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System approach problem diagnosis and development strategies for a competitive mandarin to industry in the Karo highlands, North Sumatra, Indonesia

F. Mengistu[1], A. Davtyan[2], I. Vorster[3], D. Xuecheng[4], E. Sembiring[5], Y. GasmElseed, A Bashir[6]
Adet Agricultural Research Center, P.O.Box, 08, Bahir Dar, Ethiopia,
[1]Scientific Center of Agriculture and Plant Protection, Armenia,
[2]Vegetable & Ornamental Plants Research Institute, Pretoria, South Africa
[3]Ganshu Agricultural University, China
[4]Research and Assessment Institute for Agricultural Technology, Indonesia
[5]Agricultural Research Corporation, Elobeid Agricultural Research Center, Sudan

Abstract

A system approach is a principal component of Agricultural Research for Development (ARD) procedure and integrates the different perspectives of stakeholders and disciplines in a holistic process of improving technology, policy, markets and social organization for the betterment of farming and development. In the past, North Sumatra was used to export mandarin to Malaysia and Singapore but exports have now ceased and even in local markets it is facing stiff competition from imports from China, Australia and Argentina. A system approach was employed to study the causes of loss of competitiveness of North Sumatra mandarin and suggest strategies for its improvement. The study was conducted by a multidisciplinary team of researchers represented from different countries delegated by International Centre for development-oriented Research in Agriculture (ICRA) from April to July, 2003. Participatory Rural Appraisal (PRA) methods and tools were used in the data collection and analysis process. Different stakeholders had different perceptions about the causes of the problem. It was generally found out that the problem lies at production, marketing and information management levels. Development of an improved system for disease free seedling provision and a technical itinerary for production, a network of on-farm research and demonstration plots, the establishment of "Farmer Field Schools" etc., are suggested to improve the situation at production level. Development of a consistent definition of product quality, improving the marketing chain, access to market and price information, standardisation of grading, processing and post harvest handling are additional measures that need to be taken in the marketing process. Further, at information management level, it is essential to improve the knowledge flow between all main stakeholders and strengthening the role of the producers' associations as well as the private sector. Areas like varietal improvement, agro-techniques, seasonality of demand and supply, consumer's quality requirements, main competitors and potential markets need further research in the future.

Key words : Citrus, competitiveness, reticulate stakeholders, systems

Introduction

According to Matrick (1993), a "System" is a group or combination of interrelated, interdependent or interacting elements forming a collective entity and capable of reacting as a whole to external stimuli. Further, he defined a "System approach" as a scientific method which seeks to understand the complexity of systems through studying their interrelationships rather than simply studying their constituent components. Therefore, a system approach/ perspective/ integrates the different perspectives of stakeholders and disciplines in a holistic process of improving technology, policy, markets and social organization for the betterment of farming and development. It is a component of Agricultural Research for Development (ARD) procedure, which is, a process for planning research and development activities that respond to the needs of the clients and beneficiaries, contribute to wider and often conflicting development needs and use systems perspectives to integrate diverse perspectives ICRA (2003, unpublished). That is, it uses systems analysis and joint planning with stakeholders involved. The ARD procedure was employed to study a complex problem that the North Sumatra's mandarin industry in Indonesia faced.

North Sumatra is a province on the island of Sumatra, Indonesia. Karo is one of the 26 districts of North Sumatra province which in turn consists of 13 sub-districts and 248 villages. Karo is known for its fruits (like mandarin, pineapples and passion fruit), vegetables and flowers (Scholz, 1983) production. In Indonesia the name "Jeruk" stands for all citrus species. However, in North Sumatra more than 70% of the citrus species was found to be

Table 1. Climatic conditions of Karo in 2001

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rainfall (average '99-2000)	88.4	91.3	177.4	162.2	150.8	92.4	96.8	143.2	263.7	346.4	117.9	158.7
Temperature (°C) (average 2000-02)	18.5	19.1	19.2	19.3	19.7	19.9	19.3	19.6	19.6	19.2	19.3	19.5
Humidity (%) (average 2000-01)	89	88	91	83	89	85	87	88	87	86	92	85

Source: Badun Meteorology dan Klimatology (Dep. Perhubungan)

Mandarin (*Citrus reticulata*). Some 312,000 tons of mandarins are produced per year (Indo.com corporatre, 2003). Livestock including chicken, cattle, pigs, goats, sheep, ducks and buffalo are also raised.

In the past, North Sumatra mandarin was used to be exported to countries like Malaysia and Singapore. However, exports have now ceased and even in provincial markets, mandarin from North Sumatra is facing stiff competition from imports from China, Australia and Argentina. Different stakeholders at different levels opined various reasons for loss of competitiveness of North Sumatra Mandarin. But, the major reasons were not clearly known. The problem is very complex and can not be solved by looking only at one level that the whole system had to be examined. Therefore, the objective of this study was to analyze the factors affecting the competitiveness of mandarin within broader agricultural knowledge and information system from agro-ecological, social and economic perspectives and propose development strategies for improving its competitiveness.

Methodology

The study was conducted by a multi-disciplinary team of experts assigned by ICRA from April to July, 2003. North Sumatra lies between the equator in the south, Ache province in the north, the Malacca Straits in the east and the Indian Ocean in the west. It covers an area of 71, 680 km^2 and is dominated by high mountains and lake Toba in the center. The Karo district lies between about $2^0$5 and $3^0$19 N latitude and between $97^0$55 and $98^0$38 E longitudes. The Karo highlands cover an area of 2127km^2. The elevation in Karo ranges from 120 to 1600m a.s.l. where the highlands (500-1600m a.s.l) cover about 78%. Karo has a thin andestic tuff cover originating from more recent eruptions from the Sinabung-Sibayak volcanoes which resulted in rich andosol soils that tend to be quite permeable. The average rainfall is about 1900mm per year and is well distributed over the year (Table 1). The population of Karo is about 287,857 with the average density of 135.3/km^2. Prior to the actual field study, an initial context analysis was made based on secondary information. This was further refined through a series of workshops and the problem defined in a wider development context using stakeholders' perspectives and the major elements in the system that need to be changed in order to address the problem demarcated. A reconnaissance survey was conducted that resulted in identification of four zones and a total of six villages for further study. Participatory Rural Appraisal (PRA) techniques and tools were used for data collection. A second workshop was held to evaluate the progress of the study, that brought different stakeholders involved in mandarin industry together, and the sub-systems further analyzed with different stakeholders to identify potential improvements for solving the problem and strategies to realize these along with the future scenarios. The alternative futures and risks of various strategies were discussed with the beneficiaries and stakeholders. The choices of a realistic combination of strategies were negotiated and researches that need to be done defined and prioritized. A final workshop was held with major stakeholders to present findings and get final feedbacks and to define follow-up actions to the study with the stakeholders involved.

Results

Zonation

An attempt to delineate the Karo area into different production zones, so that strategies could be developed as per each zone's specific constraints, revealed that based on elevation four zones can be identified. These are: Zone I (600-800m), Zone II (800-1000m), Zone III (1000-1200m) and Zone IV(>1200m). The quality of mandarin varies to some extent from one zone to another that fruits are with thin green skin in Zone I, thicker yellow skin (Zone II), thickest yellow skin (Zone III) and poor skin/ small fruits (Zone IV). These zones are also found to differ with the type of other major crops grown in the farming system.

Factors affecting competitiveness of mandarin

In this study, competitiveness was taken to mean achieving a high quality and / or low price of a commodity so as to win against rivals. Accordingly, although different stakeholders opined differently about the major causes for loss of competitiveness of mandarin, generally it was found out that the problem lies at three levels: production (agro-ecological), marketing (economic) and information management (social).

Table 2. The roles of the main stakeholders as seen by themselves, others and possible future roles in Karo.

Stakeholder	Stakeholder view of own roles	Other stakeholders' views of roles	Future roles suggested by others
BPTP	Assessment of technologies Dissemination of results On-farm research (testing fertilisers etc)	Research on production technologies Testing of fertilisers Dissemination of technologies Training of extension	Research on nursery technologies
Growers Association	Representing and organising farmers Association is still working on its roles, not yet very strong on grass roots level	Representing and organising farmers	Train farmers Marketing Promotion of mandarin Facilitate marketing aspects Ensure farmers use good quality seedlings
Extension Service	Supply aid to farmers Training of farmers and nurseries Policy facilitation at Karo level	Training of farmers Ensure good seedling supply at private nursery level	Help with access to credit
Farmers	Produce good *jeruk* for a profit	Follow recommendations accurately	Train other farmers on received technologies
BBI government nursery	Provide quality seedlings to farmers Train farmers on good nursery practice	Provide seedlings to farmers Train farmers on good nursery practice	Ensure that the right varieties are available, based on farmer needs
Privately owned (farmer) nurseries	Provide good quality seedlings	Provide good quality seedlings	
Private company nursery	Provide good quality seedlings for themselves		Provide good quality seedlings to farmers
Private fertiliser and pesticide companies	Sell products Some train farmers	Products Training of farmers and PPLs	
Pesticide and fertiliser shops	Sell products Some train farmers Provide diagnostic service	Quality products Good diagnosis	
FRI (Tongkoh)	No mandarin work being done		Expect them to provide research and technologies
Orange and Sub-tropical Fruits Research Institute (Tlekung)	Research Dissemination of technologies	Provide good quality planting material Research Training	

Production

Farmers' production knowledge and skills are inadequate and orchard management is generally basic as a result of which the quality and productivity of mandarin is low. Some three types of nurseries are available; government, private owned by individual farmers and a private company nursery. The private company nursery has a strong linkage with the Citrus and Sub-tropical Fruits Research Institute. This ensures good service and open access at all times, as well as the supply of good quality scions and rootstock when needed. Farmers are using their own sources of scions. As most of the varieties grown in Karo have a huge variation in morphology, this practice could mean that the farmers are even less sure about what varieties they have in their orchards. Farmers in some areas are producing seedlings both for the community and for other communities without really being sure what the varieties are that they are using. The purity of the seedlings is not known, and this could

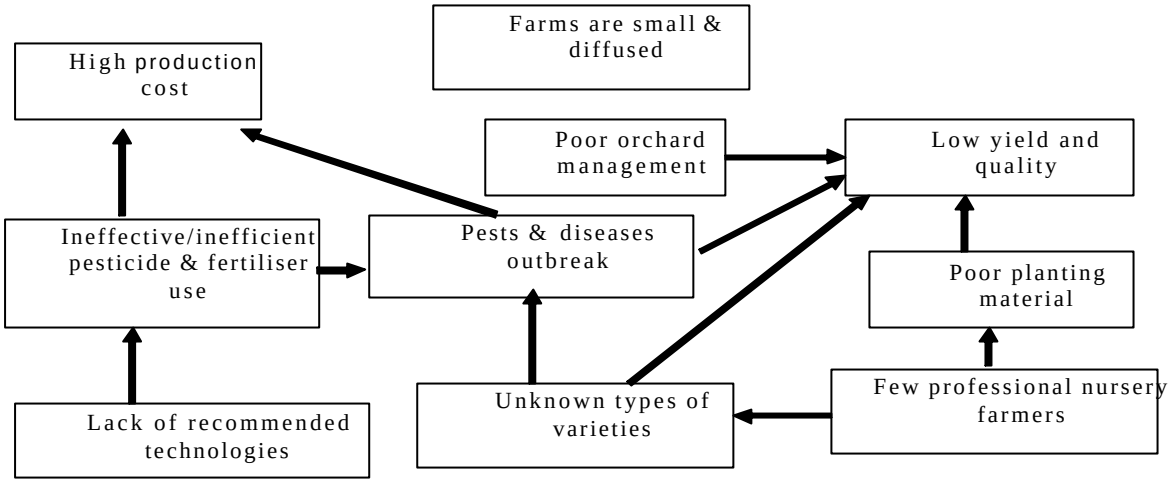

Figure 1. Inter-relationships of production factors affecting mandarin competitiveness in Karo

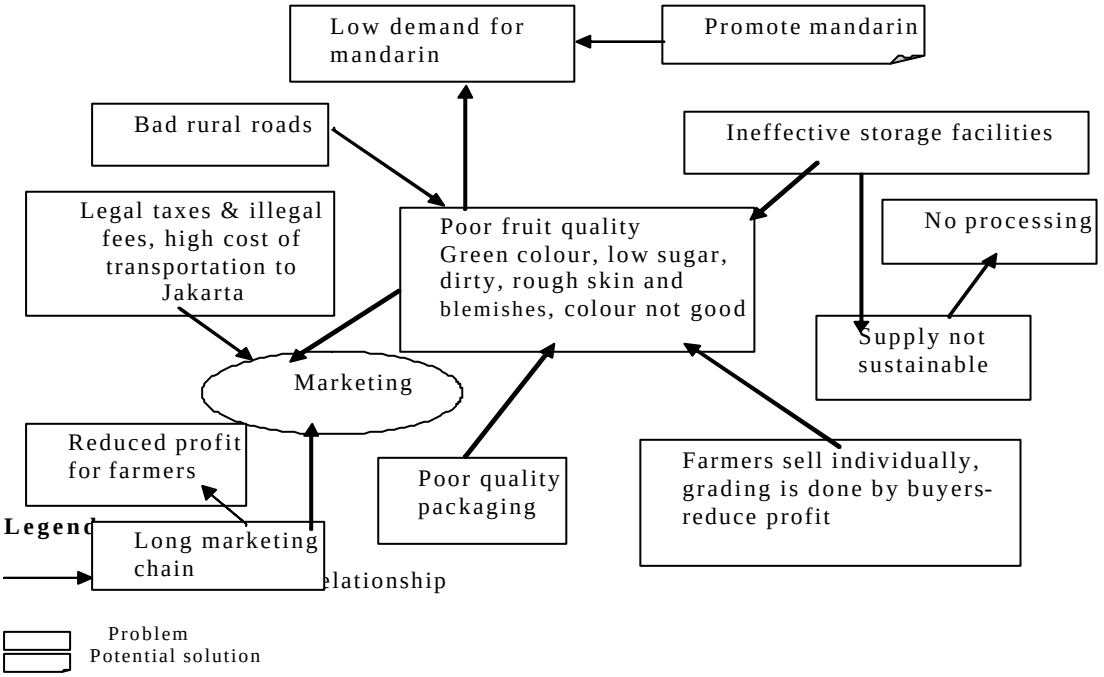

Figure 2. Marketing factors affecting competitiveness of mandarin in Karo

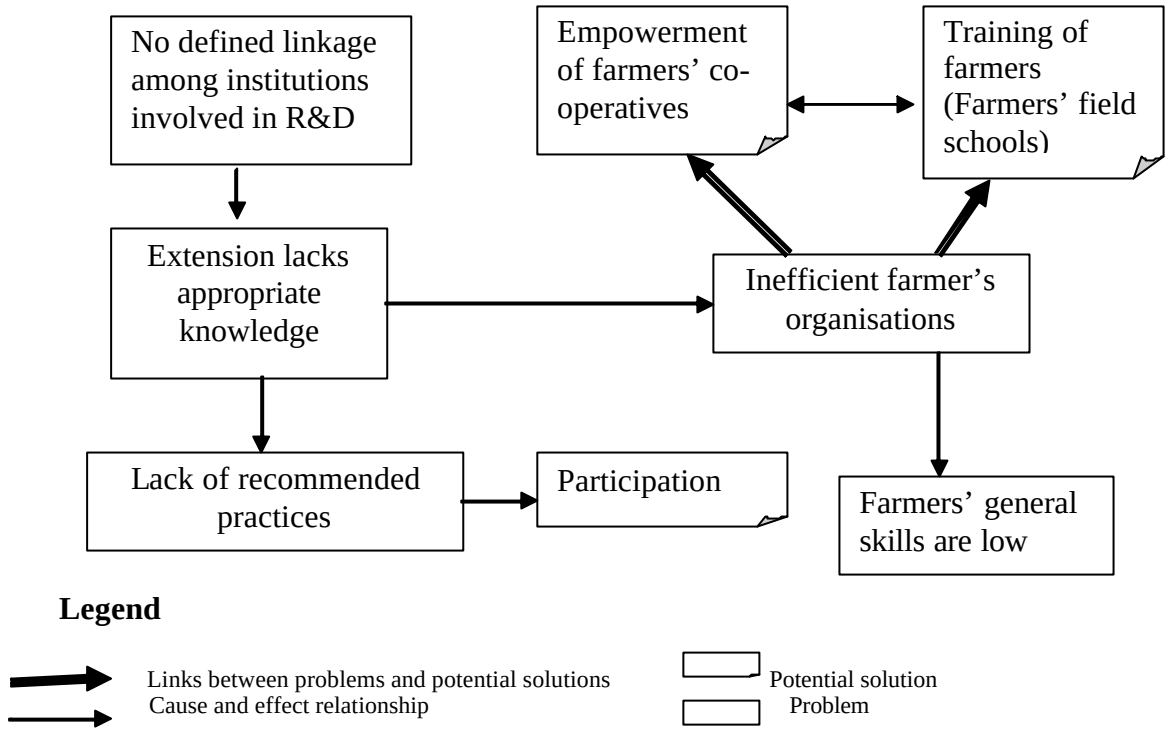

Figure 3. Institutional factors affecting mandarin competitiveness in Karo

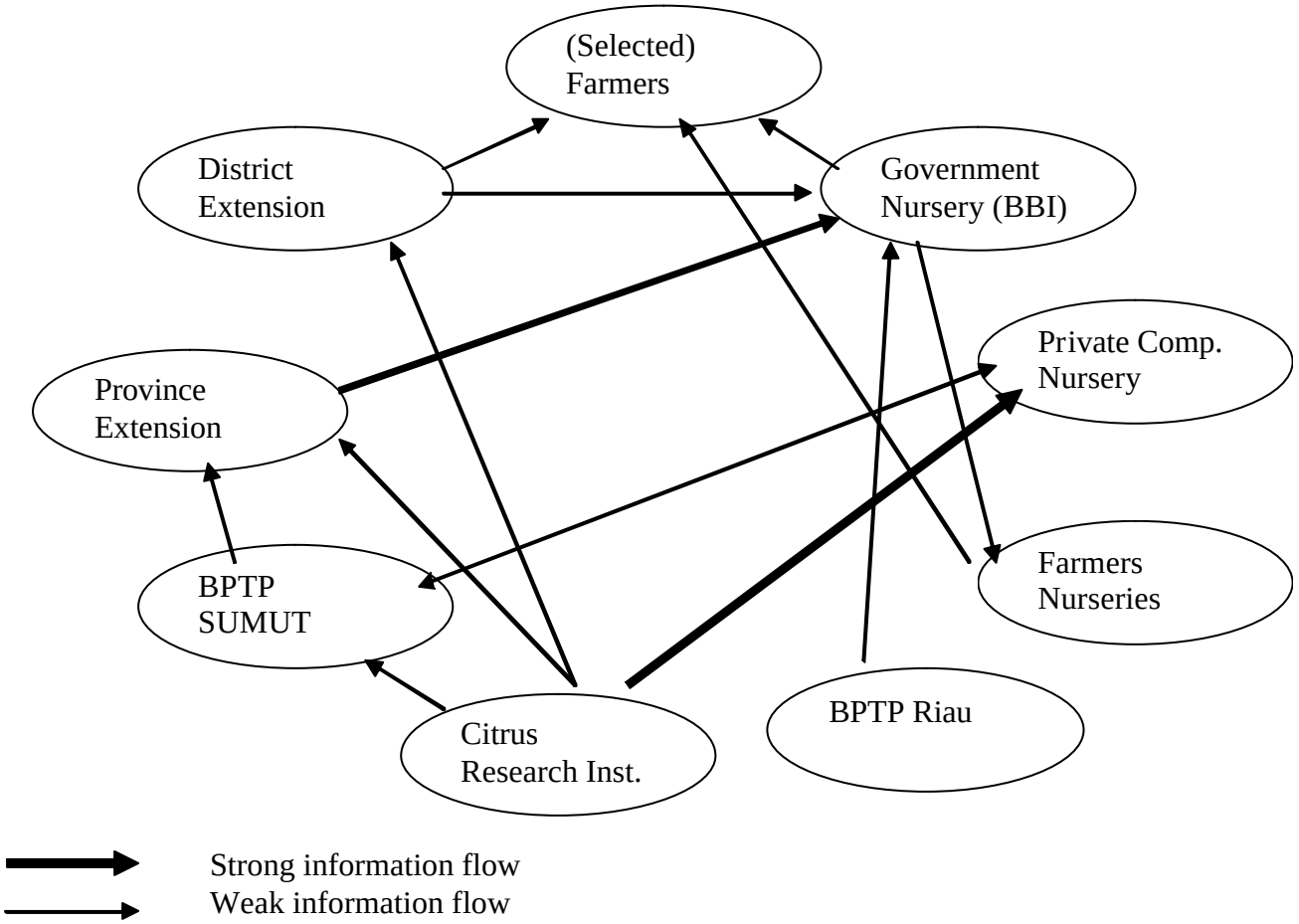

Figure 4. Information flow on varieties used in Karo

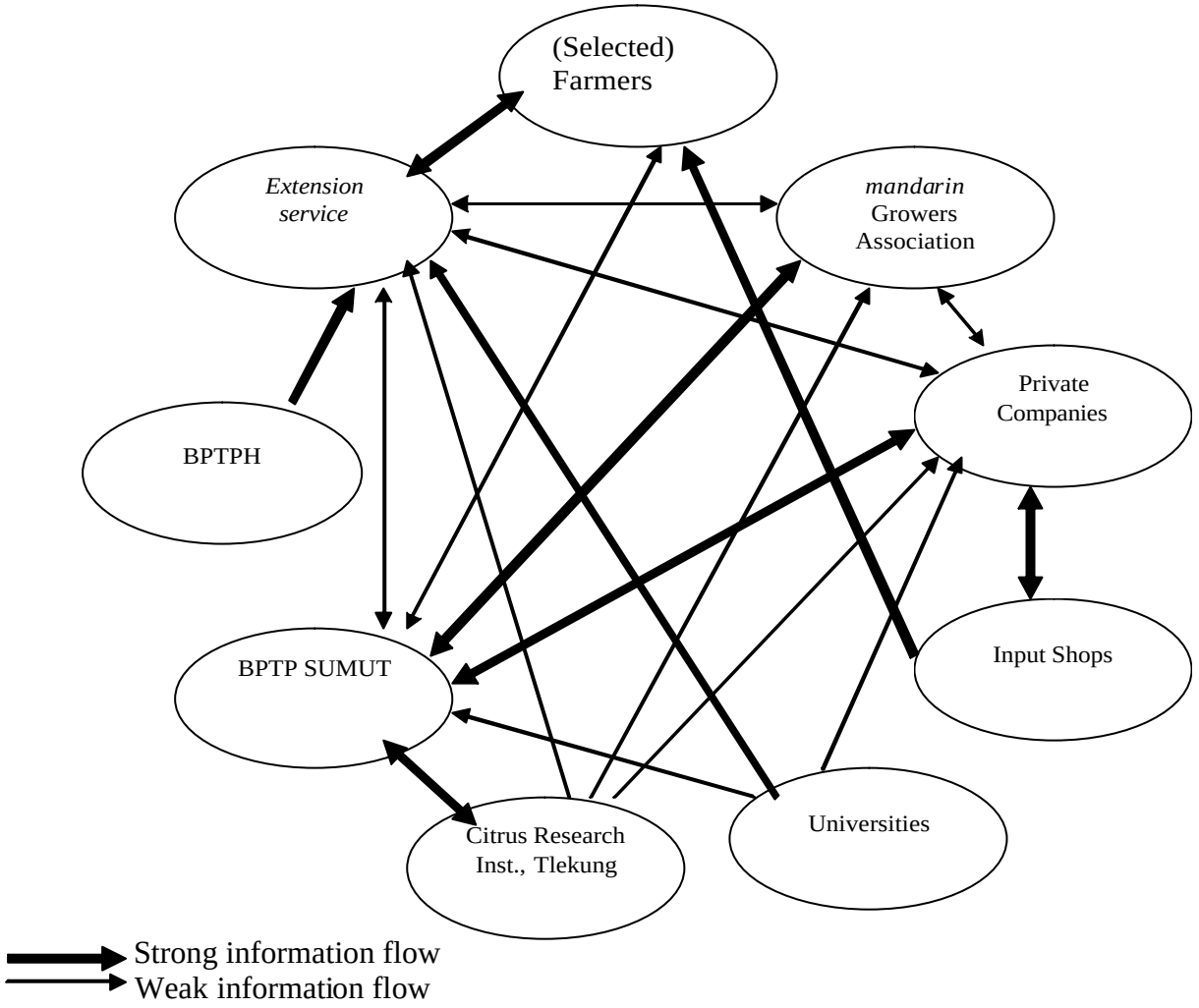

Figure 5. Information flows for mandarin production technology in Karo

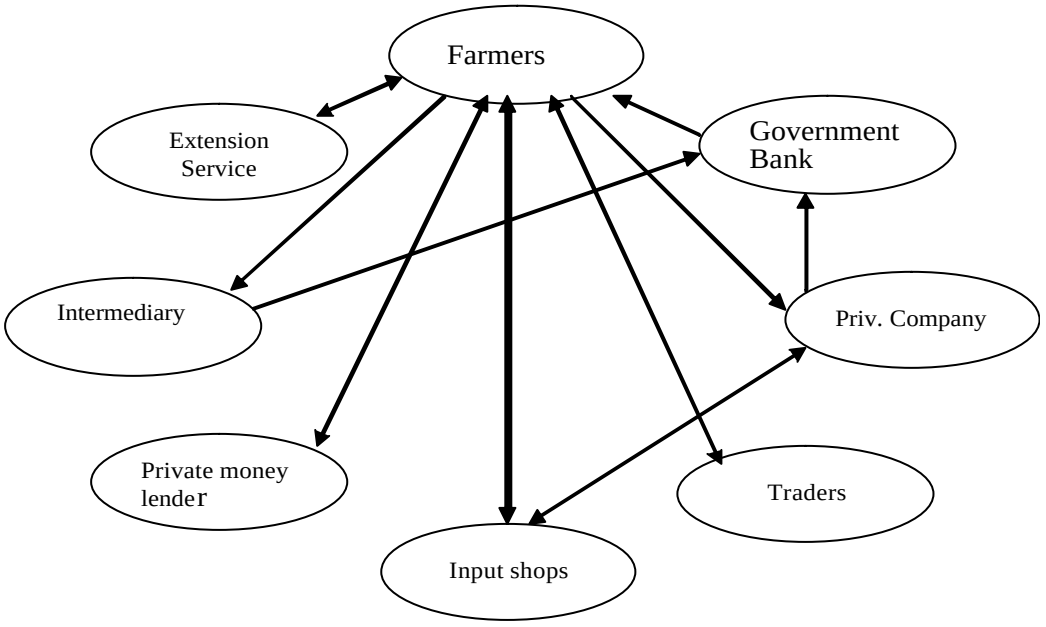

Figure 6. Financial information flows within the credit chain in Karo

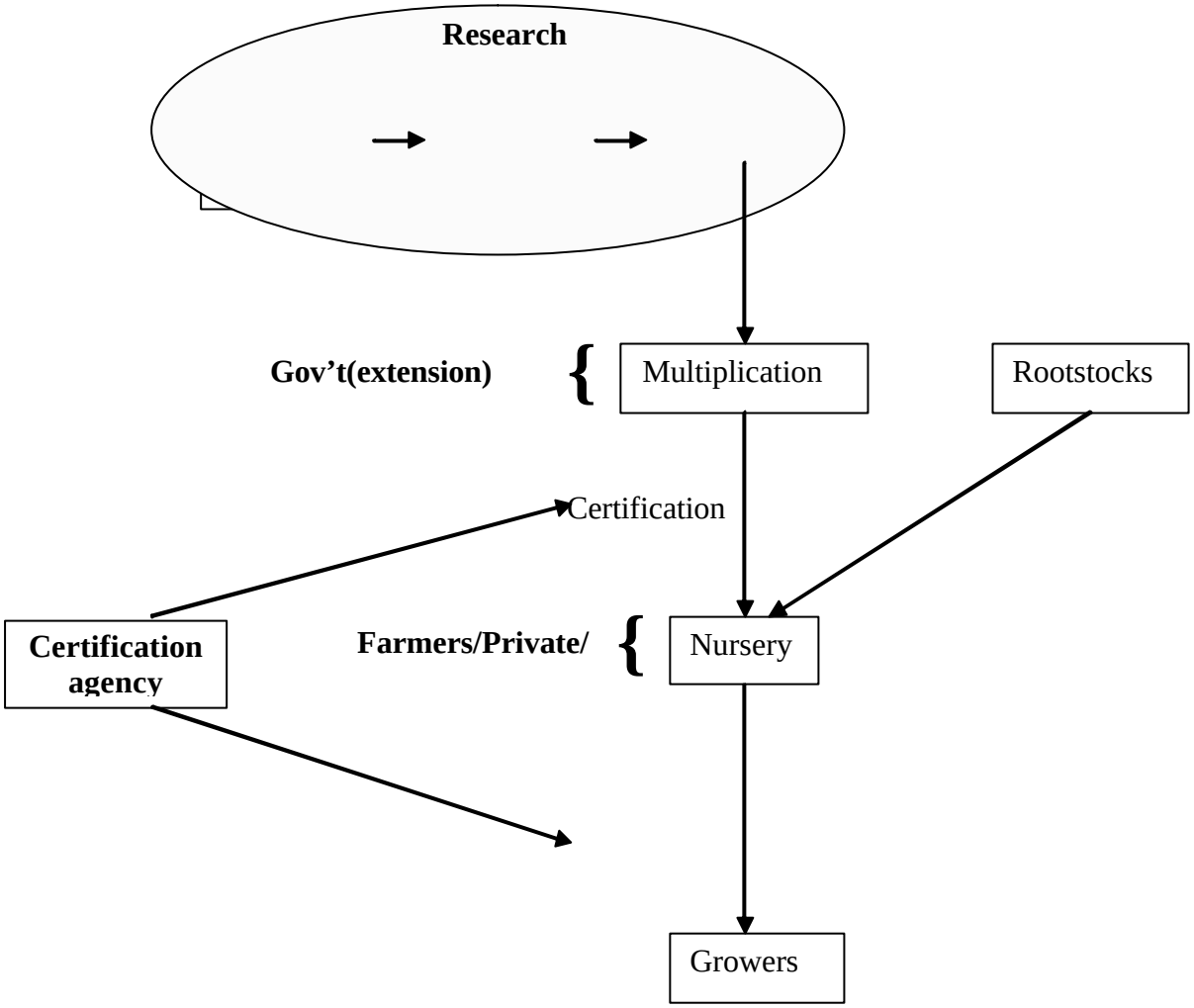

Figure 7. Proposed scheme for provision of planting material in Karo

lead to further spread of mixed varieties within Karo. It was also found out that some nurseries are not supplying the scions that the farmers ask for and this leads to farmers not using the nursery and turning to other farmers for mother material (once again increasing the uncertainty about what variety is really grown). Generally, planting materials used are largely unknown and are mixtures that are susceptible to insect pests (miners and scales) and diseases (mildews). These force farmers expend more on pesticides that in turn increase production costs and add to a loss of competitiveness. Grafting is not practiced timely; older (1-1.5 years old), seedlings are grafted than the appropriate 3-6 months old. It is essential that rootstocks should be selected to best suit local conditions and tolerate inherent pathogen loads on the young tree. That is they need to differ based upon soil texture, soil pH, drainage, diseases, nematodes, etc. Unfortunately, only a single rootstock, "Japanese Citroen", is predominant in Karo highlands irrespective of soil and climatic conditions, from the lower elevations (Zone I) where paddy rice is grown to well-drained highlands (Zone IV). It is also known that scion choice depends on the type of market, climate, soil and production costs and gross margins for the variety. Again in Karo, irrespective of soil and climatic differences, the dominant variety is appeared to be one, "Siam Madu" and in few instances Keprok and Batu 55. Intercropping of mandarin with several annual and perennial crops like chilies, cabbage, potatoes, maize, coffee etc., is a very common practice in the farming system. However, farmers do not know how much and up to what stage they have to intercrop. Mandarin plantations are closely spaced than recommended by research institutions. Despite the closer spacing and intensive inter-cropping practices, however, pruning is not done timely. The few technological recommendations available for the sole mandarin production are also indiscriminately used for both sole and inter-cropped mandarin which resulted in severe competition with the accompanying crop and inefficient utilization of inputs thereby low productivity and quality.

Micro-nutrients which are known to have paramount importance in citrus production, are not used by the majority of the growers so that lumpy(hard) and small fruits, die-back with gum pockets and mottling of leaves caused by boron, copper and zinc deficiency, respectively, are very common. Diseases like the red fungi, and insect pests like the oriental fruit fly and others are causing great losses. Farmers use a considerable amount of pesticides and fertilizers but still complain of a long-list of on-farm problems. This is found to be due to their ineffective / inefficient use of pesticides and fertilizers. Growers also lack appropriate recommendations for production and management of their crops.

The fruit quality is generally poor; green in color, sometimes with yellowish spots, instead of more desired yellow. Fruits are not sweet and have a poor presentation (rough skinned and dirty looking). All the above and similar production constraints are found to have resulted in low productivity and quality of mandarin and to have contributed to its loss of competitiveness at production levels (Figure 1).

Marketing

The roles are well defined and understood within the marketing system. Traders (often linked by family ties) usually employ collectors to buy and grade produce, who then bring it to a collection point. Sometimes transporters are also traders. The traders in Jakarta also tend to be family of the middlemen in Karo. Due to this system, the traders set their price with farmers (who usually sell individually) who have to accept these prices. Where a farmer group is selling directly to Jakarta, the prices they receive for their product is much higher.

Within the credit system for mandarin farmers, there are seven major stakeholders: *government bank* (very complicated procedure with many forms and field checks), which discourages farmers from applying for a small amount of credit, *Intermediaries* (governmental institutions and qualified lawyers), a*id providers* (e.g. Extension Service, and some international donors) provide aid in kind for farmers, *Fertiliser and pesticide* companies usually provide credit to shops for a short period, p*rivate lenders* and, *traders* also provide credit for farmers in some cases, to reserve fruit before harvest (Figure 6).

In Karo, price fluctuation of the produce is common because of the seasonality of products, while at farm gate, the price is low and more or less constant within a certain range indicating that farmer's lose a lot. Product supply is not also sustainable due to lack of storage facilities to lead to investment in processing plants. The cost of transport from china to Jakarta is similar to that from Sumatra to Jakarta. However, due to legal taxes and illegal fees charged on the roads to Jakarta, the overall transport costs are higher and contribute to increase cost to consumers so that low demand of the product. Packaging is poor and rural roads are bad that also leads to a high loss and contribute to high marketing costs. Besides, the marketing chain is long, involving 5-6 middle men thereby increasing cost of marketing and ultimately lowering price that can be offered to farmers and hence their profit (Figure 2).

Information management

*Several Institutions, organiz*ations and individuals who have a stake or interest in the mandarin industry are found to be BPTP(North Sumatra Research and Assessment Institute for Agricultural Technology), Agricultural Extension Service, Karo Government, Budget & planning office, Fruit Research Institute, Socio-economics Institute, Citrus Growers Association, Citrus growing farmers, Citrus nursery farmers, fertilizer companies, pesticide companies, transportation companies, retailers, and consumers.

However, linkages among institutions involved in mandarin research and development are found not to be strong & well defined (Figures 3, 4 & 5). Being in proximity and within one province, the linkage between the Fruit Research Institute and BPTP and extension service are generally weak and not well defined. Also, the linkage between research and farmers appears to be not well established and farmers are not involved in prioritization of problems for research. The sustainability of the overall research and development institutions involved in the system is questionable. The institutional arrangements between agricultural research and development are often changing. In the majority of cases, roles of one institution are not well known by the others and the expectations are usually high and sometimes beyond what it is mandated to do (Table 2). Sometimes there is even a disparity between government interests and institutional mandates. For example, the Karo government is interested at both on-farm and off-farm level constraints while the agricultural extension service is mandated to work only at the on-farm level. The information flows in the marketing system are limited to between a few stakeholders, making it very difficult to get information. Linkages between the different types of traders (middlemen to wholesalers in Jakarta) are strong as they often keep the trade within the family. This makes it very difficult to break into this circle, and this could possibly have an effect on the profits that the farmers make.

The farmers' organizations are weak at local level. Farmers sell their products individually to traders. Grading is usually done by the buyers, leaving farmers with little bargaining power. All stakeholders agree that farmers' general skill is low which can be accounted to weak support from research and extension. All these weak institutional linkage and weak organizations have a negative bearing for a competitive mandarin production.

External Factors

Besides those factors constituting the system and are responsible for a loss of competitiveness of mandarin, some other factors could also be identified that affect the whole system externally. These external factors include price

fluctuation, government policies (tax, subsidies) and globalization.

Scenarios

Future scenarios that might provide alternative future development of events were also identified. Accordingly, it appeared that Government support seems not guaranteed beyond the lifetime of the present Karo Government. Also, the BPTP's priority will shift to other commodities as the current financing from the federal Government ceases as of 2006. Besides, development and sustainability of the mandarin grower's association is uncertain. These scenarios formed the basis of the strategy for future development of the mandarin industry in Karo.

Recommendations

Several factors at production level appeared to contribute to the loss of competitiveness of North Sumatra mandarin. Measures that enhance yield and quality are needed. Healthy planting material is a basis for a successful orchard development. This calls for a need to establish an improved system for quality seedling provision as suggested on Figure 7. There is a considerable confusion concerning mandarin varieties and their characteristics in Karo. This varietal uncertainty entails the need for varietal characterization both morphologically and genetically. Besides, as varieties that have been developed by the Central Fruit Research Institute at Malang have not yet been introduced to North Sumatra it is advisable to evaluate them and pass adaptable varieties on to the farmers before any varietal development research is initiated. Farmers' knowledge of orchard management is generally low for which development of an improved technical itinerary for orchard management is required. Farmers lack information on production recommendations like time, rate, type and frequency of fertilizer application. Similarly, information is lacking on nutrient requirements of mandarin when it is grown intercropped with other crops. This has resulted in increased costs of production and under- or over- use of nutrients by plants which in turn results in poor productivity and quality. Nutrient removal in the expected yield, leaf and soil analyses can be resorted to determine fertilizer needs (Koo, 1985). Farmers rely heavily on chemical pesticides to protect their crop that increases production cost and lead the development of resistance in addition to the high level of residue it left on products that lead to rejection of produce on the export market. Integrated pest management can be practiced that involves resistant varieties/rootstocks, healthy seedlings, intercropping with non-host crops and general sanitation along with judicious use of pesticides.

The practices of thinning, skirt pruning, topping and hedging which are important management practices for productivity and quality of mandarin trees but hardly used currently in Karo should be practiced. Proper selection of intercrops and stage of intercropping, appropriate spacing, orchard rejuvenation etc. also need consideration. As Karo has abundant vegetation, raising of cattle can be taken as an opportunity that would help in providing organic manure, transport, milk, meat and draught power.

For agricultural technologies to be adopted, adapted and practiced by farmers, field based and hands-on demonstrations are desirable. Demonstrations or learning plots managed by farmers for practical field sessions in addition to participatory discussions facilitated through Farmers' Field School, give a better chance to farmers to meet with research and development institutions involved in their problem. Demonstration plots can serve as an excellent learning media, by providing a site where farmer groups (field schools) can visit to see the technology being demonstrated in the field. Farmers should have a vital role in managing the plots that will ensure the ownership by farmers of the technological packages applied, and ensure close contact with researchers and extensionists. Government institutions like BPTP, FRI, Extension Service can initially arrange the coordination. The private sector can play a vital role in better demonstration of technologies like pesticides and fertilizers. Eventually, the producers associations could play a stronger role. Farmers Field Schools have the advantage of integrating participatory problem analysis, activity planning and implementation. It aims at developing the capacity of farmers as policy makers, experts and planners. It is suggested that a structure of committees at village and district level coordinate the activities of FFS and integrate the efforts and facilities needed for a successful learning system.

Currently standards are lacking for fruit quality accepted by all stakeholders. Therefore, a consistent definition of product quality is required. Internal and external fruit quality can be improved through practices like controlling the moisture level & temperature, Gibberelic acid spray, application of optimum phosphorus and calcium fertilizers and positioning of fruits by maintaining drooping shoots with hanging fruits on thin stalks. Attaining the right fruit size is a major problem in the area. Measures like fruit thinning, hormone application and girdling can be practiced to overcome the problem. Introducing the practices of washing, sorting, waxing etc., can also improve the cosmetic appearance and increase the price for growers and traders. The marketing system should be improved by extending the target markets from domestic to abroad, improving the facilities for packaging and transporting and encouraging sea transport than road to reduce transport costs. Also, encouraging involvement of producer's associations in marketing so as to strengthen their bargaining power, standardization of mandarin grading for export market and strengthening of information channels between different stakeholders in marketing are required.

The agricultural knowledge and information system includes dimensions of organization and power as well as technology. According to Rogers *et al*. (1976), for effectiveness of a system it is important to have user control over the entire system. At Karo, both organization and

power dimensions show problems. Active user groups comprise of people who network and interact. Farmers need to be active in developing and adapting information as well as in asking for kinds of information they find useful. They must also assume responsibility for their own learning. They must share their experiences (e.g. through study groups) and the knowledge they receive from other sources.

By strengthening farmers' organizations, the end-users of the knowledge and information system will be able to make themselves heard, and will also ensure effective use of resources within this system. A strengthened association at village level could become an intermediary between the farmers and traders. It can also look at the input supply at village level. The roles that mandarin producers association might consider in the future include: facilitation of learning-organizing farmer study groups, meetings between these groups and other stakeholders, promotion of farmers interests through representation with government departments at different levels, provision/facilitation of access to planting material, inputs, soil testing, leaf analysis etc, credit and credit information, technical information, markets and market information and conducting research commissioned by government agencies.

Conclusion

Approaching the problem systematically from different perspectives and participation of different stakeholders and dealing with multi-disciplines enabled to clearly identify the major constraints hindering the competitiveness of the north Sumatra mandarin. Problems are generally found at production, marketing and information management level. Therefore, to improve the situation and become competitive, interventions are needed at all level. A net-work of on-farm research, demonstration plots and farmer field schools should be established. The marketing system need to be improved that alternative routes need to be looked at as the distance to Jakarta and associated costs are higher than to potential export markets in Singapore and Malaysia. The roles of stakeholders need to be revised and information flow needs to be strengthened. The producers associations need to be strengthened to fill the void likely to be left by the current government and BPTP so that they can take up the role of coordinating development efforts in mandarin including the organization of demonstrations and Farmers' Field Schools and identifying research priorities.

If associations can develop sufficient strength, the possibility of commissioning research via a grower's levy can also be considered, to provide continuity of research efforts beyond 2006. Generally, through the modest improvement of production techniques, keeping the international quality standards and re-defining the roles of different stakeholders involved in mandarin industry and establishing a strong linkage among them it is possible to restore the popularity of North Sumatra mandarin and make it competitive.

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References

ICRA., 2003. Towards a competitive jeruk(mandarin) production: Enhancing production and institutional factors for quality jruk production in the North Sumatra highlands, Indonesia. Working Document Series 110.

ICRA., 2003. Agricultural Research for Development. Learning materials for 2003 trainees, Wageningen, The Netherlands(Unpublished)

Indo.com corporatre. 2003. Available online at: www.info-indo.com/sumatra/etsumatra.htm. [

Mettrick, H.1993. Development oriented research in Agriculture: An ICRA text book, Wageningen, The Netherlands.

Karo Statistics., 2001. Kabupaten Karo Dalam Angka 2001. Published by Badan Pusat Statistik Kabupaten Karo

Koo, R.C.J., 1985. Citrus. World fertilizer use manual. Available on line at: www.fertiliser/org/ifa/publicat/html/pubman/citrus.htm [accessed on 28 april,2003]

Rogers, E.M, Eveland, J.D. and Bean, A.S.1976., Extending the agricultural extension model. Stanford. Stanford University. Institute of Communication Research.

Scholz, U., 1983. The natural regions of Sumatra and their agricultural production pattern. A regional analysis. Vol. 1. CRIFC.