it is done in the neighbouring provinces of Luang Prabang and Sayabury (Aubertin, 2004; Helberg, 2005). **Collecting the bark** is very flexible, depending on price and labour availability, thus allowing farmers to decide when to invest time in collecting and preparing the bark (Forsen et al., 2001: 28; Hamman, 2001). Generally the bark is collected twice per year: during the dry season in March-April (most of the yearly quantity) and at the end of the rainy season in October-December (Aubertin, 2005: 225). It is feasible to harvest the bark the whole year, but farmers just collect it during these two periods because is easier to strip the bark and easier to dry it, which reduces losses due to fungal problems (Aubertin, 2004).

Following the harvest, the bark of paper mulberry is **cleaned**, dried and graded. It is important to dry the bark properly to obtain good quality and higher prices (Vernon, 2006). It is labour intensive to remove and clean the bark (Helberg, 2005; Vernon, 2006). Especially if grade A is produced, villagers prefer thicker stems because it is easier and faster to process (Helberg, 2005). One person can produce a maximum of 5 kg of grade B bark per day (Helberg, 2005). There are two techniques that can enhance labour productivity as well as the quality of the end product: a) boiling the fresh stems before stripping the bark, and b) using machines to strip and clean the bark (however these are not used in Lao PDR) (Vernon, 2006). These activities could be the basis for developing small-scale enterprises (Vernon, 2006). Despite low prices, most villagers prepare paper mulberry bark because it is easily accessible and can be processed when no other activities are carried out (Helberg, 2005).

Normally, there are **village marketing groups**, also called village selling groups, which gather the bark for the district or provincial traders (Forsen et al., 2001). District traders and exporters transport the bark from the villages to the main towns where the bark is stocked in warehouses until it is shipped to Thailand or to Luang Prabang (Forsen et al., 2001). The trade of paper mulberry bark is allowed by the Lao PDR government, who supports it with technical advice (OCISP, 2003). Vernon (2006) reported that quotas, taxes and documentation requirements add to traders costs. Reducing or eliminating these costs may increase market demand and lead to higher prices paid to farmers who in turn would find cultivating paper mulberry to be a more attractive option.

The supply chain goes mostly to Thailand, China and Luang Prabang (Forsen et al., 2001). The process of **pulp and paper production** in Lao PDR is mainly non-mechanical and limited to the province of Luang Prabang. It is estimated that 10 million ton of dried, mixed-grade bark is **exported** annually from Lao PDR to Thailand (CIAT/SADU, 2006b). Large-scale export started in 1989, just after the economic opening of the country. The bark is shipped to Thailand by boat up-stream on the Mekong River (Forsen et al., 2001). The strategy used by the biggest Thai importers of bark is to buy during the dry season when prices are low and sell during the raining season when prices are higher (CIAT/SADU, 2006b).

Bark of mixed grade (mostly grade B and C) was sold in Xieng Khong at 14 Baht/kg[1], while grade A was sold for 30 Baht/kg (Vernon, 2006). Currently most of the bark harvested in Oudomxay is of grade C. In Oudomxay the **prices** for collectors varied between 7.2 Bath/kg and 10 Bath/kg during the 2005/06 season. There is no knowledge about grading, pulp or paper processing in Oudomxay. In 2001, only a small share of the harvested bark (approx. 25%) was processed in Luang Prabang, the remaining was exported to Thailand (see Fig. 6) (Forsen et al., 2001).

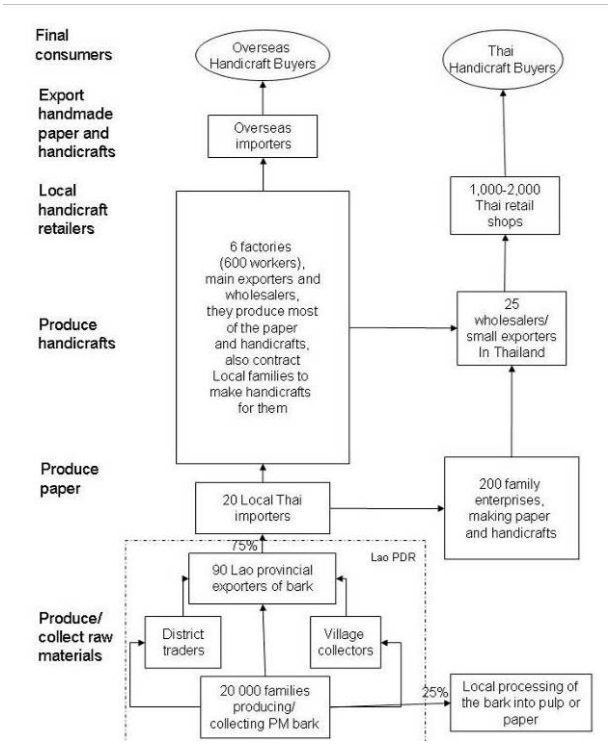


Figure 6: Supply chain of paper mulberry bark from Lao PDR to Thailand

Source: adapted from Forsen et al. (2001) and Eureka Consulting (2003)

Hamman (2001) reports that 75-85% of the bark used in Thailand is from Lao PDR, 5-7% from Myanmar and the rest from Thai farmers. One of the biggest Thai importers of Lao bark is Kuang Thai Special Ltd. In 2001, this company bought one million ton (Hamman, 2001). In 2006, this company claims to have been supplied between two and three million ton, even though the company aspired to five million ton (CIAT/SADU, 2006b). The latter indicates the potential growth in demand for paper mulberry bark.

Once the bark is in Thailand, it is sorted out into **grades**: A+, A, B and C. Grades B and C are sold to paper manufacturing plants for handmade paper (Forsen et al., 2001). While grades A+ and A are exported to Japan and South Korea to produce specialty papers (banknotes, liturgical objects). In Thailand the bark of grade A+ and A have to be young, i.e., 5 to 6 months; well dried; and is worth between 18 and 25 Baht/kg (CIAT/SADU, 2006b). Grades B and C are older than 7 months and are paid 17 to 18 Baht/kg at the Thai border (CIAT/SADU, 2006b). A Japanese company published their own standards and they are not the same as the Thai standards. In a document published by a Japanese company it states that bark of grade A+ should be harvested from one-year old stems, should be stripped fresh (i.e., not boiled to facilitate the cleaning), the bark should be well

[1] The exchange rate in March 2006 was approximately 40 Baht per 1 US$

cleaned of its outer layer and have more that one meter length (Sun World Limited, 1999) (see Tab. 2).

Table 2: Quality specifications of various grades of paper mulberry bark

Criteria	A+ Japan	A+ Thailand	A Japan	A Thailand	B or C Japan	B or C Thailand
Age	Mature, 1 year old and soft	5-6 months	Mature and not so mature, 1 year old	Max 1 year	Over 1 years old and tough	> 7 months
Method of stripping	Fresh stripping	Boil the bark before stripping	Fresh stripping, steamed before stripped	Boil the bark before stripping	Fresh stripping, steamed and burned before stripping	n.s.
Length	Fully grown stem min. 1m	Max. 1 meter	Mix of long and short stem	n.s.	n.s.	n.s.
Surface colour	White	white	White, light green	n.s.	Light brown	n.s.
Colour of back	White	white	Light brown	n.s.	Dark brown	n.s.
Dark skin	None	none	1-2 per bark	n.s.	More than Grade A	n.s.
Joints	None	n.s.	1 per bark	n.s.	More than Grade A	n.s.
Bruise	None	n.s.	None	n.s.	Both with and without	n.s.
Sand / Mould / Dust	None	None	None	None	None	None
Dryness	Fully dry	Fully dry	Fully dry	Fully dry	Fully dry	Fully dry
Sorting	Less than 10 % mix of A	n.s.	Less than 10% mix of B	n.s.	No sorting All grades mixed Grade B only Grade C only	n.s.
Weight (bundle)	Fully dried product and weighing 1% more than designated weight during the time of bundling	n.s.	Fully dried product and weighing 1% more than designated weight during the time of bundling	n.s.	Fully dried product and weighing 1% more than designated weight during the time of bundling	n.s.
Pressing	Bundled neatly parallel to the long lever of the pressing equipment and are not over pressed	n.s.	n.s	n.s.	n.s.	n.s.

n.s.: not specified

Sources: Sun World Limited (1999) and CIAT/SADU (2006b)

In Thailand there are both small scale production, usually household production of handmade paper, and industrial production. **Handmade paper production** consists of the following steps (Forsen et al., 2001):

1. soak the bark in water to make it softer and to remove dust;
2. cook the bark in caustic soda and rinse it with water to spread the fibres;
3. bleach the bark with hydrogen peroxide (less harmful for environment) or chlorine (cheaper);
4. beat the fibres by hand or using a machine to produce the pulp. This pulp is washed again. Colour can be added at this stage;
5. spread the pulp on mesh screens of cotton or plastic;
6. dry the paper in the sun (see Fig. 7).

In 2001, approximately half of the mulberry paper was produced by six paper mills (Forsen et al., 2001). The main markets for mulberry paper from Thailand are in Japan, Europe and North America. Although the Japanese market is the largest, it is also the most demanding regarding quality requirements (Forsen et al., 2001).

Figure 7: Mulberry paper drying on mesh screens

2.3 Objectives of the study

The study aims to identify ways to improve the supply chain of paper mulberry bark. The goal is to ensure an attractive source of cash income for the stakeholders, based on an environmentally sustainable production (i.e. cultivated paper mulberry trees).

Given that the supply chain involves a range of stakeholders (farmers, traders, extension officials, etc.) and that their perception of the factors influencing the supply chain, of their interdependencies, as well as of the changes that can lead to an improvement is likely to differ, each stakeholder group's perception must be taken into account. The study thus aims at comparing how various stakeholder groups propose to improve the supply chain, to capture their insider's knowledge and understanding, their perceptions of the interrelations, bottlenecks, hurdles and potentials. Synthesising these heterogeneous perceptions should allow to identify ways to develop the supply chain that are acceptable by all stakeholders, thus allowing for concerted action.

Specifically, **this study's aims** are:

1. To identify factors perceived by different stakeholder groups as influencing the supply chain of paper mulberry bark;
2. To understand the interrelations between the influencing factors named by each stakeholder group;
3. To analyse the differences between stakeholder groups in their perceptions of the factors that can lead to an improvement of the supply chain;
4. To propose options for improving the supply chain that are acceptable to all stakeholder groups;
5. To assess the potential for a shift from wild collection to domesticated production in Oudomxay.

2.4 Methods used to build the causal maps

2.4.1 Overview

Individuals who perform a specific function in the supply chain (e.g. bark collection, trading, processing) are likely to be affected by the same factors and thus have similar perceptions of what could or should be changed. The perception of one functional group might differ from that of individuals who live and work in a different location, perform a different function in the supply chain and have different interests, priorities and constraints. To differentiate between the various perspectives regarding the factors influencing the supply chain of paper mulberry bark, **six stakeholder groups** were identified based on the activities they perform: (1) producers, (2) district traders, (3) Lao provincial traders and exporters, (4) Thai manufacturers, (5) government extension services, and (6) development organisations and consultants. These were called 'functional groups' to indicate that they carry different functions along the supply chain from collecting the bark in the Lao PDR uplands to manufacturing pulp and paper in Thailand.

To capture the understanding of the supply chain, **causal maps** were built for each stakeholder group. Causal maps enable to graphically represent and study a person's or a group's knowledge and beliefs of a system (Laukkanen, 1998: 169). Causal maps are a schematic representation of the reality that guides and orients stakeholders' actions. Causal maps thus allow to compare the understanding of cause-effect relationships along the supply chain as seen by the various stakeholders and to compare the proposed changes and the factors that are perceived as most important.

The causal maps were also aggregated to build one **causal map** representing the whole supply chain. This aggregated causal map can be used to facilitate a common process of discussion, reflection and planning so as to identify possibilities for concerted action and facilitating change towards improvement as seen by all stakeholders along the supply chain of paper mulberry bark.

Data collection and analysis was divided into **following steps**: first, interviews were held to collect the range of factors that influence the supply chain of paper mulberry. From these, the most important factors were identified and a preliminary list of factors established. This list of factors was used by a second set of interviewees to build individual causal maps. The individual maps were then aggregated into causal maps for each functional group. Following the analysis of the functional groups' maps, the aggregated causal map of the supply chain was built.

2.4.2 Interviews to collect preliminary data

Causal mapping approaches can be challenging to implement when working with individuals that are not used to abstract thinking and in situations where the researcher needs to work with a translator. To cope with such challenges Fairweather et al. (2006) proposed an exploratory phase that results in a preliminary list of factors. These factors are then used by a second set of interviewees when building the map, thus making the map-building process easier for them and reducing the errors due to translations.

Thus, sixteen supply chain stakeholders were **interviewed**. The interview partners were selected so as to maximise diversity and ensure that all functional groups in Lao PDR are represented: six people working for NGO and implementing projects to develop the market for NTFP, four government officials; a district trader; an exporter; a female farmer, a male farmer; a pulp manufacturer and a manufacturer of paper and handicrafts working in Luang

Prabang. The aim was to obtain a list of the most important factors influencing the supply chain of paper mulberry bark as well as the causal links between the individual factors.

Following the suggestions by Eden and Ackermann (1998a) on how to elicit an interviewee's knowledge, the translator sat at right angles with the interviewee so as to easily show the map as it is drawn, while the researcher sat right angles with translator. The researcher drew the map on an A4 page at the same time as the information was being translated. The translator also drew a map but in lao language following the same structure as the researcher so that the interviewee could support him/herself in the picture to explain relations between factors (Hjortso et al., 2003).

The interview was started by showing our appreciation for the time devoted to the interview. The translator then explained that the interview would take approximately one hour and the interviewee was asked if the time was convenient to him/her. The objective of the interview was explained (see Table 3) and an example of a causal map was given for illustration (see suggestions by Fairweather et al., 2006). It was explained that all information would be treated as confidential. The interview was tape-recorded so that the researcher could return to the tape, in case causal links were unclear (Lukkanen, 1998: 178).

Table 3: Interview guidelines

We are trying to understand what things/factors are influencing the success/failure of the supply chain of paper mulberry bark so as to be able to promote improvement of supply chain through specific interventions where it is necessary.

When you think about a supply chain of paper mulberry bark activities and actors (collection, processing, manufacturing paper, exporting and selling).

1. What are the factors that come into your mind? Please, mention all factors.

2. How are these factors affecting each other?"

If necessary further questions were asked to help the interviewee:

For example let's look at this particular factor:

- *Why is this factor influencing the activities of the supply chain of paper mulberry bark?*
- *How that factor influences the activities of the supply chain of paper mulberry bark?*
- *What, if anything, does this factor cause?*
- *Is there anything else that this factors causes?*
- *What, if anything, causes this factor?*
- *Is there anything else that causes this factor?*

These questions were repeated for several factors to make sure not to influence the interviewee's answers.

As suggested by Eden and Ackermann (1998a) during the interview factors of 3 to 5 words were written as rectangular blocks of 3-2 cm. Each **factor** was written in an imperative form to give the map an action orientation. Periodically, the interviewee was asked about the accuracy of the emerging map. During this process the answers of the interviewee were paraphrased. Factors not linked to others were identified so that the interviewee could clarify them and explain how they influence the paper mulberry supply chain.

The interviewee was asked to draw arrows linking factors to each other. However, most of the interviewees preferred to delegate that task to the translator, while they read and corrected it, if necessary. The arrows indicate

that factor X 'may lead to', 'has implications for', 'supports', or 'may be explained by' factor Y.

When the map was finished, the interviewee was asked to name the most important factor, in case he/she had not already done so. If the most important factor was poorly linked to other factors, more information about its importance and links was requested from the interviewee.

The interviews took in average 1 to 1.5 hours. For seven interviews the agreed time had finished before finishing the interview. Thus the interviewee was visited again for a second interview to finish the map.

2.4.3 Compiling the preliminary list of factors

The causal maps drawn during the interviews were transferred to Decision Explorer®. This software (distributed by Banxia Software) allows to explore ideas and gain new understanding through causal mapping. The digital format also allowed to produce a list of the factors included in each map. These factors needed to be standardised, e.g. identify factors that have largely the same meaning but where interviewees used different words. When doubts about the meaning of a factor emerged, the map was consulted to analyse the context in which the factor is embedded. This allowed to condense the initial list of 332 factors to 123.

The list of 123 factors included the 16 that were selected by the interviewees as 'the most important' factor. From the remaining 107 factors, the 14 factors that were most often mentioned were selected. This allowed to compile the **list of 30 factors** that would be used in the next round of interviews.

The limitation to 30 factors was based on the objective of having a list of factors that would be manageable by interviewees. The limitation to 30 factors is in line with other reports in the literature: Ozesmi and Ozesmi (2004) stated that the average number of factors in the maps of six studies were 23, while Fairweather et al. (2006) used 36 factors in their predefined list of factors. Also, the maps drawn during the first round of interviews had an average of 25 factors, ranging from 17 (government official) to 38 (consultant).

The selected 30 factors were translated back to Lao and written on separate cards. Each factor was assigned a code number. This allowed the factors to be easily referred to, and allowed the researcher to follow the discussion between the translator and the interviewee.

2.4.4 Interviews for the construction of individual causal maps

Thirty stakeholders of the paper mulberry bark supply chain were asked to build a causal map using the 30 factors. The interviewees were selected by **snowball sampling**, starting in the villages Mang, Huay Sang and Changvang (these are the focus-villages of the larger research project). The goal was to interview four farmers (two men and two women) who are involved in collecting paper mulberry bark from the wild or who plant it on their plots in each of the three villages. However, in Changvang it was not possible to complete the interviews with the women because they were very shy and spoke very little Lao Loum (the translator does not speak Khamu). The farmers identified the district traders who visit their village, and the district traders indicated the provincial traders to whom they sell the bark. The biggest exporter of paper mulberry in Lao PDR was interviewed, as well as his Thai business partners. Additionally, members of the extension staff working in the three villages were interviewed. The interviewees further recommended the consultants to be interviewed. Overall, ten farmers (six men and four women),

four district traders, four provincial traders, three manufacturers in Chiang Mai (Thailand), three government extension officials and five consultants (two working for a local NGO and three experts from Thailand) were interviewed.

The **interviews** followed the same guideline as the first set of interviews (see Tab. 3). The only difference was that they were asked to use the pre-defined list of factors. However, following the approach used by Fairweather et al. (2006), the interviewees were free to eliminate factors, add new factors or change the wording of a factor. The interviewees were asked to select from the set of factors written on cards the factors that in their opinion influence the supply chain. Then the interviewee was asked to organise the cards on a diagram, to explain how these factors were interrelated and how they influence the different activities in the supply chain (see Fig. 8).

Figure 8: Interview setting

Once the interviewee had organised the factors on the diagram and drawn links between factors, he/she was asked to score the strength of the **causal connections** between factors, ranging from -9 (strongly negative relation) to 9 (strongly positive relation). Once the links were drawn, the causal map was discussed with the interviewee, focusing on questions such as:

- the most important factor(s), which were are indicated with a tick (√) on the causal map (see Fig. 9);
- the factor that should decrease (indicated using a circled tick);
- the factor that is most difficult to change (indicated by a circled P);
- the factor that the interviewee uses to assess the improvement of the supply chain (indicated by a circled A);
- the factor that is the goal of the business activity (indicated by a circled triangle).

This discussion allowed to collect additional information and to validate the map (see Fairweather et al., 2006).

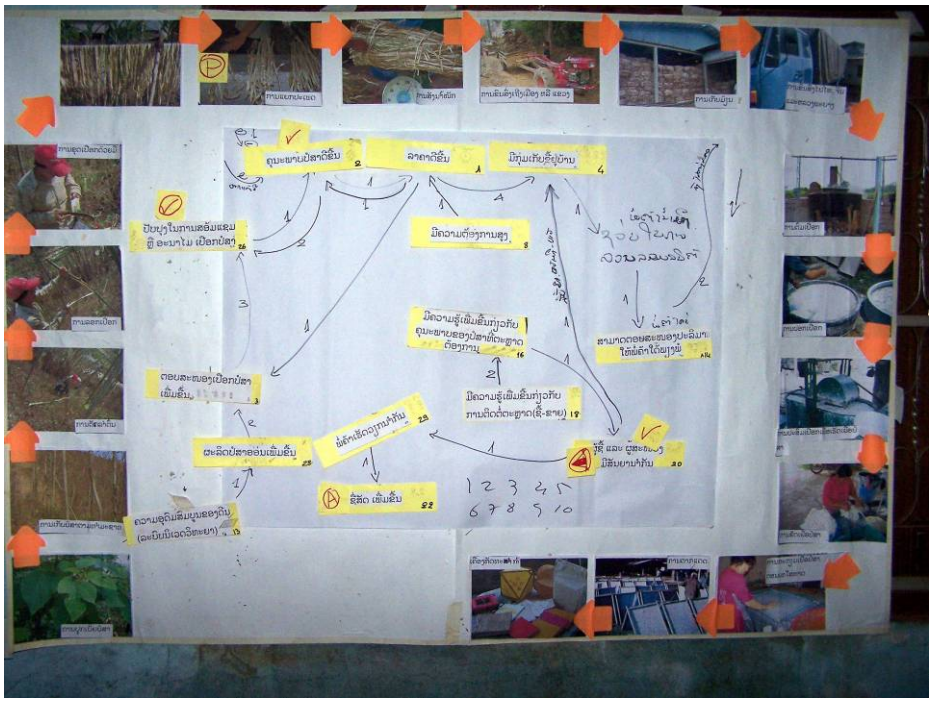


Figure 9: A completed causal map (from a government official). The photographs around the causal map indicate the supply chain of paper mulberry bark (the photographs can be found in the appendix)

2.4.5 Building and analysing the functional groups' causal maps

The individual maps were analysed by transferring the graphical data to a matrix, as suggested by Ozemi and Ozemi (2004). The **matrix** included the 30 initial factors as well as the factors that an interviewee might have added. The code-number for each factor is entered both in the top row and in the left column. The matrix is interpreted so that the row factor causes or influences the column factor. The strength of the causal connection between the two factors stated by the interviewee is entered in the cell of the matrix. A '0' thus indicates that the interviewee did not draw a link between these two factors (see Fig. 10).

	1	2	3	4	5
1	-	0	0	0	6
2	7	-	0	0	0
3	0	0	-	0	0
4	0	0	0	-	- 4
5	0	0	0	0	-

Figure 10: Detail of a matrix

Following the suggestion by Dickerson and Kosko (1994) as well as Ozesmi and Ozesmi (2004), the individual causal maps were added to form an **aggregated causal map** for each functional group. The matrices of the individual maps were additively superimposed, i.e. the value in each cell of a functional group's matrix is the sum of the values in the corresponding cell of each individual matrix of this functional group.

Given that there were between three and ten individual matrices that are aggregated into one functional group matrix, the strength of causal connections between the functional groups cannot be compared. In this study this does not

represent a problem since the strengths of the connections are only analysed within a functional group. The comparison between functional groups is limited to the existence or non-existence of a causal-connection between two factors.

For each functional group a second matrix was calculated, where the cells contained the absolute values of the strengths of the causal connection between factors. These values were used to calculate the indegree, the outdegree and the centrality score for each factor (Ozesmi and Ozesmi, 2004). The **indegree** (i.e. the sum of the values in the column of each factor), shows to what extend the factor is a result of others, i.e. the weight of the links leading to this factor. The **outdegree** (i.e. sum of the values in the row of each factor) indicates the extent to which this factor causes other factors, i.e. the total weight of the links leaving this factor for others. The **centrality score** is the sum of the indegree and outdegree of each factor and shows the importance (centrality) of this factor for the causal map.

These values can be used to distinguish between transmitter factors (i.e. those with an indegree of zero and a high outdegree) and receiver factors (those with outdegree of zero and a high indegree). As a preliminary analysis of the causal maps showed that most factors had both indegree and outdegree values it was decided to calculate the ratio of reception (Rc, see formula below) to be able to distinguish between the two types of factors. **Transmitters** (i.e. the main causes of the map) are thus those factors with a ratio of reception lower or equal to -0.2, while **receivers** (i.e. the main goals of the system) are those with a ratio of reception higher or equal to 0.2.

$$Rc = \frac{|Indegree - Outdegree|}{Centrality}$$

To focus on the most important factors, the ratio of reception was calculated only for those factors that have more than two connections to other factors. Thus the many factors which were cited by only one interviewee and those that are marginal to a map are not included.

Based on the links between factors as included in the matrix, a **causal map** was drawn for each functional group, using Microsoft® PowerPoint. Following the suggestion by Eden et al. (1992: 319) causal chains were simplified where possible, i.e. a factor was deleted if it had only one link in and one link out. To maintain that information, an "F*n*" in the graphical representation of the causal maps indicates that *n* factors were deleted in that causal chain.

To describe the changes in the supply chain that each functional group perceives as desirable, how these changes can be achieved as well as their expectations of other stakeholders' actions, the matrices of each functional group were **analysed** along following lines:

- The factors with a high centrality score were compared with those factors that the interviewees selected as being the most important.
- The factors that are receivers: the receivers are factors that represent the main results of improving the supply chain as perceived by that functional group and are thus a good starting point to describe how that functional group would improve the supply chain.
- The factors that are transmitters. These are the main causes as seen by the interviewees of that functional group.
- The number of factors in each map. Eden et al. (1992) argued that the more factors a map has, the more complex it is. Complexity might

indicate difficulties concerning meeting multiple and possibly conflicting objectives.

- The number and type of new factors added by the interviewees of a functional group.
- Focus on those factors that have links with a score higher or equal to 7 (with the exception of the consultant's map, where the focus is on scores higher or equal to 8, since the consultants tended to use higher scores).
- Identify feedback loops as these may represent synergy from the synthesis of individual wisdom (Eden et al., 1992: 321).

2.4.6 Compiling the aggregated causal map

The model for the paper mulberry bark supply chain was build by aggregating the causal maps of the six functional groups. The maps were aggregated starting with the factors that were mentioned as central by three of more functional groups. The links leading to these factors or leaving these factors that were mentioned by two or more functional groups were then drawn. The model also includes the links that were drawn in opposite ways by two functional groups.

3 Results

The causal maps are presented for each of the six functional groups, i.e. the farmers, the district traders, the exporters of raw material, the Thai manufacturers, the government extension agents and the consultants.

First, the causal map of each functional group is described. The arrows in the causal maps represent a perceived causal relationship between two factors. The strength of these arrows depends on the sum of the score given by the different interviewees and it is represented by a number that is normally located next to the tip of the arrow. For each functional group the goal of their activity is presented as well as the factors that it perceives as most important and those that are most difficult to change, as well as the indicators the group uses to assess whether the supply chain has improved. The calculated outdegrees, indegrees and centrality scores for each factor of the map are also presented. Secondly, the six causal maps are compared to analyse the differences between the functional groups

3.1 Descriptive analysis of the causal map of each functional group

3.1.1 Causal relationships as perceived by farmers

The farmers named a total of 33 factors. Twenty-nine factors were taken from the pre-established list and the following four factors were added during the interviews: "resources are closer to home"; "weight of the bark"; "difficult to find seedlings in the forest"; and "farmers boil the bark at the village".

For farmers improvement of the supply chain is an increase in income for all stakeholders. This is dependent on an increase in the area planted with paper mulberry (only three of the 10 interviewed farmers had a plot with paper mulberry). This is the most central factor in their map (see Fig. 11). They see the role of farmers as very important since an increase of planted area influences the income of all stakeholders.

The farmers explained that if they have more knowledge on the **quality requirements**, it would lead to a better cleaning of the bark, thus to a higher quality and better prices. Better prices have a strong and direct link to increased income by all stakeholders. Also, better prices are an incentive for farmers to plant more paper mulberry, thus increasing the supply while decreasing the time needed to clean the bark (the farmers report that it is easier to strip off the bark from stems of planted paper mulberry). It would also allow farmers to have paper mulberry in their gardens, closer to their home. An increase in planted area indirectly results in higher sales volume and thus higher income for all stakeholders.

The tradition in the farmers' villages is to produce upland rice for family consumption. An increased income will lower the importance of **rice production in relation to cash crops**. This allows to extend the area planted with paper mulberry and other cash crops. In addition, if there are more cash crops planted in the village, farmers expect government extension staff and development organisations to intensify and extend their technical support. Technical support increases technical knowledge about production techniques. This allows to increase the area planted with paper mulberry and thus the production of young bark. The production of young bark is important because it leads to stable prices. Also, it is of better quality than old bark and thus it leads to better prices. Better prices increase the income of all stakeholders.

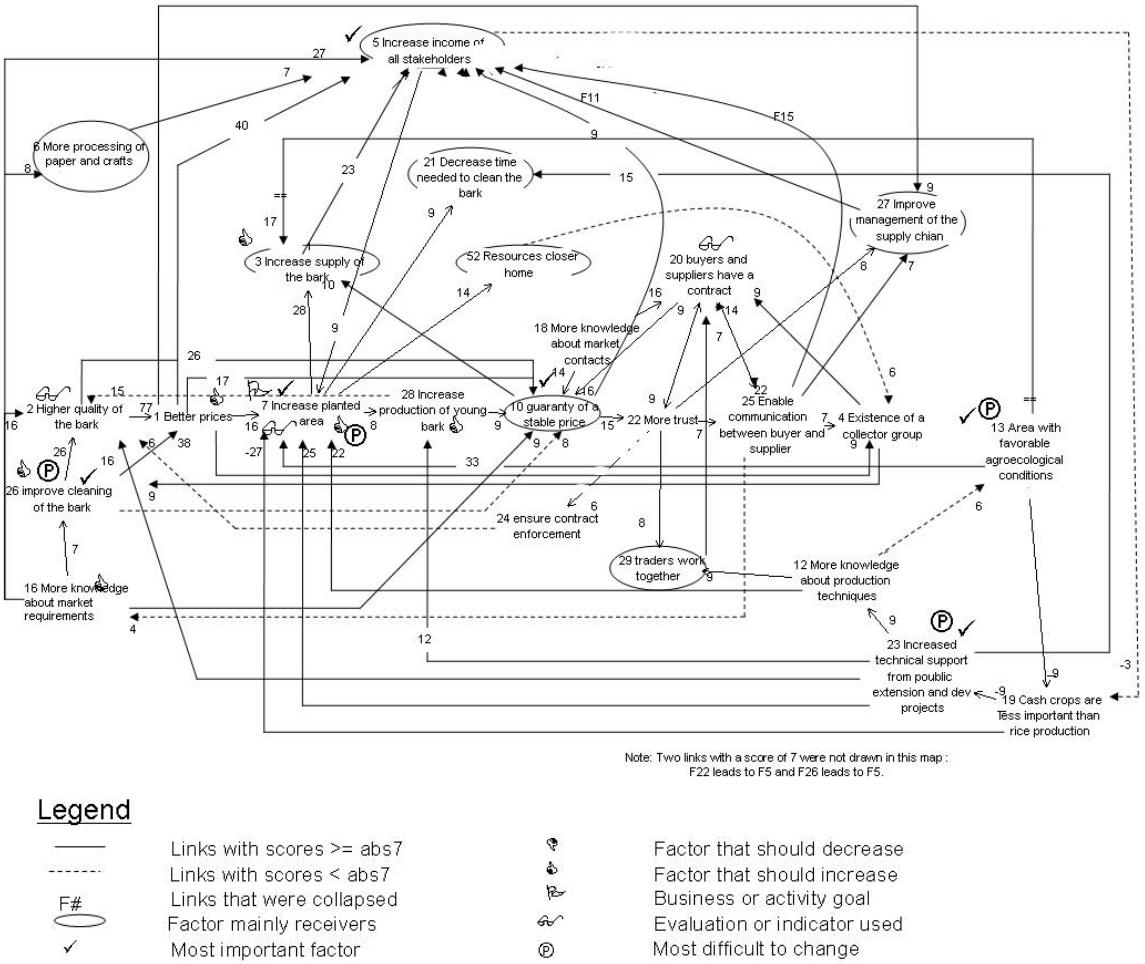


Fig. 11: Farmers' causal map

Stable prices increase **trust**, and trust enable production contracts[2] between farmers and traders, improves management of the supply chain and allows traders to cooperate. If traders cooperate, there are higher chances that production contracts are enforced. From contract enforcement there is a feedback loop that leads to increased bark quality. The latter will strengthen further production contracts. Having a contract increases trust and enables communication between buyers and suppliers. Enabling communication improves the management of the supply chain. It also enhances knowledge about market quality requirements, since communication enables information exchange about required quality standards with other levels of the supply chain.

Better prices, more communication and resources closer to home are incentives for farmers to organise themselves and form a **village marketing group**[3]. Such a

[2] Production contracts are formal or informal agreements between the village marketing group and a district trader or exporter regarding the provision of paper mulberry bark. Such contracts can be of three types (Belcher, 1998): based on market specifications (quantity, quality, price); based on resource provision (provision of inputs such as seed and credit) and product management contracts (characterised by technical assistance plus market specificities). In Oudomxay the system used by traders and farmers was often provision of credit by the trader to the village marketing group.

[3] A village marketing group allows farmers to jointly market their products to an outside trader. The group's manager might or might not be given the power to negotiate contracts for the group. In

group has a positive effect on the quality of the bark and is an incentive to establish production contracts since traders are keener to have contracts with villages that an have organised extraction and collecting system. Both contribute to better prices and increased income for all stakeholders.

Table 4: Indicators for each factor of the farmers' causal map (the factors are listed according to the Position Centrality Score (PCS), i.e. starting with the most central factor)

Factor	Out-degree	In-degree	Ratio of reception	Centrality	PCS
7 - Increase planted area	111	163	0.19	274	1
1 - Better prices	101	133	0.14	234	2
2 - Higher quality of the bark	129	102	-0.12	231	3
5 - Increase income of all stakeholders	17	172	0.82	189	4
20 - Buyers and suppliers have a contract	67	76	0.06	143	5
10 - Guaranty of a stable price	44	94	0.36	138	6
26 - Improve cleaning of the bark	86	43	-0.33	129	7
23 - Increase technical support from Gov. extension and development organisations	85	9	-0.81	94	8
25 - Enable communication between buyer and supplier	46	43	-0.03	89	9
16 - More knowledge about market quality requirements	72	12	-0.71	84	10
3 - Increase supply of the bark	27	55	0.34	82	11
22 - More trust	56	24	-0.40	80	12
4 - Existence of a collector group	48	29	-0.25	77	13
28 - Increase production of young bark	31	45	0.18	76	14
14 - Ensure enough quantity	44	31	-0.17	75	15
12 - More knowledge about production techniques	63	9	-0.75	72	16
13 - Area with favorable agro-ecological conditions	60	6	-0.82	66	17
18 - More knowledge about market contacts	50	13	-0.59	63	18
8 - High demand	26	34	0.13	60	19
19 - Cash crops are less important than rice production	33	20	-0.25	53	20
27 - Improve management of the supply chain	15	30	0.33	45	21
15 - Existence of many traders	23	15	-0.21	38	22
21 - Decrease time to clean the bark	0	31	1.00	31	23
29 - Traders work together	7	24	0.55	31	24
6 - More processing into paper and crafts	7	17	0.42	24	25
52 - Resources are closer home... saving time	6	14	0.40	20	26
11 - Reach more rewarding market opportunities	5	13	0.44	18	27
24 - Ensure contract enforcement	6	9	0.20	15	28
30 - Paper mulberry had low prices when compared with other crops	6	9	0.20	15	29
17 - Less need for credit	0	13	1.00	13	30
54 - Weight of the bark	9	0	-1.00	9	31
53 - Difficult to find seed in the forest	7	0	-1.00	7	32
39 - Farmers boil the bark at the village	1	0	-1.00	1	33

Farmers explained that better dried bark is of higher quality. If the bark is dried better, then it will look cleaner and have less fungal infections. Thus, improved cleaning of the bark, better drying and sorting in different grades stabilises prices. However, it is also related to loss of weight (which might lead to lower income since the bark is often sold by weight).

some cases the group is constituted by a trader that has enough credit to pay the farmers to collect and deliver the product at his warehouse.

When asked for factors that should increase to improve the supply chain, farmers mention knowledge about quality requirements, price, supply of the bark, planted area, improve cleaning of the bark and more production of young bark. Regarding the goal of their activities, farmers stated that their goals were to increase planted area and to improve cleaning of the bark. When asked how they evaluate the result of their activities, farmers said that their efforts were successful if they have a contract with traders, if the area planted with paper mulberry trees increases and if the bark is of higher quality. The most difficult factors to change for farmers was to increase planted area; to improve cleaning of the bark, and the provision of technical support.

The farmers' answers regarding the most **important factor** are compared with the **centrality score** of the factor as calculated based on the causal map. This allows to test if the centrality score effectively identifies the factors that interviewees selected as the most important factors. For farmers the most important factors influencing the supply chain were: the increase in planted area (PCS=1), increase in income for all stakeholders (PCS=4) and stable prices (PCS=6). The factors with the highest centrality score are: increase of planted area, better prices, and quality of the bark.

The analysis of the farmers' causal map shows that there are eight factors acting as receivers and ten acting mainly as transmitters. The **receivers** are:

- Increase income of all stakeholders (this factor has the highest ratio of reception: 0.82)
- decrease time needed to clean the bark; traders work together
- more processing of pulp and paper
- resources are closer home
- guaranty of stable prices
- more supply of the bark, and
- improved management of the supply chain.

The factors acting mainly as **transmitters** are:

- area with favourable agroecological conditions;
- increased technical support from government extension services and development projects;
- more knowledge about production techniques;
- more knowledge about market quality requirements, and
- more trust.

3.1.2 Causal relationships as perceived by traders

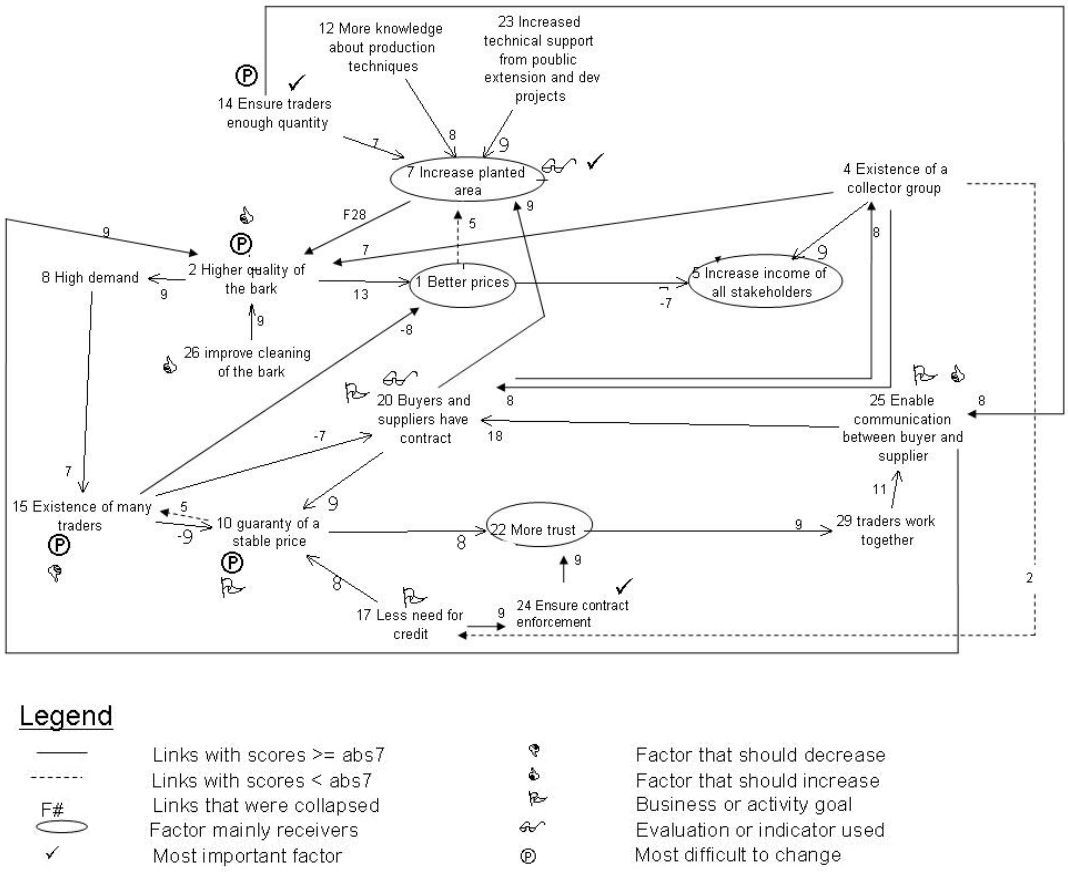
This group is represented by four traders who collect bark directly in the villages. They cited 30 different factors. Two factors are specific to this group: the importance of government agencies (commerce and agriculture) to provide incentives, and to facilitate the process of contract development and enforcement; as well as boiling the bark in the village to facilitate cleaning and improve quality.

For the traders, the increase in planted area is the most central factor (see Fig. 12). For district traders an improvement of the supply chain means that: there is an increase in the planted area; there are better prices; there is more trust and all stakeholders have an increased income.

The district traders focused their arguments on four issues: poor quality of the bark (i.e. farmers do not dry the bark properly[4]), existence of many district traders, the inability of farmers to fulfil production contracts and poor availability of credit. All these factors lead to **unstable prices**. This is

[4] Farmers contest this. The farmers explained that often the district traders are aware that the bark that is still moist, but they want to buy it anyway and do not want to wait until it is ready to be sold.

problematic for this group, especially if prices drop, because they provide credit in advance to farmers. The credit is given from exporters to district traders.



Legend

———	Links with scores >= abs7		Factor that should decrease
-------	Links with scores < abs7		Factor that should increase
F#	Links that were collapsed		Business or activity goal
	Factor mainly receivers		Evaluation or indicator used
✓	Most important factor	Ⓟ	Most difficult to change

Fig. 12: Traders' causal map

Increase of planted area is a signal of improvement because it increases the **quality of the bark**. However the district traders' map shows that under certain conditions quality might be a constraint for district traders. Higher quality has two opposing effects: on the one hand it directly contributes to better prices for this group, but on the other hand, higher quality leads to higher demand and to the existence of many traders. Traders compete to be able to buy enough bark, increasing purchasing prices for district traders. Since they have a credit to pay to exporters and the bark is paid by weight, the incentive to decrease quality through adding other products and water is high. Furthermore these dynamics will impact on the farmer's capacity to keep the contracts as farmers will be tempted to sell to the trader who offers a higher price. This also impacts on the stability of prices. The stability of prices is affected by the fact that farmers need cash in advance to collect the bark. During the interviews district traders related that lack of credit leads to the need to buy and sell the bark quickly. This reduces the retention period to a minimum by both farmers and district traders. If farmers do not keep the contracts, it decreases trust. If there is poor trust, traders do not cooperate. And since there is no horizontal communication with other traders, quality requirements and contracts cannot be fulfilled. This negative feedback loop does not allow the system to improve.

If farmers had less need for credit, they may keep their commitments and produce for the trader to whom they agreed to supply bark. This would stabilise prices, increase trust and traders would cooperate. This would

improve communication, increasing chances of having supply contracts with farmers and increasing the quality of the bark.

Table 5: Indicators for each factor of the traders' causal map (the factors are listed according to the Position Centrality Score (PCS), i.e. starting with the most central factor)

Factors	Out-degree	In-degree	Ratio of reception	Centrality	PCS
7 - Increase planted area	23	49	0.36	72	1
20 - Buyers and suppliers have a contract	28	38	0.15	66	2
2 - High quality of the bark	31	29	-0.03	60	3
25 - Enable communication between buyer and supplier	31	27	-0.07	58	4
10 - Guaranty a stable price	19	27	0.17	46	5
15 - Existence of many traders	24	18	-0.14	42	6
4 - Existence of a collector group	27	8	-0.54	35	7
1 - Better prices	12	21	0.27	33	8
22 - More trust	10	21	0.35	31	9
17 - Less need for credit	26	2	-0.86	28	10
5 - Increase income of all stakeholders	0	22	1.00	22	11
14 - Ensure traders enough quantity	16	5	-0.52	21	12
29 - Traders work together	11	10	-0.05	21	13
3 - Increase supply of the bark	12	8	-0.20	20	14
24 - Ensure contract enforcement	9	11	0.10	20	15
8 - High demand	7	9	0.13	16	16
26 - Improve cleaning of the bark	9	7	-0.13	16	17
12 - More knowledge about production techniques	15	0	-1.00	15	18
55 - Gov. supports and controls contract enforcement	11	0	-1.00	11	19
21 - Decrease time needed to clean the bark	0	9	1.00	9	20
23 - Increase technical support from gov. extension and development organizations	9	0	-1.00	9	21
30 - Cash crops are less important than rice production	0	9	1.00	9	22
9 - High costs of taxes, quota and documents	8	0	-1.00	8	23
16 - More knowledge about market quality requirements	7	0	-1.00	7	24
28 - Increase production of young bark	4	3	-0.14	7	25
39 - Farmers boil the bark at the village	0	7	1.00	7	26
11 - Reach other more rewarding market opportunities	0	6	1.00	6	27
27 - Improve management of the supply chain	0	6	1.00	6	28
18 - More knowledge about market contacts	5	0	-1.00	5	29
6 - More processing into paper and crafts	0	2	1.00	2	30

The analysis of the causal map shows that the three most central factors are: increase in planted area; buyers and suppliers have a contract; and higher quality of the bark. The causal map of the traders has four factors that are mainly receivers and four that are mainly transmitters. The factors that are mainly **receivers** are: increase income of all stakeholders increase planted area; more trust, and better prices. The **transmitter** factors are: less need for credit; existence of a collector group at the village; ensure enough quantity to traders and more supply of the bark.

For district traders the most important factors influencing improvement of the supply chain were: increase planted area (PCS=1); to ensure traders enough quantity (PCS=12) and to ensure contract enforcement (PCS=15). To the question about what factors should increase district traders answered: higher quality of the bark, increase communication between buyer and supplier and improve cleaning of the bark. For district traders the most difficult factors to

change are the quality of the bark (SCP=3), stability of prices (SCP=5), existence of many traders (SCP=6) and to ensure enough quantity to traders (SCP=12).

District traders stated that the number of traders and export taxes should decrease. Their business goal is to have contracts with buyers and suppliers, to guarantee stable prices, to reduce the need for credit and to improve communication with buyers and suppliers. District traders evaluate their efforts as successful if they have a contract with a village marketing group, if there is more planted area with mulberry bark and if there was an increase in the quality of the bark.

3.1.3 Causal relationships as perceived by Lao exporters

This functional group is represented by four stakeholders from Oudomxay province and one from Luang Prabang province. They cited 30 different factors. There are three factors that were cited by the exporters, that were not part of the initial list of factors: it is the importance of government agencies (commerce and agriculture) to provide incentives, facilitate and be involved in the process of contract development and enforcement (this factor was also mentioned by district traders). Another factor is to have a factory in Lao PDR that is linked to more chances of existence of supply contracts with manufacturers. A last factor of low frequency is weight of the bark (it was also mentioned by farmers). One of the interviewees explained that the existence of many district traders increased the weight of the bark at the expense of quality (addition of other substances and produce not dried enough).

For exporters to **improve the supply chain** requires:

- to improve the quality of the bark;
- the existence of contract between buyers and suppliers;
- to increase the area planted with paper mulberry trees;
- to increase the income of all stakeholders;
- to reach more rewarding market opportunities;
- to increase the level of trust between the supply chain stakeholders; and
- to make sure there is enough bark for the traders.

For the exporters **quality** is a central factor and it influences prices. A low-quality bark results in weight loses: if the bark is not well dried it can lose up to 30% of its original weight. To improve the quality of the bark exporters propose the following factors: more knowledge about market quality requirements by all stakeholders; improved cleaning and drying of the bark by farmers; enhanced communication; more technical support from government extension staff and development projects.

It is important to increase the quality of the bark not only because poor bark quality results in costs for exporters, but also because it promotes the existence of contracts, it guarantees stable prices and higher demand, and thus leads to better prices. Better prices increases the income of all stakeholders and feeds back into increasing the planted area and increases knowledge about market contacts. Having more knowledge about market contacts leads to more contracts between buyers and suppliers and increases the chances of reaching **more rewarding market opportunities**. This allows to improve the management of the supply chain and to increase the area planted with paper mulberry. Increasing the planted area does not only have a positive effect on increasing the income of all stakeholders but also on ensuring enough quantity for traders.

Higher bark quality, more knowledge about market contacts and trust increases the chances of having **contracts** in the future. Existence of contracts leads to more knowledge about production techniques because buyers give suppliers

more information about how they can improve their production techniques to comply with the quality requirements of buyers. Knowing more about production techniques leads to reduction of the time to clean the bark that will encourage farmers to supply more and feeds backs into ensuring traders enough quantity. These contracts results in more incentives for farmers to form marketing groups in the villages and will ensure enough quality to traders, this feeds backs into production contracts. Having contracts between buyers and suppliers also improves the supply chain because it improves the stability of prices leading to increased income for all stakeholders.

In short, if farmers have more knowledge about market quality requirements then they will improve cleaning and drying of the bark. Cleaning of the bark improves the quality of the bark, leading to better prices. Better prices increase the income of all stakeholders, which leads to more knowledge about market contacts. This knowledge will promote more contracts that guarantee prices, increase the income of all stakeholders, increase planted area, and ensure traders enough quantity (see Fig. 13).

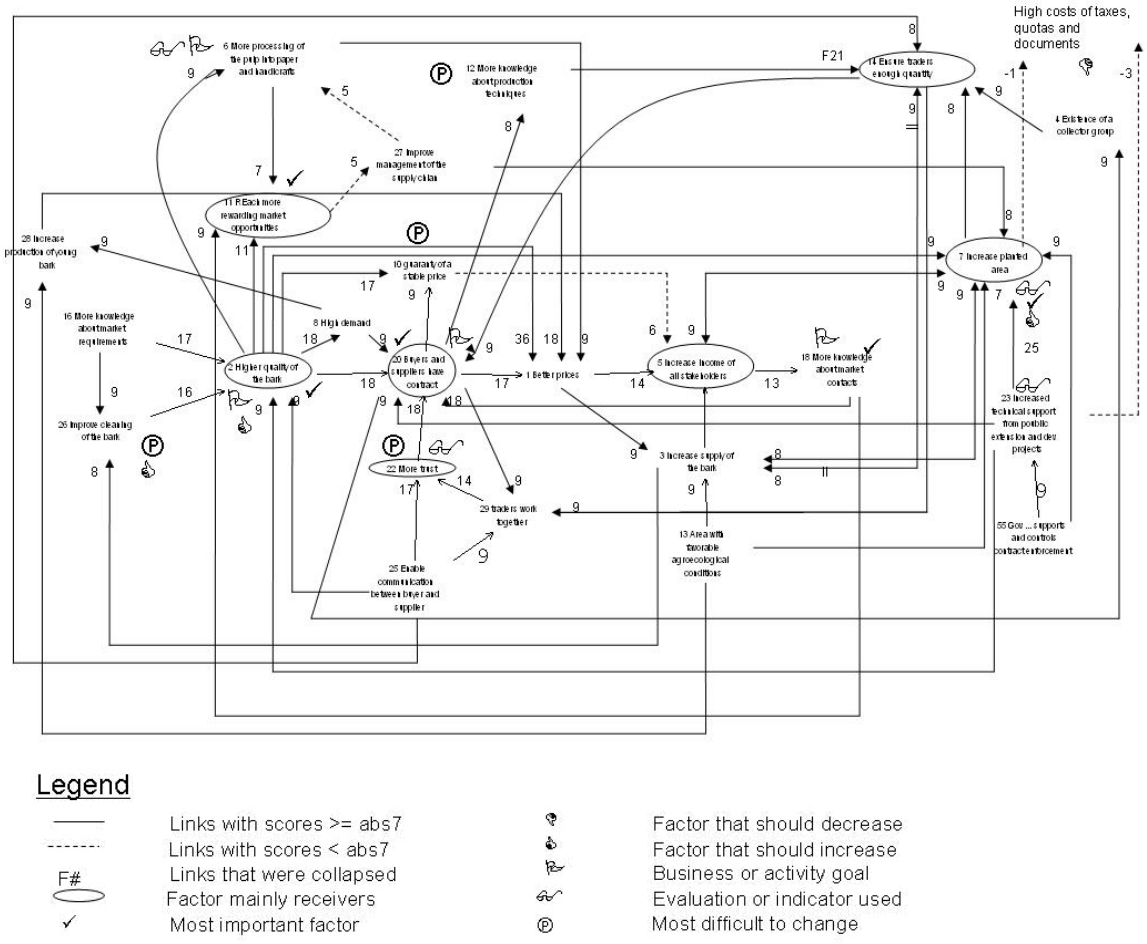


Fig. 13: Exporters' causal map

The analysis of the causal maps shows that the three most **central factors** for exporters are: higher quality of the bark; buyers and suppliers have a contract; and better prices (see Tab. 6). The main **receivers** of the traders' map are: to reach more rewarding market opportunities; the guarantee of stable prices; and to ensure enough quantity to traders. The main transmitters are: to enable communication between buyer and supplier; an area with favourable agro-ecological conditions; and more knowledge about market quality requirements.

Table 6: Indicators for each factor of the exporters' causal map (the factors are listed according to the Position Centrality Score (PCS), i.e. starting with the most central factor)

Factors	Out-degree	In-degree	Ratio of reception	Centrality	PCS
2 - High quality of the bark	145	67	-0.37	212	1
20 - Buyers and suppliers have a contract	66	116	0.27	182	2
1 - Better prices	58	87	0.20	145	3
7 - Increase planted area	39	67	0.26	106	4
3 - Increase supply of the bark	41	53	0.13	94	5
18 - More knowledge about market contacts	40	37	-0.04	77	6
29 - Traders work together	48	29	-0.25	77	7
23 - Increase technical from gov. extension and development organizations	53	17	-0.51	70	8
5 - Increase income of all stakeholders	22	45	0.34	67	9
16 - More knowledge about market quality requirements	47	15	-0.52	62	10
26 - Improve cleaning of the bark	25	33	0.14	58	11
11 - Reach more rewarding market opportunities	5	48	0.81	53	12
22 - More trust	19	32	0.25	51	13
25 - Enable communication between buyer and supplier	51	0	-1.00	51	14
8 - High demand	18	25	0.16	43	15
14 - Ensure traders enough quantity	9	33	0.57	42	16
24 - Ensure contract enforcement	18	21	0.08	39	17
28 - Increase production of young bark	18	18	0.00	36	18
6 - More processing into paper and crafts	16	19	0.09	35	19
10 - Guarantee a stable price	6	26	0.63	32	20
4 - Existence of a collector group	15	15	0.00	30	21
13 - Area with favorable agro-ecological conditions	25	5	-0.67	30	22
12 - More knowledge about production techniques	15	14	-0.03	29	23
27 - Improve management of the supply chain	13	5	-0.44	18	24
21 - Decrease time needed to clean the bark	8	8	0.00	16	25
15 - Existence of many traders	7	5	-0.17	12	26
55 - Gov. supports and controls contract enforcement	9	0	-1.00	9	27
56 - Have a paper factory in Laos	9	0	-1.00	9	28
9 - High costs of taxes quotas and documents	0	4	1.00	4	29
54 - Weigh of the bark	0	1	1.00	1	30

The exporters have as **business goal** to have supply contracts with foreign or Lao buyers. So they need to increase their list of market contacts and increase the quality of the bark. One of these exporters wanted to expand his manufacture of paper and crafts. For Lao exporters the three most important factors influencing the supply chain are also part of their goals: higher quality of the bark (PCS=1); buyers and suppliers have a contract (PCS=2); more knowledge about market contacts (PCS=6) and reach more rewarding market opportunities (PCS=12). Exporters answered that quality of the bark, cleaning of the bark and planted area should increase.

Exporters evaluate their efforts by observing if there was an increase in planted area, an increase in technical support to farmers and if there is more trust. One of the exporters has a small paper factory; he observes the amount of paper that is produced.

Exporters believe that the most difficult factors to change are: cleaning of the bark (SCP=11); trust (SCP=13); stability of prices (SCP=20) and knowledge about production techniques (SCP=23).

3.1.4 Causal relationships as perceived by Thai manufacturers

This group map results from three interviews made to Thai managers of paper mulberry factories in Chiang Mai (Thailand). One of the Thai factories produced paper and handicrafts which were exported to North America and Europe. The other two Thai companies buy raw materials, design and export the products, but subcontract small companies to produce the paper and the handicrafts.

This functional group suggested 39 factors, which is higher than the average of 33.5 factors. The Thai manufacturers mentioned the following 14 new factors:

- improved quality of paper and crafts;
- ensuring on-time delivery to final buyers in importing countries;
- lack of quality standards (need for more transparency about quality standards);
- high production costs;
- low use of water;
- lack of professionalism from subcontractors;
- reduce the oil-content of the bark;
- reduce the use of chemicals during paper production;
- increase the supply of the paper;
- environmentally friendly production;
- reduce the time for boiling by the manufacturer;
- manufacturers pay labour to clean fibres after boiling and chemical cleaning;
- farmers boil the bark at the village;
- stock bark or paper;
- subcontract paper or craft production.

This group perceives **improvement** as an increased supply of bark, the existence of contracts with buyers (importing companies in Europe, Japan and North America), more processing of the paper and crafts, increased income for all stakeholders, on-time delivery to buyers, access to more rewarding markets and reduction of production costs.

Some of the links in the causal map were not scored because stakeholders said they did not know how to score these links. It was decided to add them because they help to justify some specificities of the manufacturers' causal map (see Fig. 18).

An important difference between this and other functional groups is their definition of better prices. For the Thai manufacturers a **better price** is a lower price, i.e., cost and quality competitive prices, while for other groups better prices were related to increased prices.

The reduction of the oil content of the bark is important so that manufacturers can produce paper of higher quality for the Japanese market. The reduction of oil also allows to reduce the use of chemicals (bleach) in the process of paper production and to reduce the time that bark needs to boil. Both of these factors decrease **production costs**. The lack of a standard quality increases production costs because manufacturers never receive a standard quality that allows them to standardise the processes. Production costs are also dependent on the timely delivery of paper and crafts to the final buyers. If manufacturers do not deliver on time, the costs of delivery will increase because the contract states that for each day that the order is delayed the manufacturer is punished in the price paid for the paper by the retailer. For the manufacturer, production costs are a critical issue since they influence directly on the competitiveness of the price of the final produce.

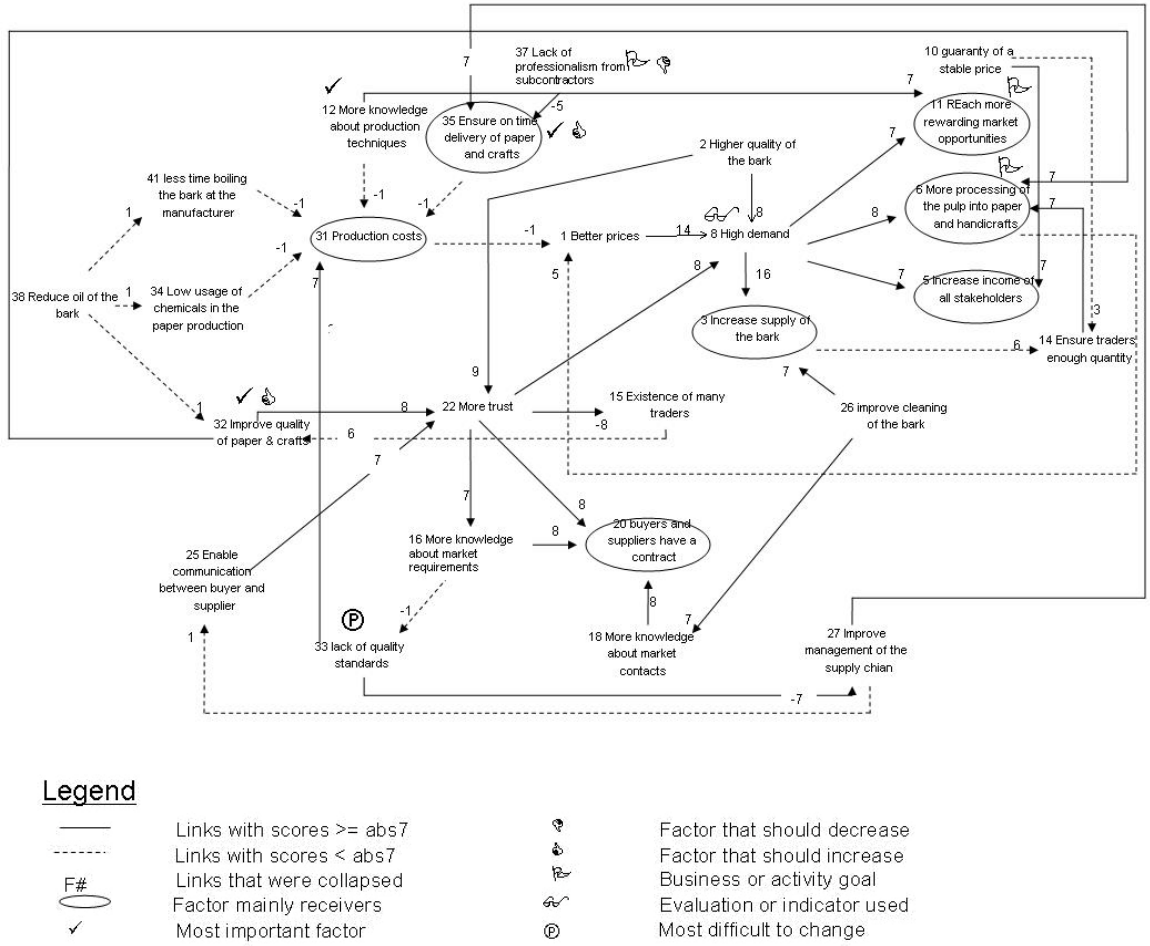


Fig. 13: Thai manufacturers' causal map

The most central factor in the Thai manufacturers' causal map is the **demand for paper and crafts**. Competitive prices and quality of the bark have a positive effect on demand. Higher demand results in more processing of paper and crafts that will lead to even more competitive prices. Higher demand also leads to increased income of all stakeholders and enables manufacturers to reach more rewarding market opportunities. Higher demand and improved cleaning of the bark increases supply of the bark ensuring traders enough quantity and enables processing of paper and crafts.

Market contacts, the level of trust of foreign buyers towards the company, and on the company's knowledge about market quality requirements leads to existence of contracts with buyers in North America, Europe and Japan. However, having market contracts in not enough, manufacturers need to ensure on-time delivery of orders. This is not always easy because there is a lack of professionalism by subcontractors and the management of the supply chain is inexistent. Management of the supply chain is seen by manufacturers as a responsibility of government institutions and development organisations. The problem of lack of professionalism is due to subcontracted parties (small companies or organised upland dwellers) who produce paper or handicrafts made of paper as a seasonal work, and not as a main income provider.

Table 7: Indicators for each factor of the Thai manufacturers' causal map (the factors are listed according to the Position Centrality Score (PCS), i.e. starting with the most central factor)

Factor	Out-degree	In-degree	Ratio of reception	Centrality	PCS
8 - High demand	38	39	0.01	77	1
22 - More trust	30	23	-0.13	53	2
3 - Increase supply of the bark	6	43	0.76	49	3
1 - Better prices	25	15	-0.25	40	4
27 - Improve management of the supply chain	15	18	0.09	33	5
18 - More knowledge about market contacts	21	7	-0.50	28	6
20 - Buyers and suppliers have a contract	0	28	1.00	28	7
6 - More processing into paper and crafts	5	22	0.63	27	8
32 - Improved quality of paper and crafts	17	10	-0.26	27	9
5 - Increase income of all stakeholders	0	26	1.00	26	10
16 - More knowledge about market quality requirements	19	7	-0.46	26	11
2 - Higher quality of the bark	17	8	-0.36	25	12
12 - More knowledge about production techniques	15	5	-0.50	20	13
26 - Improve cleaning of the bark	11	8	-0.16	19	14
35 - Ensure on time delivery	6	12	0.33	18	15
11 - Reach other more rewarding market opportunities	0	16	1.00	16	16
14 - Ensure traders enough quantity	7	9	0.13	16	17
33 - Lack of quality standards	14	2	-0.75	16	18
31 - High production costs	3	11	0.57	14	19
10 – Guarantee of a stable price	10	2	-0.67	12	20
15 - Existence of many traders	12	0	-1.00	12	21
23 - Increased technical support from gov. extension and development organizations	12	0	-1.00	12	22
25 - Enable communication between buyer and supplier	11	1	-0.83	12	23
37 - Lack of professionalism from subcontractors	7	3	-0.40	10	24
24 - Ensure contract enforcement	0	7	1.00	7	25
7 - Increase planted area	6	0	-1.00	6	26
9 - High costs of taxes, quota and documents	4	0	-1.00	4	27
13 - Area with favorable agro-ecological conditions	4	0	-1.00	4	28
38 - Reduce oil of the bark	3	1	-0.50	4	29
34 - Low usage of chemicals in the paper production	1	1	0.00	2	30
36 - Increase supply of the bark	0	2	1.00	2	31
40 - Production environmentally friendly	0	2	1.00	2	32
41 - Less time boiling at manufacturer	1	1	0.00	2	33
48 - Manufacturers pay labor to clean fibers after boiling and chemical cleaning	2	0	-1.00	2	34
19 - Cash crops are less important than rice production	1	0	-1.00	1	35
30 - Paper mulberry bark has low prices when compared with other crops	1	0	-1.00	1	36
39 - Farmers boil bark at the village	1	0	-1.00	1	37
42 - Stock bark or paper	1	0	-1.00	1	38
49 - Subcontract paper and craft's production	1	0	-1.00	1	39

Improving the quality of the paper and of the crafts increases **trust**. Trust decreases the number of traders (in this context understood as competitors). A lower number of competitors results in a lower quality of the paper and crafts. Thus, more trust will indirectly have a negative impact on the quality of the paper and crafts. Trust is also necessary to increase knowledge about market quality requirements that will reduce the problem of lack of quality standards. This will decrease production costs and improve price competitiveness. Thus,

an unexpected insight is that for this group trust has a negative impact on the quality of the paper and crafts because it eliminates competition while increasing price competitiveness.

One interesting detail was mentioned by a manufacturer in Luang Prabang (it was not included in the causal map): he said that he also uses fibres from kheua salea to produce mulberry paper. Kheua salea is also an NTFP but its price is 43% lower than that of mulberry bark. The manufacturer said that up to 50% of other fibres can be mixed with mulberry bark to produce mulberry paper.

The analysis of the Thai manufacturer's causal map shows that the three most central factors are: high demand, more trust and increased supply of the bark, (see Table 7). The main **receivers** are: the existence of a contract, the increased income of all stakeholders; and the aim to reach other more rewarding market opportunities. The **transmitter** factors (i.e. the main causes) are: better prices; more knowledge about market contacts and improved quality of the paper and crafts.

For Thai manufacturers the most **important factors** influencing the supply chain are: the quality of paper and handicrafts (PCS=9); a good knowledge of paper production techniques (PCS=13) and to ensure on-time delivery (PCS=15). For manufacturers the factors that should increase are: quality of the paper and crafts and ensure on time delivery. The manufacturers stated that export taxes, quotas and documentation costs for NTFP should decrease. They also added that in Thailand the sector is characterised by subcontracting to small companies which lack professionalism. This lack of professionalism should be reduced.

The business **goal** of the Thai manufacturers is to increase the production of paper and crafts, to reach more rewarding market opportunities and to strengthen their relations with subcontractors so as to increase their professionalism.

One of the manufacturers interviewed explained that lack of **quality standards** (SCP=18) for the bark and paper production makes it difficult to improve the supply chain. This factor is difficult to change because the standards need to be set by the government and public institutions.

3.1.5 Causal relationships as perceived by government extension staff

Three professionals working for the agriculture and forest extension services of Oudomxay province were interviewed. The map of this functional group has a total of 23 factors, which is less than the average number of factors (33.5). The support of the government extension staff depends on the existence of a market demand. For the extension staff, improving the supply chain means to:

- ensure enough quantity for traders;
- better prices for farmers (because the result of better prices is an increase in planted area and the existence of a village purchasing group);
- increase the quality of the bark;
- more knowledge about production techniques at the farm level, and
- less need for credit.

Increasing the planted area is central because if farmers plant more, it will ensure enough bark, so that the traders can be supplied with a sufficient amount. Also farmers can increase the production of young bark, which will improve the quality of the bark. Quality is important to obtain better prices as it allows to reduce the need for credit by the farmers and it lowers the costs for taxes, quota and documents for exporters (cultivated NTFP are subjected to lower taxes than wild NTFP produce).

Through cultivation of paper mulberry, farmers are able to achieve a higher cash income. Low need for credit by farmers increases knowledge about production techniques, which will in turn increase the planted area. As one interviewee notes: "Farmers need cash quickly so they are not interested to learn techniques to cultivate the bark. It is easier for them to extract the bark from nature" (interview 2P2). However, if farmers increase the planted area, they can reduce the need for credit and increase the production of young bark, which in turn will increase bark quality and prices.

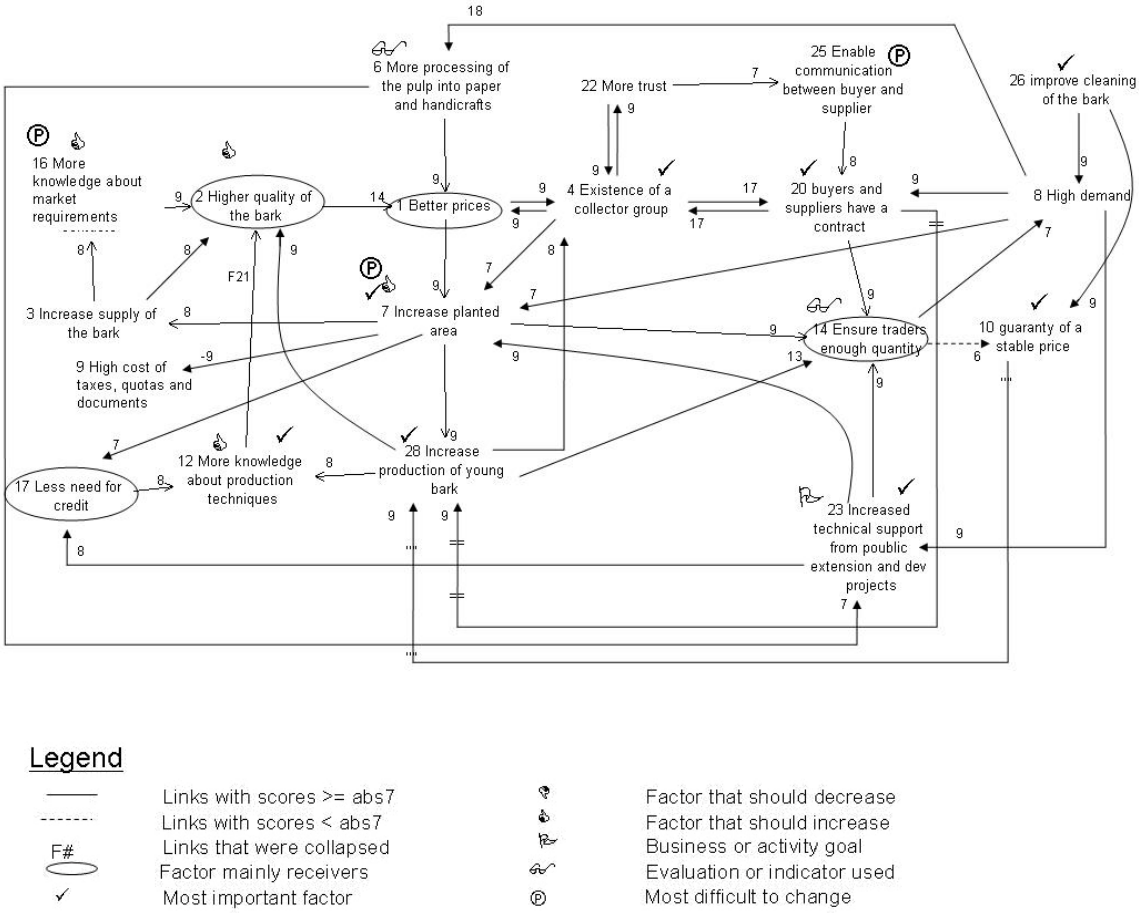


Fig. 14: The causal map of the government extension staff

The causal map (see Fig. 14) shows that government extension staff agrees with farmers that higher farm-gate prices for paper mulberry is an incentive for farmers to form village marketing groups. These are important to negotiate terms with traders, since aggregation of the production at village level enables farmers to have formal production contracts. These groups are also more efficient in increasing the planted area, in obtaining better prices for their product (higher bargaining power) and increasing trust. More trust enables communication but also makes it easier to build and keep village marketing groups. The existence of contracts between village marketing groups and traders ensure traders enough quantity. The latter guarantees stable prices. Stable prices have a positive influence on the production of young bark. Farmers will harvest the bark regularly when it is young, instead of harvesting the bark every couple of years when the prices happen to be high.

Government extension staff stated that the quality of the bark; area planted and knowledge of quality requirements are factors that should increase. Their main

goal was to provide agriculture and forest extension services. As an indicator for an improvement in the supply chain, the extension staff propose an increase in amount of bark processed into paper and crafts and to see if traders have sufficient quantity. For the extension staff, the most difficult factors to change are: to increase the area planted with paper mulberry trees; to increase the knowledge about market quality requirements and to improve the communication between the stakeholders of the supply chain.

Table 8 presents the most central factors. The three most central factors are: the existence of a collector's group at the village level; existence of contracts between farmers and district traders; and the increase of the planted area.

Table 8: Indicators for each factor of the government extension staff's causal map (the factors are listed according to the Position Centrality Score (PCS), i.e. starting with the most central factor)

Factors	Out-degree	In-degree	Ratio of reception	Centrality	PCS
4 - Existence of a collector group	43	49	0.07	92	1
20 - Buyers and suppliers have a contract	43	34	-0.12	77	2
7 - Increase planted area	42	33	-0.12	75	3
28 - Increase production of young bark	38	35	-0.04	73	4
14 - Ensure traders enough quantity	26	46	0.28	72	5
8 - High demand	43	22	-0.32	65	6
1 - Better prices	18	41	0.39	59	7
2 - High quality of the bark	20	36	0.29	56	8
23 - Increase technical support from gov. extension and development organizations	26	25	-0.02	51	9
6 - More processing of the bark	16	18	0.06	34	10
3 - Increase supply of the bark	23	8	-0.48	31	11
25 - Enable communication between buyer and supplier	24	7	-0.55	31	12
26 - Improve cleaning of the bark	21	5	-0.62	26	13
22 - More trust	16	9	-0.28	25	14
16 - More knowledge about market quality requirements	15	9	-0.25	24	15
12 - More knowledge about production techniques	7	16	0.39	23	16
17 - Less need for credit	8	15	0.30	23	17
10 - Guaranty a stable price	9	9	0.00	18	18
21 - Decrease time needed to clean the bark	9	7	-0.13	16	19
9 - High costs of taxes, quotas and documents	0	15	1.00	15	20
13 - Area with favorable agro-ecological conditions	9	0	-1.00	9	21
27 - Improve management of the supply chain	0	9	1.00	9	22
5 - Increase income of all stakeholders	0	8	1.00	8	23

Government extension staff named the following factors as the **most important** influencing the improvement of the supply chain: existence of a marketing group at the village level (PCS=1); buyers and suppliers have a contract (PCS=2); increase in planted area (PCS=3); technical support for public extension and development projects (PCS=9); improve cleaning of the bark (PCS=13); and knowledge about production techniques (PCS = 16).

The table also shows that there are five receiver and six transmitter factors. The main **receiver** factors are: better prices, more knowledge about production techniques by farmers; and less need for credit. The main **transmitter** factors are: improved cleaning of the bark; enable communication between buyers and suppliers; and increase supply of the bark by farmers.

3.1.6 Causal relationships as perceived by consultants

This group is represented by five stakeholders who provide information services to or about the supply chain of paper mulberry bark in Lao PDR (3 interviewees from a local NGO) and in Thailand (2 interviewees). These consultants mentioned 46 factors that influence the improvement of the supply chain. **Eight factors** were added: increase farmers' bargaining power; difficulties in drying paper during the rainy season; traders trading other goods besides bark; stock pulp rather than paper since it is easier, cheaper and saves space; existence of other fibres that are more price competitive; buyers start to require environmental standards and existence of other materials mixed with the bark. The map included so many links that to ensure clarity only links with a score equal or higher than eight are included (see Fig. 15).

This group considers **quality** as the most central factor to improve the supply chain. For this group to improve the supply chain of paper mulberry bark the following factors should be present:

- better prices;
- more processing of the bark into paper and crafts;
- increased supply of the bark;
- increase in planted area;
- ensure enough quantity to traders;
- income of all stakeholders;
- stable prices;
- improve quality of paper and crafts;
- reach rewarding markets for manufacturers.

The consultant stated that an improvement in the supply chain would also be shown by a decrease in the time needed to clean the bark at the village level; and increased bargaining power of farmers and contracts that are enforced.

The quality of the bark can be increased by using young bark, better cleaning of the bark, better drying and more knowledge about market quality requirements. Higher bark quality decreases the time needed for boiling the bark in the factory and reduces the use of chemicals during paper processing. These two factors decrease production costs for manufacturers. Improved quality of the bark leads to higher prices for farmers and to improved quality of paper and crafts that will benefit manufacturers with higher prices resulting in increased incomes for all. This increase in income will improve communication between buyer and suppliers. Communication increases trust and trust ensures contract enforcement.

Existence and knowledge about quality standards, more knowledge about market contacts, increased technical support for government extension and development organisations, price stability are all factors that can **improve management** of the supply chain. Improved management of the supply chain leads to high prices for farmers through two different paths: first, it is an incentive for farmers to organise themselves in village marketing groups. The latter increases farmers' bargaining power that leads to higher prices. Second, it provides an incentive for farmers to improve the cleaning of the bark, thus improving quality and leading to higher prices. Another way to increase farmers' bargaining power is to stock bark in the village. Farmers cannot harvest the bark during the whole year because it is more difficult to peal off the bark and dry it well during the rainy season. Mulberry bark paper also gets spoiled easily if it is not well dried. This is especially difficult for handmade paper since most of it is sun dried. So ideally, bark and paper should be harvested and produced during the dry season and kept in warehouses to continue supply during the wet season. If the storing capacity for paper and bark increases, it will allow more processing into paper and crafts.

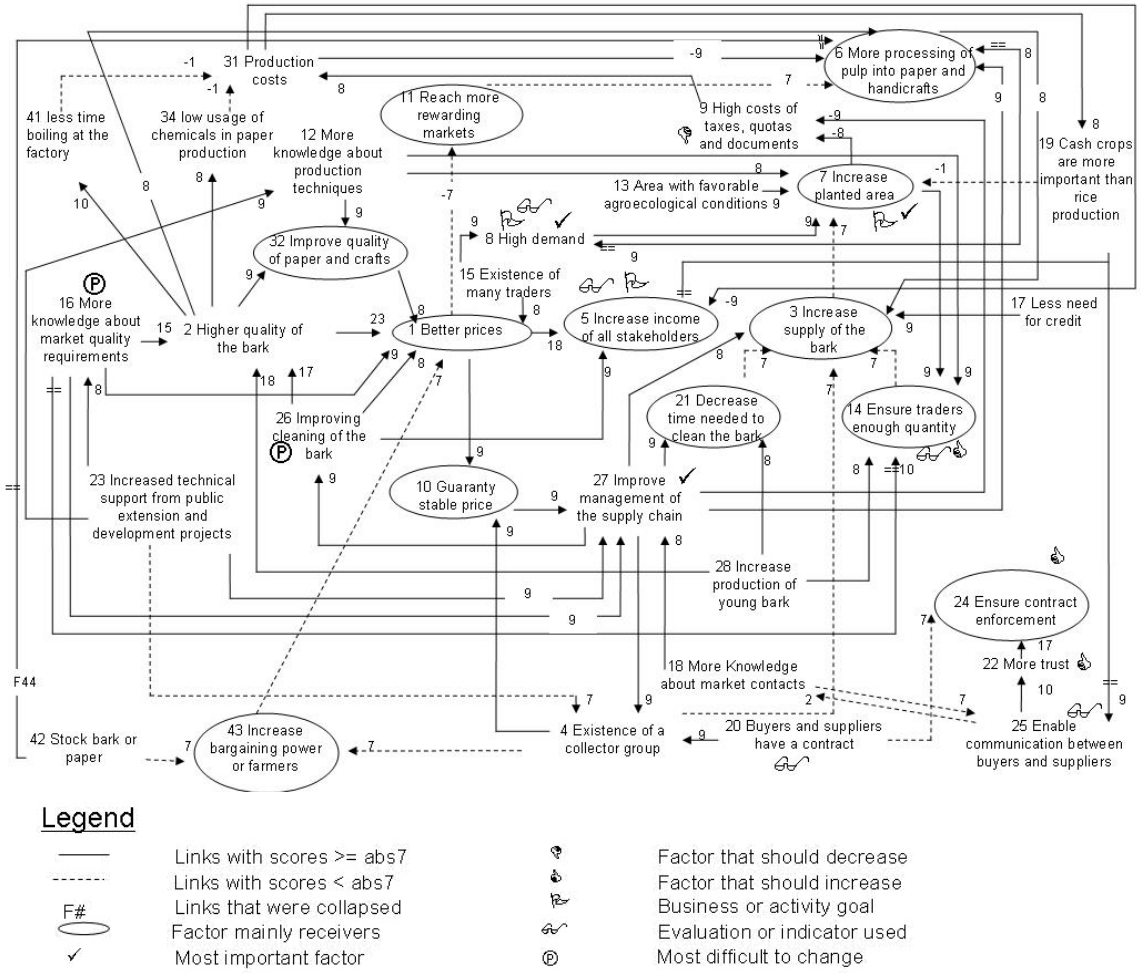


Fig. 15: The causal map of the consultants

Improved management of the supply chain also increases processing into paper and crafts, ensures enough quantity of bark for traders. But improved management of the supply chain can also contribute to increased quality of the bark due to improved cleaning of the bark. Farmers benefit from improved management because they are better informed about the techniques they can use to decrease the time needed to clean the bark. Exporters benefit because they can better coordinate with other members of the supply chain (farmers, government extension staff, consultants) and certify that the bark comes from cultivated plots and not from wild collection. This reduces the costs for taxes, quotas and documents. Manufacturers benefit from improved management of the supply chain because they are sure to deliver their products on time to the final buyer. Overall improved management will decrease production costs through two different paths: lower costs of taxes and quotas for exporters and decrease the time needed to clean the bark at the village level. A reduction in the time needed to clean the bark at the village level leads to more supply of the bark to traders. The cleaning of the bark is a time demanding process that can be facilitated with the production of young bark and improved management of the supply chain. Young bark decreases time needed to clean the bark but it is perceived as having less dried weight than old bark.

Table 9: Indicators for each factor of the consultants' causal map

Factors	Out-degree	In-degree	Ratio of reception	Centrality	PCS
2 - High quality of the bark	50	60	0.09	110	1
1 - Better prices	35	63	0.29	98	2
27 - Improve management of the supply chain	54	35	-0.21	89	3
6 - More processing into paper and crafts	27	45	0.25	72	4
4 - Existence of a collector group	34	31	-0.05	65	5
16 - More knowledge about market quality requirements	42	19	-0.38	61	6
3 - Increase supply of the bark	7	45	0.73	52	7
7 - Increase planted area	17	35	0.35	52	8
14 - Ensure traders enough quantity	9	41	0.64	50	9
8 - High demand	25	22	-0.06	47	10
5 - Increase income of all stakeholders	9	36	0.60	45	11
26 - Improve cleaning of the bark	35	9	-0.59	44	12
12 - More knowledge about production techniques	30	11	-0.46	41	13
23 - Increase technical support from Gov. extension and development projects	40	0	-1.00	40	14
22 - More trust	19	19	0.00	38	15
28 - Traders work together	36	0	-1.00	36	16
31 - High production costs	26	10	-0.44	36	17
10 - Guarantee a stable price	9	23	0.44	32	18
9 - High costs of taxes, quotas and documents	13	17	0.13	30	19
25 - Enable communication between buyer and supplier	17	10	-0.26	27	20
32 - Improved quality of paper and crafts	8	18	0.38	26	21
11 - Reach more rewarding market opportunities	7	17	0.42	24	22
21 - Decrease time needed to clean the bark	7	17	0.42	24	23
15 - Existence of many traders	23	0	-1.00	23	24
20 - Buyers and suppliers have a contract	16	7	-0.39	23	25
43 - Increase bargaining power of farmers	7	15	0.36	22	26
24 - Ensure contract enforcement	1	19	0.90	20	27
30 - Paper mulberry bark has lower prices when compared with other crops	14	1	-0.87	15	28
42 - Stock bark or paper	10	4	-0.43	14	29
18 - More knowledge about market contacts	11	2	-0.69	13	30
44 - Difficulties to dry bark during the raining season	4	7	0.27	11	31
17 - Less need for credit	10	0	-1.00	10	32
19 - Cash crops are less important than rice production	2	8	0.60	10	33
13 - Area with favorable agro-ecological conditions	9	0	-1.00	9	34
29 - Traders work together	0	9	1.00	9	35
34 - Low usage of chemicals in the paper production	1	8	0.78	9	36
46 - Increase stock of pulp (easier to keep and saves space)	1	6	0.71	7	37
35 - Ensure on time delivery	1	2	0.33	3	38
49 - Subcontract paper and crafts production	1	1	0.00	2	39
50 - Buyers demand for environmental standards	2	0	-1.00	2	40
51 - Other materials are mixed with the bark	2	0	-1.00	2	41
33 - Lack of quality standards	1	0	-1.00	1	42
40 - Production environmentally friendly	0	1	1.00	1	43
45 - Traders trade other things besides mulberry bark	1	0	-1.00	1	44
47 - Existence of other more price competitive fibers	1	0	-1.00	1	45
54 - Weight of the bark	0	1	1.00	1	46

A decrease in production costs feeds back to an **increase in income** for all stakeholders. Higher prices also lead to an increased income for all stakeholders. The strength of the connection to increased income is higher for higher prices than for lower production costs. This means that if there is an increase in prices, the income of all stakeholders will increase more than if there is a reduction in production costs. An increase in income of all stakeholders enables communication between stakeholders, resulting in better knowledge about the market, thereby improving management of the supply chain through more discussion of its problems and opportunities.

Many **district traders** increase the demand for paper mulberry bark at the village level. The demand for bark is reduced by the existence of substitute fibres[5]. High demand leads to an increase of planted area. Cultivation of paper mulberry bark is seen as a positive factor influencing the supply chain. This shows that while other functional groups state that the number of traders should decrease to improve the supply chain, consultants mention that many traders are good because there are better prices and all stakeholders increase their incomes.

The analysis of the causal map of the consultants shows that the three most **central factors** are: higher quality of the bark; better prices; and improved management of the supply chain. The causal map has 12 receivers and 13 transmitters, which is more than any other group. Ozesmi and Ozesmi (2004) argue that this is an indicator of complex thinking. The most important **receiver** factors are: ensuring contract enforcement; increasing the supply of the bark; and ensuring enough quantity to traders. The most important **transmitter** factors are: increase technical support from extension services; higher production of young bark; and the existence of many traders.

Consultants considered that the **most important factors** to improve the supply chain high are: to improve the supply chain management (PCS=3); to increase the area planted with paper mulberry (PCS=8) and a high demand (PCS=10). They cited three factors that should increase: ensure traders enough bark, trust and contract enforcement. Consultants believed that export taxes, quotas and documentation costs for NTFP should decrease. The goals of their activities are to: increase the income of all stakeholders, ensure that there is higher demand and support the increase of planted area. Consultants find difficult to find information about quality requirements for the bark (SCP=6) and improve cleaning of the bark (SCP=12) as the most difficult factors to change.

3.2 Comparison of the causal maps of the six functional groups

3.2.1 Differences in the factors identified as central, receivers and transmitters

On average, the interviewees selected 33.5 factors to be included in their causal map. Manufacturers and consultants selected the highest number of factors: 39 and 46 factors respectively. The causal map with the lowest number of factors is that of the government extension staff. However, since there were not the same number of interviewees in each functional group, these figures (see Tab. 10) are only indicative.

Consultants mentioned a higher number of factors and a higher number of receivers (see Tab. 10). Manufacturers cited many new factors because the three

[5] This item was not cited enough be included in the causal map, but it is important as it was an important factor cited by Homma (1996).

interviews were made in Thailand while during the first phase (where the preliminary list of factors was established) only stakeholders in Lao PDR were interviewed. This shows that the pre-defined list of factors was not well adapted to the Thai part of the supply chain.

Table 10: Selected quantitative indicators from the six causal maps

	Farmers	Traders	Exporters	Manufacturers	Extensionists	Consultants
No. of factors	33	30	30	39	23	46
No. of receivers	8	4	8	7	5	12
No. of new factors	4	2	3	14	0	8
No. of interviews	10	4	4	4	3	5

All functional groups perceive better prices as an important factor influencing the improvement of the supply chain (see Tab. 11). This is the only factor, where all stakeholders agree. Higher quality of the bark and an increase in the area planted with paper mulberry were seen by five groups as a central factor, but not by manufacturers. The existence of a marketing group in the village is perceived as important only by district traders, extension staff and consultants. Farmers, who are the implementers of such a group, see few advantages in having a village marketing group. The farmers are the only group that considers an increased income for all stakeholders and improved cleaning of the bark as central factors to the improvement of the supply chain. More processing into paper and crafts is a central factor only for manufacturers and consultants. Demand is central only for manufacturers and extension staff. Farmers do not even consider this factor in their map. More knowledge about the market is only central for exporters and manufacturers.

Table 11: The 8 most central factors for each functional group (Farmers, Traders, Exporters, Manufacturers, Government extension and Consultants)

Central factors for the six functional groups	**F**	**T**	**E**	**M**	**G**	**C**
1 - Better prices	■	■	■	■	■	■
2 - Higher quality of the bark	■	■	■		■	■
7 - Increase planted area	■	■	■		■	■
20 - Buyers and suppliers have contract	■	■	■	■	■	
3 - Increase supply of the bark			■	■		■
4 - Existence of a collector group		■			■	■
27 - Improve management of the supply chain				■	■	■
6 - More processing into paper and crafts				■		■
8 - High demand				■	■	
10 - Guaranty a stable price	■	■				
18 - More knowledge about market contacts			■	■		
23 - Increased technical support from extension staff and development projects	■		■			
5 - Increase income of all stakeholders	■					
14 - Ensure traders enough quantity					■	
15 - Existence of many traders		■				
16 - More knowledge about market quality requirements						■
22 - More trust				■		
25 - Enable communication between buyer and supplier		■				
26 - Improve cleaning of the bark	■					
29 - Traders work together			■			

A guaranteed stable price is central for farmers and district traders. Although exporters and manufacturers recognise that stability of prices leads to an

increased income for all stakeholders, it is not a central factors for them. The existence of many traders is a central factor and a problem only for district traders. More knowledge about the quality requirements on the market is only central for consultants. Increased trust is central only for manufacturers in Thailand, since if their customer trusts them, it reduces competition, increases existence of contracts (sometimes there is no need for formal contracts) and increases the number of market contacts.

Table 12 allows to compare the factors that were identified as transmitters (i.e. the main causes of the system) and as receivers (i.e. the factors are the main results of the system) in each group's causal map.

Table 12: Comparison of the factors identified as receivers and/or transmitters in the six causal maps (Farmers, Traders, Exporters, Manufacturers, Government extension and Consultants)

Factors	Receivers						Transmitters					
	F	T	E	M	E	G	F	T	E	M	E	G
5 - Increase income of all stakeholders												
11 - Reach other more rewarding market opportunities												
1 - Better prices												
3 - Increase supply of the bark												
6 - More processing of pulp into paper and crafts												
7 - Increase planted area												
14 - Ensure traders enough quantity												
21 - Decrease time needed to clean the bark												
20 - buyers and suppliers have contract												
2 - Higher quality of the bark												
10 - Guaranty a stable price												
16 - More knowledge about market quality requirements												
23 - Increased technical support government extension staff and development projects												
25 - Enable communication between buyer and supplier												
12 - More knowledge about production techniques												
4 - Existence of a collector group												
13 - Area with favorable agroecological conditions												
15 - Existence of many traders												
18 - More knowledge about market contacts												
26 - Improve cleaning of the bark												
22 - More trust												
27 - Improve management of the supply chain												
17 - Less need for credit												
24 - Ensure contract enforcement												
28 - Increase production of young bark												
29 - Traders work together												
30 - Paper mulberry bark has low prices when compared with other crops												
31 - Production costs												
32 - Improved quality of paper and crafts												
33 - Lack of quality standards (or low transparency)												
35 - Ensure on time delivery												
39 - Farmers boil the bark at the village												
42 - Capacity to stock bark or paper												
43 - Increase bargaining power of farmers												
52 - Resources are closer home... save travel time												
53 - Difficult to find seed in the forest												
54 - Weight of the bark												

Eight factors appear as receivers (i.e. goals) in three or more causal maps. 'Increase in income by all stakeholders' is even mentioned by five of the six functional groups (see Tab. 12).

Four factors appear as transmitters (i.e. factors that are seen as main causes allowing to improve the supply chain) in the causal maps of at least three functional groups:

- more knowledge about market quality requirements;
- increased technical support from government extension and development organisations;
- enable communication between buyers and suppliers, and
- more knowledge about production techniques

The other causal factors are specific for one functional group or shared by two groups. For example, district traders are the only group to consider 'less need for credit' and 'ensure enough quantity to district traders'. This group is often under-supplied and has to provide credit in advance so that farmers collect the bark. Traders are the only group to perceive 'not having sufficient knowledge of the market quality requirements' as a cause influencing the improvement of the supply chain. This is in agreement with this group's map, since the quality of the bark is not perceived as beneficial. Farmers mention the weight of the bark and difficulty to find seedling as influencing the improvement of the supply chain

The tables 11 and 12 show that different functional groups have different perceptions about how to improve the supply chain. The central factors for each map are different, only 'better prices' is central for the six groups. But 'better prices' has opposite meanings. While for the Lao stakeholders it should be higher prices, for the manufacturers and consultants in Thailand it should be more competitive (i.e. lower) prices.

3.2.2 Differences in logics on how the supply chain can be improved

Even though each group has its own specific goals that lead to change, in general they complement each other and form a common idea of improvement. Receivers in the maps of exporters, manufacturers and consultants coincide to some extent with the goals suggested during the interviews.

Farmers have as goal to start or to **increase the area planted with paper mulberry trees**. It enables them to increase production of young bark, since with wild collection all ages are harvested. It also allows to reduce labour time since the trees will be closer to their homes. Cultivation also reduces the time necessary to clean the bark because it is easier to strip-off the outer and inner layers[6] from young bark. Planting mulberry trees also results in straighter stems which might make it easier to strip. The government extension staff states that it is difficult to provide technical support to farmers about how and where to increase the area planted with paper mulberry trees. However, once farmers start to produce, they can increase the supply of the bark (e.g. by harvesting twice a year) and produce more young bark. This increases quality, leads to better prices and lowers the farmers' need for credit (since farmers will sell their paper mulberry bark instead of focusing on subsistence farming) and ensures enough quantity for traders. Consultants also believe that if farmers increase the planted area, it will have a positive effect on the supply chain. Consultants and extension staff also point out that if there are more planted mulberry trees, exporters can reduce their costs for taxes, quota and documents (if they prove that they purchase bark only from villages that do not collect mulberry bark

[6] Tests made with CIAT/SADU farmers from Luang Prabang in the presence of some of the interviewees demonstrated that time spent to strip the bark was higher if stems are more than one year old.

from the wild). For exporters an increase in planted area is important because it ensures that district traders have enough quantity, thus reducing the existing competition between traders and enhancing trust. Only district traders have a different opinion. They explain that if farmers increase the planted area, it will lead to higher bark quality, which has higher demand. However higher demand intensifies the competition (i.e. there will be more district traders). This negatively affects price stability, trust and threatens the existence of production contracts with farmers. Fewer contracts impacts negatively on planted area, because farmers are better motivated to plant paper mulberry trees if they have contracts with district traders. Thus, for traders the increased planted area might not change the supply chain on the long-run. This group's perception is opposite to the other functional groups and that may endanger the results of actions aimed at improving the supply chain due to interference by the members of this group.

The margins of Lao exporters is reduced due to the **export tax** for NTFP collected from the wild. Lao exporters, to increase their benefits, cut prices up the chain, consequently farmers do not have an incentive to invest their time in the production of paper mulberry bark. This keeps the system from evolving from wild collection to domesticated paper mulberry. If farmers domesticate, then exporters would pay less for taxes, quotas and documentation.

Boiling the bark in the village was suggested to reduce the oil content of the bark and reduce the time to clean the bark. But not all villagers are convinced that boiling is less time consuming. In Luang Prabang villagers said that boiling was a good technique when bark was hard to strip-off, i.e. during the rainy season (Mai to September). During the dry season (October to November and February to March) it is better to use the traditional technique, i.e., clean the bark without boiling, because it saves the time needed for collecting the fuelwood, filling the boiling tank with water and boiling the water. Furthermore, to use the boiling technique the paper mulberry garden should be located near a source of water, which limits the applicability of this technique.

There is a high **demand** for paper mulberry bark: orders from China, Thailand, Luang Prabang and Vietnam reach Oudomxay and are seen as an opportunity by many traders. However, there are no means to disseminate prices through the whole province, resulting in price fluctuations. Thus often the traders give credit to the villagers with clear indications when they will return to collect the bark, but meanwhile farmers may decide to sell the bark to another trader.

Consultants aim to increase the **bargaining power of farmers** as a result of an improved supply chain. They believe that through helping farmers to stock the bark, farmers could achieve higher farm-gate prices. However, it seems that farmers already have a good bargaining power since district traders are very keen to have contracts with farmers. District traders need to find credit to finance farmers in advance, so that village marketing groups can organise the collection of the bark. Traders also see the importance of stable prices to decrease the risk of losing the bark to another trader or the risk of a low margin due to price change.

Exporters have as goals to improve the **quality of the bark** and to have a long-term **contract** with their buyers. According to exporters, better technical support from extension, improved cleaning of the bark and more communication leads to higher bark quality. This will result in more demand and thus more chances to have a contract. These two later factors stabilise prices, leading to increased prices and increased incomes for all stakeholders.

Nonalignment is defined as divergence between what is believed by one stakeholder group and what another stakeholder group believes about the same issue. There are three instances where there are important differences between the causal maps of the functional groups: regarding the question of who is in

charge of providing information on production techniques, regarding the effect that a price change will have on the supply of paper mulberry bark, and regarding what constitutes bark of high quality.

Consultants, farmers and exporters expect the **provision of more knowledge about production techniques** to be the task of extension staff. However the extension staff does not directly link their work to more knowledge about production techniques. Nor do they see an impact of extension activities on "existence of contracts" which is a task they expect exporters to fulfil.

For manufacturers improvement will depend on low costs for raw material, since it will decrease **prices** for the final product, leading to a higher demand. High demand increases the quantities processed and allows to reach more rewarding market opportunities. The prices can thus decrease if manufacturers create economies of scale by producing more paper. The gap between exporter in Lao PDR and manufacturers in Thailand is shown by how 'better prices' shift from 'higher prices' to 'lower prices'. Farmers believe that higher prices lead to increased income for all stakeholders. Consultants take a middle position. They show that higher prices increase the income of all stakeholders but higher production costs have the opposite effect on the income of all stakeholders. Manufacturers take a completely different approach about how the supply chain should improve through a price change. Nevertheless, these different conceptions between a supply-oriented approach taken by farmers, district traders, exporters and government extension staff and a demand-oriented approach taken by manufacturing companies means that the first group does not understand why the second group does not pay higher prices for the product. This might result in situations of non-cooperation unless a common understanding can be achieved.

The **quality** of the bark is of central importance for all stakeholders except for manufacturers. Most stakeholders expect to receive higher prices for a bark of higher quality. Manufacturers agree that there is more demand for bark of higher quality, but they do not make the link between higher quality and increased prices. In 2006 there were no quality-related premiums to farmers. This lack of incentives to produce higher quality bark leads to poor quality especially regarding the loss of weight of the bark due to poor drying and losses due to spoilage from fungal diseases. These losses affect mainly exporters who keep the bark for longer periods of time. The question is where to intervene so that this downward cycle of low quality shifts to an upward cycle of higher quality. Manufacturers might play a key role in increasing the demand for higher quality. If manufacturers would share information on quality criteria with the levels up the chain, they could take advantage of the lower production costs derived from the use of standardised quality in the production process.

The explanation why a lack of quality standards leads to higher production costs is given by the consultants. They show that knowledge about market quality requirements leads to higher quality of the bark. Higher quality reduces the time for boiling at the factory, lowers the amount of chemicals used and improves the quality of the paper and the crafts. Manufacturers further clarify that the quality criteria for mulberry paper is strongly influenced by the requirements of the Japanese market, which is the largest and most demanding (Helberg, 2005). The Japanese market requires mulberry paper without brown or black dots. These dots result from a natural resin or oil produced by the plant. Bark coming from older plants and bark that is not well cleaned contains a higher percentage of this oil. Reducing the oil content of the bark at the village level reduces manufacturers' production costs as it reduces the energy requirement for boiling the bark and the chemicals used to eliminate the oil. However, despite these apparent benefits, manufacturers do not offer clear quality criteria.

Three **explanations for this lack of quality standards** have been offered in the interviews:

First - Manufacturers in Thailand work in a highly competitive environment. They have to compete with the low prices for similar products manufactured by Chinese and Vietnamese companies. Manufacturers in Thailand thus follow two approaches. Their long-term strategy is to diversify by offering products with a better design and implementing higher environmental standards. But on the short-term, and while these environmental standards are not fully recognised and implemented, they compete based on price and knowledge about market requirements. This explains why market requirements for raw material are considered "a business secret" by Thai companies. However, this impedes the development of transparent quality standards.

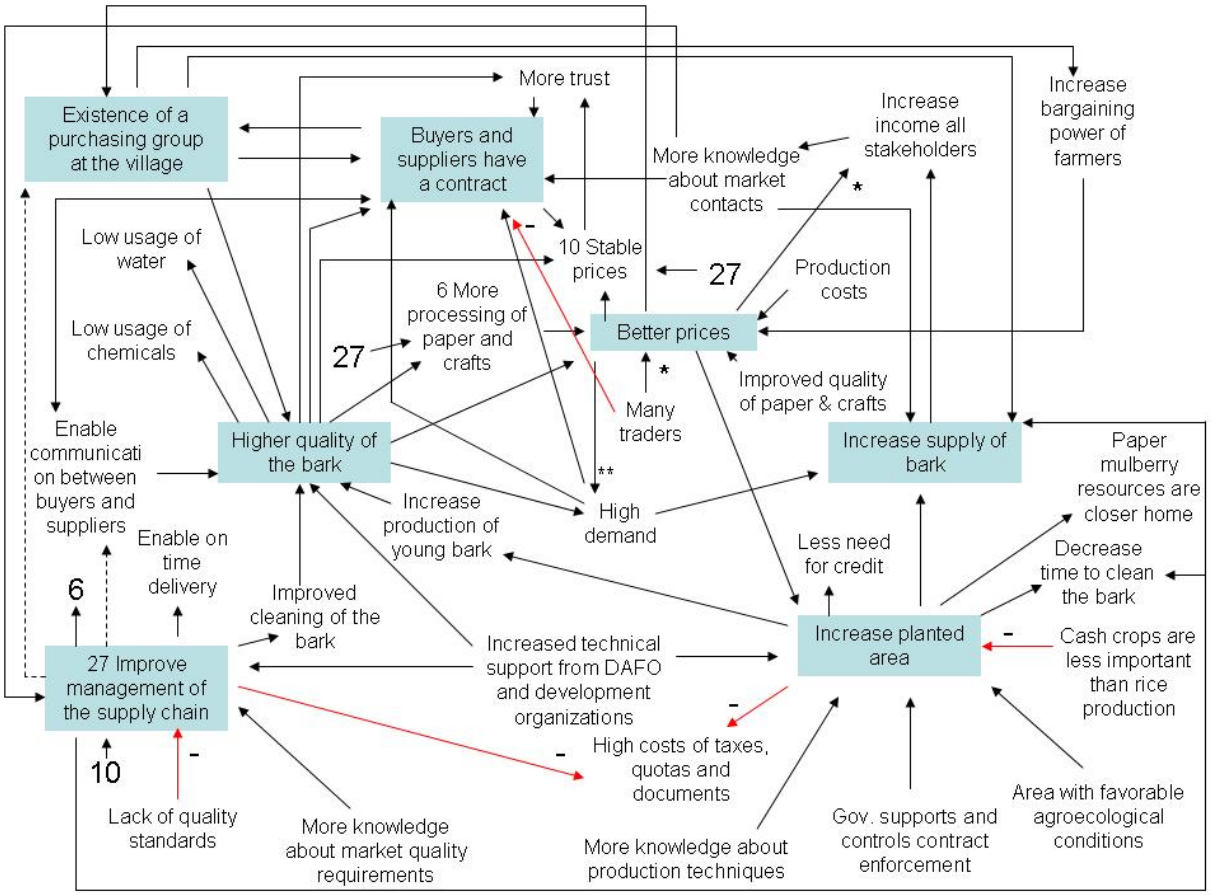
Second - Manufacturer's map shows that the lack of quality standards negatively influences communication. Low communication decreases trust. Lack of trust between stakeholders decreases knowledge about market requirements. Thus, lack of communication lowers trust and this impedes the sharing of information about quality standards for raw material. Communication might also be impeded by geographical distance, lack of means of communication (phone lines often do not work in Oudomxay) and language difference. Indeed, at least three different languages are spoken by different levels of the supply chain. Farmers speak Khamu and a little Lao, district traders speak Lao and sometimes Khamu, exporters speak Lao, extension staff speak Lao and manufacturers speak Thai.

Third - The existence of substitute fibres that can be mixed with mulberry bark with different percentages also impact on development of quality standards for the bark. These substitute fibres are cheaper to produce than mulberry bark and only consultants can notice the difference. In Thailand and in Lao PDR there is no demand requiring that mulberry paper is made from 100% paper mulberry bark. This decreases the demand for the mulberry bark and might reduce the incentive to increase the planted area (all maps with exception of manufacturers and producers have this link).

Thus, there is no guarantee that farmers who follow the recommendations of extension staff and consultants, and start cultivating the bark will be able to achieve better prices as a result of producing higher quality bark.

3.2.3 The aggregated causal map: options to improve the supply chain

The aggregated map shows those links where two or more functional groups are in agreement and the links have a high score. An analysis of this map allows the comparison of the seven most central factors for the supply chain. These are put in grey boxes in the aggregated map (Fig. 16).



*Non-alignment (Groups have opposing signal for this link).
** Only mentioned by one functional group. - Negative relation.
6 – Factor: more processing of paper and crafts;
27 – Factor: Improve management of the supply chain;
10 – Factor: Guarantee of stable prices.

Fig. 16: The aggregated causal map of the factors influencing the supply chain of paper mulberry bark

Seven factors, that were considered central for the improvement of the supply chain by three or more of the functional groups allow to derive the main options for improving the supply chain.

Offer support to increase the area planted with paper mulberry. During the CIAT/SADU workshop (2006a) it was suggested that cultivating paper mulberry trees can lead to better quality bark. To reach a higher quantity of grade A bark, young stems (six months to one year) should be harvested from cultivated paper mulberry trees. Because it is labour intensive to properly clean the bark, proper technology needs to be developed to reduce the time that farmers need to strip out the inner and outer bark. To address this problem Vernon (2006) proposes a) boiling stems at village level and b) machines for

striping off the bark. Cultivating paper mulberry and cutting the trees properly will also allow to collect the bark twice per year. If more grade A is produced, then more bark could be sold to markets paying higher prices (e.g. ~30 Baht/kg[7] for the Japanese and South Korean market instead of the ~14 Baht/kg obtained for grade C).

There are a range of reasons why stakeholders believe that cultivation would improve the supply chain of paper mulberry bark:

- it increases the quality of the bark through increasing the share of young bark;
- it lowers the need for credit at village level, because farmers will sell more an thus will have more disposable income;
- it will reduce the costs for taxes, quotas and paper work for exporters since paper mulberry becomes a normal cash crop and is no longer a protected NTFP;
- it leads to the increase of supply of the bark (two harvests/year) and thus it will ensure enough quantity to traders. This could reduce the competitive behaviour of traders, stabilise prices and increase the incomes of all stakeholders;
- it reduces the time necessary to clean the bark as farmers perceive younger bark as easier to peal off compared to older bark;
- it benefits farmers because plantations will be closer to their home saving time to travel to collect them.

Stakeholders of the paper mulberry bark supply chain perceive that increased technical support by government extension staff and development organisations is directly linked to an increase in planted area. Technical support improves technical knowledge about production techniques and thus increases the planted area. High prices and increased income for all stakeholders are considered by farmers as factors influencing cultivation of the bark. Manufacturers suggest that government's involvement in supporting contracts at village level and ensuring that these contracts are enforced would also improve the supply chain. Finally, the existence of a village marketing group and of a contract between farmers and traders would also influence paper mulberry cultivation.

The literature calls attention to the issue of land tenure. Private ownership reduces "free-ridding" behaviour and provides an incentive for cultivation (Belcher and Kusters, 2004: 7; Ruiz-Perez et al., 2004). In the villages under study, the land has so far not been allocated (IFAD, 2005). However, no cases of free-ridding were reported, i.e., no cases of extractors taking advantage of other's trees. However, one farmer mentioned that the land that she had planted with paper mulberry and sapan (*Boehmerica malabarica* wedd.) has been slashed by a Chinese rubber company to plant rubber trees.

Offer an incentive to improve the quality of the bark. Higher quality bark contributes to improving the supply chain because it leads to better prices. Better prices are understood by stakeholders as higher prices (except for the Thai manufacturers). Nevertheless manufacturers also benefit from improved quality of the bark since manufacturers benefit from a 20% reduction in input of chemicals if bark is young and a reduction of up to 100% in energy consumption if the bark is of grade A. A share of these reductions could be used to provide an incentive for farmers to improve the quality of the bark. However, even if manufacturers are ready to pass on some of their cost savings to provide a price incentive for farmers, it is unclear how this can result in incentives for middlemen (traders and exporters). Mainly exporters (because

[7] Price paid at the Thai border in January 2006. Exchange rate: 1US$ ≈ 40 Baht

they keep the bark for longer periods) benefit with lower losses from fungal infection and reduction of the weight of the bark by 30%. But it is unclear if district traders are aware of the benefits they would have from higher quality. It is thus important to enable communication between stakeholders of the supply chain so that they can discuss the conditions of the contracts. This communication also includes providing more information about market demand, quality criteria and ensuring technical support for production.

Ensure quality-related higher prices for farmers. Higher prices can provide an incentive for farmers to cultivate paper mulberry trees. However, manufacturers in Thailand have an incentive to lower prices since on the international market Thai handicrafts are less price competitive than Chinese or Vietnamese handicrafts. On the other hand poor quality and high taxes lead Lao exporters also to cut prices up the chain. If this situation continues, farmers do not have incentive to invest their time in the production of paper mulberry bark, thus keeping the system from evolving from wild collection to domestication of paper mulberry. This also hinders the supply chain in Oudomxay from providing bark of higher quality to manufacturers (thereby reducing their costs) and to reduce the taxes paid by exporters. Thus both exporters and manufacturers would have an incentive to ensure that a part of their benefits from receiving high quality bark from cultivated trees are passed on to farmers.

Higher prices would also be an incentive to improve the management of the supply chain by creating marketing groups in the villages and by increasing the volumes traded. Some stakeholders believe that many traders are good for the supply chain because it enables better prices for farmers. But others argue that many traders just lead to unstable prices and to the inability to enforce contracts. Existence of contracts is an important factor leading to better prices. In Oudomxay exporters are informed a couple of weeks before about the price offered and quantities demanded by a Thai or Chinese importer. There is no opportunity to plan production and train farmers. To address this issue CIAT/SADU is organising exporters and promoting a planning for the supply chain at the national level.

Thai manufacturers could achieve competitive prices by reducing production costs through better bark quality and by receiving a premium for environmentally sustainable practices. They could apply for fair trade and organic certification of their products to have competitive advantage in relation to the cheaper produce from China and Vietnam. This would strengthen the supply chain relations, enable communication, enable the formation of a common vision and the understanding about the interdependence between functional groups (Ketchen and Hult, 2006).

The strategy used by the larger Thai importers is to buy during the dry season when prices are lower and sell during the raining season when prices are higher (CIAT/SADU, 2006b). Problems related to the seasonality of paper mulberry bark could be eliminated if prices would increase. The supply is limited during the raining season because: it is difficult to peal the bark during the raining season, it is difficult to dry it well, farmers are busy with the rice farming, and district traders have no credit to buy bark. Together cultivation and boiling the bark at village level could solve the problem of seasonality. Higher prices would thus support the perception of paper mulberry as a cash crop.

Facilitate the negotiation of (formal or informal) contracts. Contracts, if effectively agreed by the buyer and supplier at the different levels of the supply chain, could improve the commercialisation of NTFP (Belcher, 1998). Contracts

promote stable prices, increase communication between buyers and suppliers and promote the existence of village marketing groups.

To increase the number of contracts, trust must be created between parties and village marketing groups must be formed. If traders are sure to receive enough bark, then there are more chances that they will collaborate and increase the reliability of contracts. Another factor influencing the existence of contracts is the knowledge of market and market agents. Government agencies and development organisations could link exporters and manufacturers to other potential buyers and not only work at the village level. Nevertheless, it is important to remember that contracts cannot work if the litigation system takes too much time, if it is expensive or if it is difficult to control (Brennan, 2004). So it is important to implement a system of self-governance of the supply chain, where stakeholders perceive the benefits, i.e. have a common goal.

Improve village organisation by forming marketing groups. The literature focuses on the bargaining power of village marketing groups in relation to traders and on their capacity to increase supply (Belcher, 1998; Larsen, 2000; Morries, 2002; Marshall, 2003; Best, 2005; Gotschi et al., 2006). But the marketing groups are also important to regulate the harvest and the selling of NTFP especially if these groups include all farmers of the village (Newman and Hirsch, 2000: 93). A village marketing group can also increase the bark quality if it is responsible to control the quality of the bark provided by the farmers.

But in this study, the main reasons for the village marketing group to contribute to improving the supply chain are above the village level. Such groups are necessary to enable communication between buyers and suppliers. For example, before a contract between farmers and trader is signed, all suppliers agree with the contracts' conditions and not only the core of the marketing group. Both parties need to be satisfied with the prices and be fully aware of the quality standards required.

Increase supply of paper mulberry bark. Developing countries often lack infrastructure such as roads, storage facilities, energy and transportation, so that costs to reach markets increase and margins for farmers are reduced (Best et al., 2005). These market costs decrease demand for products such as NTFP, which grow in remote areas. Supply chains of agricultural products in developing countries can be trapped in a vicious circle of low demand and lack of scale which results in poor quality, low volume, weak market links and high transaction costs (Best et al., 2005). The argument is to increase supply of the bark so that economies of scale can be achieved to compensate for higher transaction costs and transportation costs.

To reach this objective, it is important that stakeholders are aware of the existing demand. Existence of a marketing group in the village; good local conditions for production; increased planted area; less need for credit by stakeholders; better prices for farmers; less time to clean the bark by farmers and improved management of the supply chain are all factors influencing the increase of supply of paper mulberry bark.

Improve the management of the supply chain. Better management of the supply chain refers to better coordination, which would allow decisions to be accorded along the supply chain, despite functional and geographic differences. Better coordination between the different levels allows on-time delivery of the final produce; enables communication between buyers and suppliers; improves cleaning of the bark and enables marketing groups in the villages. Coordination and information flow also allows exporters to reduce costs for taxes, quota and documents for since they have access to the necessary information and know-how. More coordination also decreases cleaning time for farmers since they learn about less labour-intensive processes from buyers. More coordination between consultants, development organisations and manufacturers enable them to benefit from increased revenues and allows to lower costs through reaching economies of scale. It reduces environmental impact and from the benefits of certifying paper mulberry as organic and fair-trade.

It seems that the supply chain governance for paper mulberry bark in Lao PDR is mainly done by development organisations (mainly CIAT/SADU, GTZ, DED) and local government (through linking extension staff to implement projects with farmers and contact main local business) (CIAT/SADU, 2006a). Development organisations enable communication between buyers and suppliers by creating platforms to exchange information, discuss prices, agree on quality standards and promote trust. For example, a group of Lao exporters was taken to Thailand to negotiate directly with potential buyers (CIAT/SADU, 2006a). Such meetings ensure that there is more knowledge about market requirements and allows the development of quality standards for the supply chain of paper mulberry bark. The development organisations see themselves as facilitators of a process that later, to reach economic sustainability, will be handed over to the private sector.

4 Discussion and conclusion

This section is divided into three parts. First, the ability of Homma's model to the predict behaviour of farmers regarding the domestication of paper mulberry bark is discussed. Secondly, the key factors affecting the supply chain of paper mulberry bark will be discussed. Finally, the last part identifies the major influencing factors and proposes elements that can contribute to improving the supply chain.

4.1 Dynamics between extraction and cultivation

The results from this study support Homma's model about extraction economies and how domestication can affect the supply chain (Homma, 1995). Homma's model anticipates that if there is high demand, extraction of NTFP will be abandoned to start cultivation or the product will be substituted by a synthetic product. Since in Oudomxay there is little cultivation of paper mulberry, the factors encouraging a shift from extraction to cultivation included in Homma's model will be analysed in detail.

Profitability in comparison with other income generating alternatives. The causal maps show that five functional groups consider paper mulberry bark to have lower prices than other crops, which negatively affects the area planted with paper mulberry trees. In 2000, areas closer to a market such as Luang Prabang were cultivating paper mulberry (Forsen et al., 2001; Aubertin, 2005). Both in Luang Prabang and in Sayabury, near the Thai border, prices are higher than in Oudomxay (in 2006 the prices were 3,000-3,700 kip/kg in Luang Prabang compared to 1,700-2,500 kip/kg paid in Oudomxay).

Farmers stated that they extract mulberry bark only when they are paid a certain amount that is equal or higher to their labour cost in comparison to other income opportunities. In one interview a farmer said that she receives twice the price for puak muak than for paper mulberry bark, although puak muak needs less labour. Thus farmers do not harvest paper mulberry every year but wait to know the price before deciding whether or not to collect the bark from the wild. This behaviour affects both the quantity and the quality of the bark since young bark is of better quality than bark from older trees. Thus, the low prices for paper mulberry bark in relation to other income generating opportunities affects not only the domestication of this NTFP but also the quantity and the quality of the supplied bark.

As discussed by Homma (1992) cultivation enables to increase productivity per land and per labour unit resulting in an increased supply at lower costs per unit of NTFP. In this study, it is expected that this contributes to cultivation of paper mulberry bark, since farmers argued that cultivation allows to decrease the time to reach resources of bark and the time required to clean the bark.

Knowledge about production techniques. Homma's model predicts that farmers' ability to cultivate an NTFP depends on their access to and knowledge of production techniques. This factor can be increased through increasing technical support offered by extension staff and development projects. The Lao PDR government and development organisations are promoting the change from livelihoods based on self-sufficiency through shifting cultivation and extraction of forest resources towards a market-driven production of goods (Evrard and Goudineau, 2004; Raintree, 2004). The farmers' causal map shows

that for farmers it is important to have support from extension services, from the government and from development organisations to increase the planted area. The government understands the need for technical support as a necessary condition for this change, thus they support farmers with extension services and train their extension staff (MAF, 2006). Despite this, extension is often of poor quality (Helberg, 2005: 12) and it is a farmer demand-driven service (GoL, 1999). This demand depends on the farmer's knowledge about market opportunities and market quality requirements which they may not have. For example, during a workshop, farmers stated that they did not know that there was such a high demand for paper mulberry bark, or that there were specific quality requirements for the bark. Training for planting paper mulberry was planned in Oudomxay (OCISP, 2003), but so far has not been implemented.

The interviewed farmers said that technical support will be provided only when they start to give more importance to cash crops in relation to rice production. The farmers also stated that cash crops will only get more important than rice once they have enough money to buy rice. However, to be able to buy rice, they need to increase their cash income through selling more mulberry bark. So this is a negative self-feeding system.

Shortage of natural resources. NTFP resources are normally accessible to all farmers, including the poorest (Angelsen and Wunder, 2003; Schreckenberg et al., 2006). Farmers will start planting when resources become scarce resulting in higher labour costs for foraging than for cultivation (Homma, 1995).

The farmers' causal map shows that planting mulberry trees leads to resources closer to the village. This support Homma's model because cultivation reduces the cost of labour when tree resources start to become exhausted in the nearby forests and more time has to be allocated to search for the NTFP, i.e. cultivation starts to become less costly than wild harvesting. However, so far there are no indications that paper mulberry is becoming scares in Oudomxay, maybe because paper mulberry is a fast growing tree, sometimes with an invader character (Aubertin, 2005).

High demand. A high demand is generally expected to lead to high prices. In Oudomxay there is a high and growing demand for paper mulberry bark (CIAT/SADU, 2006b). Interviews with exporters in Lao PDR and importers in Thailand also show a keen interest in increased supply of the bark and there are many district traders competing for this bark. But as seen above, prices at the village level are perceived by farmers as low. So prices are not motivating farmers to start cultivation. The puzzling issue is: why do prices continue to be low even though there is a high demand? The literature of supply chains in developing countries points out that transportation and transaction costs are higher in remote areas (Best et al., 2005; World Bank, 2006). NTFP are often produced in remote areas with low access to markets (Belcher, 2005). Sending produce to China instead of Thailand has been reported as better, because although prices are lower, transportation costs and labour were lower in China than in Thailand. In addition two interviewees noted that the transport costs for paper mulberry is high because it is bulky.

Absence of industrial and natural substitutes. Homma (1992) gave the example of several NTFP that were substituted by synthetic or natural products. These substitutes could be used for the same purpose, but had lower costs (e.g. rubber, rosewood, natural insecticides). The existence of industrial substitutes has a negative impact on cultivation of NTFP. It saturates the market

for the NTFP that is substituted but will generally not completely eliminate the need for the extracted product (Homma, 1992).

The interviewed consultants pointed out that there are fibres from other NTFP that can be mixed at different percentages with mulberry bark fibres to produce paper. These fibres are cheaper and more readily available. A manufacturer said that he uses a mixture of 50% of paper mulberry bark with 50% of kheua salea (which costs 43% less than paper mulberry bark). A consultant argued that this reduces demand for mulberry bark and thus impacts negatively on the area planted with paper mulberry trees. However this cannot be a sine qua non explanation for non-cultivation, because paper mulberry bark continues to be necessary for the production of mulberry paper and because it cultivated in other areas of Lao PDR, e.g. in Sayabury (Helberg, 2005) and Luang Prabang (Aubertin, 2004). In Luang Prabang the supply chain is shorter: farmers provide the bark directly to the manufacturer, who motivates farmers to cultivate it and offers better conditions to farmers (prices, capacity building, credit and assess to machinery). In Sayabury, the cultivation seems to be due to the lack of better income alternatives (Helberg, 2005).

Geographic relocation. It is possible that geographic relocation of extraction happens before cultivation starts. If geographic relocation is possible and feasible, then it would be difficult to reach the cultivation stage (Homma, 1992). During this study, there were no indications of geographic relocation. One possible explanation could be the easiness of cultivation techniques for this NTFP. The paper mulberry tree is a pioneer species that is able to grow fast, under a broad spectrum of conditions and is easy to propagate (Aubertin, 2005). This reduces the need to relocate extraction to other places.

In conclusion, Homma's model offers some explanation of why stakeholders in the uplands of Oudomxay have not started planting paper mulberry at a larger scale. It is suggested that resources becoming scarce are an incentive for shifting towards cultivation, but in this study there is no strong evidence that the resource base is becoming depleted. There are substitutes for the mulberry fibre since there is some evidence that manufacturers are using paper mulberry with different percentages of other fibres. However, the study also shows several factors not included in Homma's model.

4.2 Key factors affecting the supply chain of paper mulberry

The causal maps also include further factors influencing farmers' decisions regarding planting or extracting paper mulberry bark. Farmers' main reason to domesticate was that the agro-ecological conditions in Oudomxay are favourable for paper mulberry. The dominant reason cited by farmers for wild collection is that planting cash crops is less important than rice production. Indeed, upland dwellers in Lao PDR have been producing rice for subsistence for many generations (Raintree and Soydara, 2001; FAO, 2005), and this is still a more important livelihood strategy than following a market-based approach of selling cash-crops to earn money to buy food.

The dispersion of the population that lives from extraction increases transportation costs for traders. Constituting village marketing groups could be an important step to improve the supply chain of a NTFP (Belcher, 1998). However, Larsen (2000) suggests that village marketing groups in Nepal result in losses for outsider traders, due to villagers' higher **bargaining power**. In

Oudomxay the district traders have a relatively weak bargaining power. Farmers see themselves as empowered to change the supply chain and to improve the income of all stakeholders. However, there are many district traders that are competing (sometimes illegally) to get enough quantity of the bark. The ones working legally accuse the illegal traders of not paying taxes and quotas, thus allowing them to offer higher prices to farmers. Interviewed traders have reported instances where legal traders provide advance credit to villagers and when they return to collect the bark, farmers have sold it to another trader paying a better price. However, the farmers' good bargaining power does not allow them to achieve higher and stable prices.

Farmers' groups can result in higher yields, market access and strengthen social capital (Gotschi et al., 2006). Marshall et al. (2003) also found that community organisation was an important factor contributing to the commercialisation of NTFP. However, for villages in Oudomxay, it is not a common strategy to have a **village marketing group**. This is a significant difference to the villages in Luang Prabang (Forsen et al., 2001). The causal maps show that farmers did not perceive village marketing groups as an important factor to improve the supply chain. None of the villages under study had a marketing group for NTFP, instead they had individual collectors (village traders). In one of the villages studied the marketing group failed because the two village traders involved paid a lower price than the one offered by the outside trader. When the farmers realised the difference in prices, they lost their trust in the village traders and started selling to the outsider traders. This may explain why a village marketing group is mainly seen as beneficial by district traders and by exporters: they are those who would benefit from production contracts with farmers allowing an increase in volume and in bark quality. The government extension staff is well aware that the existence and the success of village marketing groups is dependent on the level of trust within the village. This study thus shows that it is important that farmers feel that they are well represented and that the village trader(s) are not taking advantage. Farmers commented that they want to read and agree with the contract beforehand.

In the commercialisation of NTFP, price can be less important than **contracts** and personal relations between buyers and suppliers (Belcher, 1998). Brennan (2004) stated that production contracts can reduce the scope for opportunism. A contract can help in situations where the price, quantity and quality are informally agreed, or where financial and technical services are provided. It can reduce the incentive for one of the parties to take advantage of the other in an opportunistic way. But contracts might not work if the litigation system takes too much time, if it is expensive, or if it is difficult to check whether the terms of the contract are being fulfilled (Brennan, 2004). Since the legal system is limited in Lao PDR (Lao Consulting Group, 2002), trust and social capital are important to reduce risk and facilitate exchange (Batt, 2004; Best et al., 2005; Minh Chau et al., 2005). In this study in Oudomxay it seems more important to improve trust within villages and with the outside than to establish formal contracts. Also, the existence of many traders, i.e. high demand at village level, is a factor that prevents production contracts. However, the causal maps show that contracts are important to five out of six functional groups. These contracts are dependent on relations of trust, existence of a village marketing group and knowledge about market contacts. If there are production contracts, which are known and agreed by all village stakeholders, farmers are most likely to engage in cultivation of paper mulberry trees. As the aggregated cause map shows, contracts are expected to lead to stable prices, to better communication and to an increased area planted with paper mulberry trees.

Vernon (2006) argued that it was important to decrease or eliminate costs of **quotas, taxes and documentation** for paper mulberry bark and other NTFP, as it would allow to increase the prices paid to farmers, making the cultivation of

paper mulberry more attractive to them. In Nepal the legislative system does not really reduce extraction and even promotes illegal rent-seeking behaviour by government staff (Larsen, 2000). He argues that abolishing restrictive legislation and review the royalty system would result in losses for government staff and for the environmental associations. The first lose illegal rents and the second group loses because lack of regulations and control would provide an incentive for people to harvest more (Larsen, 2000). As the interviews have show, in Oudomxay taxes, quotas and documentation are paid by traders and not by farmers. Farmers thus do not perceive this as a problem. Government officials see the taxes and quotas as an incentive to increase the cultivation of paper mulberry trees. Indeed, taxes and quotas are not a problem, as long as traders prove that the bark is from cultivated sources since the status of the bark then changes from a protected NTFP to a cultivated cash crop, which is subjected only to income tax. Also, farmers who provide cultivated raw material are in a better bargaining position since it reduces the exporter's costs for taxes by 100%. However, for farmers to be able to cultivate paper mulberry trees, they must own land certificates. Only then can they prove that the product comes from cultivated source.

Indeed, **land tenure**, although not included in Homma's model, is an important factor influencing cultivation. Belcher et al. (2005) show that private land ownership is important to provide an incentive to change from extraction of NTFP to cultivation. The customary land tenure system in Lao PDR was regulated by informal agreements between households and the village headmen. It is based on use rights over the land, which are acquired by bringing unclaimed land into cultivation (Seidenberg, 2003). But the current process of village relocation is creating tensions because the relocated villagers receive the poorer land (Evrard and Goudineau, 2004). In one of the villages (Mang) this has been a difficult process, because Mang is a merger of three villages. In one of the interviews, a woman said that she was a newcomer to Mang village, and that she was allocated poor land far from her house. Also, the former owner of her land does not accept the fact of having to share the land and allows his pigs to forage on her plot, destroying her garden. To change the supply chain of paper mulberry bark, it is important that land is allocated to each household. Farmers, traders and manufacturers could then prove to the authorities that the bark is not from wild sources and is thus exempted from paying taxes and requiring quotas (CIAT/SADU, 2006a).

The literature often refers to the poor quality of NTFP (Belcher, 1998; Schippmann et al., 2003). The problem of poor quality seems to be related to the lack of **market quality specifications** for these NTFP. Also, NTFP are mainly extracted, and are thus not as homogeneous as produce from cultivated species, which tend to be from genotypes displaying the commercially desirable characteristics (Schippmann et al., 2003). To cope with this problem, manufacturers are sorting the bark into different grades (SunWorld Ltd., 1999; Forsen et al., 2001; CIAT/ SADU 2006b). However, in the case of paper mulberry bark, there is no agreement on the characteristics that differentiate between grades. For example, a document distributed by the Thai North Industry Promotion Center promotes the standards of a Japanese company (SunWorld Ltd., 1999) for paper mulberry bark, but the grading system used by a Thai entrepreneur in Lao PDR is different (see the overview in Tab. 2, p. 13). This results in a lack of knowledge about the quality criteria, confusion between the different functional groups, lower trust and failure to comply with requirements. The aggregated cognitive map shows that the stakeholders agree that to improve the supply chain it is necessary to develop transparent quality standards for paper mulberry bark.

Regarding the factors that affect the **quality of the bark**, this study in Oudomxay confirms the report by Vernon (2006): the degree of dryness and the

age of the tree when the bark is harvested are perceived main factors influencing the quality of the bark. If the bark is wet, then there are higher chances that the bark will have fungal diseases (Aubertin, 2005). The bark is stored in warehouses for some time until it is sold. During this period the bark can lose up to 30% of its weight, affecting the income of exporters of raw material. Farmers perceive young bark (less of one year) as easier to peal. Young bark also has a lower oil content. If farmers can boil the bark in the village, then it becomes even easier to peal and it further reduces the oil content of the bark. This oil is considered a problem by manufacturers in Thailand because the fibres do not become completely white, even after bleaching. For the fibres to be whiter and the produce to be accepted by the Japanese market, manufacturers need to spend 20-25% more for chemical bleaches and 100% more time boiling the bark compared to what would be needed if the bark was of higher quality. However, the Japanese market is only one of the possible markets for paper mulberry. The European and the North American markets have different requirements: they are more interested in an environmentally friendly the production process. The Thai government is thus developing environmentally friendly standards for the production of mulberry paper[8]. These standards mandate a reduction of water use (using a recycling and cleaning system), limit the types of chemicals and colorants permitted, and reduce the amount of chemicals used (Thai Ministry of Natural Resources and Environment, 2006). There is also a project to develop a sustainability certificate for NTFP (Shanley et al., 2005).

4.3 Concluding remarks

The causal maps based on the interviews with stakeholders from six functional groups of the paper mulberry bark supply chain in Lao PDR show that the existence of a market demand for a NTFP is not enough for the farmers to supply the raw product in the quantity and quality required by the market. This supports Dorward's (2002) concept that social, political and technical processes need to be taken into consideration. High demand is not considered a central factor by the stakeholders in Oudomxay, but it was cited several times as a precondition for other factors. Demand will increase if prices of final products are more competitive and if bark is of better quality. However lower prices at the manufacturer level do not ensure enough supply or the required quality, keeping the system from evolving from extraction to domestication.

Homma's model can explain why farmers in Oudomxay were not, by the time of the interviews, cultivating the bark. Indeed, following factors promoting cultivation were not present: profitability compared to alternative income generating activities; access to knowledge about production techniques; shortage of natural resources; absence of substitutes. In the current context, wide-spread cultivation of paper mulberry trees in Oudomxay is not likely. Nevertheless, there is high and growing demand for the bark by manufacturers both in Lao PDR and in Thailand. This can affect the other factors and change the current situation. The fact that farmers are keen to start cultivation could be seen as a first sign that the dynamics of the supply chain may be starting to change.

[8] Presented at a meeting in June 2006 in Chiang Mai, that was organised by the GTZ and the Thai Ministry of the Environment to present a first draft of the standard and certification process and to collect feedback from the private sector about their proposal.

The causal maps have allowed to show the **impact of a wide range of factors on the supply chain** of paper mulberry bark. These include:

- Farmers perceive the agro-ecological conditions as suitable for the cultivation of paper mulberry trees.
- The tradition of self-sufficiency in rice production is still a barrier to start cultivation of mulberry bark and other cash crops.
- Establishing village marketing groups would allow to achieve economies of scale, to stabilise prices, to improve the information flow and to establish contracts. Especially district traders emphasise the importance of village marketing groups.
- Trust and good interpersonal relations within the village and with outsiders are a key precondition for contracts and their enforcement.
- The quotas and taxes for wild NTFP reduce the income for the private sector involved in the supply chain since they increase transaction costs. At the same time they are an incentive to plant paper mulberry trees since these are exempt from quotas and taxes.
- Lack of clear and secure land tenure status is an impediment to planting paper mulberry trees.
- The lack of transparent quality standards for paper mulberry bark leads to information asymmetries between farmers, traders in Lao PDR and manufacturers in Thailand. The resulting miscommunication leads to low trust levels and an unclear price structure (especially regarding the relationship between price and quality).
- Stakeholders in Lao PDR make a clear connection between cultivating paper mulberry, higher quality of the bark, higher volume of produce on the one hand and higher prices on the other hand.
- It is unclear if Thai manufacturers are willing to pay higher prices for higher quality bark. They resent higher production costs given the price pressure by cheaper paper mulberry handicrafts made in Vietman or China. However, since Thai manufacturers intend to focus on high quality handicrafts having a certified environmentally friendly production process, they might be interested e.g. in bark with lower oil content since it lowers the need for chemicals during the production process.
- Stakeholders in Lao PDR have different views regarding the effect of the number of traders on the supply chain. Consultants perceive the high number of traders at district level as a way to promote competition at village level and a way to increase prices paid to farmers. District traders see the competition mainly as threatening because it entices farmers to break contracts.

The various stakeholders have offered a range of **options to improve the supply chain** of paper mulberry bark. These include: offer support to increase the area planted with paper mulberry; offer incentives to improve the quality of the bark; establish village marketing groups; facilitate the negotiation of (formal or informal) contracts.

The study also identified several **issues that require further research** to better understand the market potential for paper mulberry. These include:

- What benefits would manufacturers have from higher bark quality?
- What are the quality standards for the Japanese market?
- What are the quality standards for the European and American market?

- Is there a demand for certified (organic and/or environmentally friendly production process) paper mulberry products?
- Is there are market of mulberry paper made of 100% paper mulberry bark?

Overall, the causal maps established for each functional group have shown the **importance of understanding the idiosyncratic logic of each functional group**. Understanding each functional group's logic is a precondition for improving the communication between stakeholders and thus the information flow within the supply chain. Only once each functional group's priorities and fears are understood, can they be taken into account when designing measures to improve the supply chain.

The causal maps also allow to reach a **systemic understanding** of the factors influencing the supply chain as well as the interactions between these factors. These interactions are perceived differently by different functional groups, showing that improving the supply chain needs to be based on concerted action by all involved stakeholders. For concerted action to be possible, the stakeholders need to reach a shared understanding of the factors impeding improvement and have a common goal as a motivation for improving the supply chain.

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Appendix: Photographs of paper mulberry bark along the supply chain

A young paper mulberry tree

A plot planted with paper mulberry trees

Stripping the outer bark from a paper mulberry stem

Cleaning the inner bark


Drying the bark


Sorting the grades

Weighing and selling the bark to traders


Transporting the bark to the district capital


Storing the bark by district traders

Transportation by truck to Luang Prabang or China

Boiling the bark at the manufacturer's

Bleaching the bark using chemicals

A manufacturer's pulp machine

Grading the fibres

Producing hand-made paper

Drying the paper on mesh screens

Handicrafts made from mulberry paper

Envelope and greeting card made from mulberry paper