Technological learning for innovating towards sustainable cultivation practices: The Vietnamese small holder rose sector

- Myrtille Danse MSc. Ba., Dr. Sietze Vellema, Agricultural Economics Research Institute/WUR
- Floor Peeters MSc Ir., Alterra/ WUR
- Nieves Garcia VictoriaMSc Ir., Wageningen UR Glasshouse Horticulture

Tel: 0031-70- 3358245/ 0031-6-48387311
Email: myrtille.danse@wur.nl
Fax: 0031-703358199
The Hague
The Netherlands

About the author(s):
Myrtille Danse is a business administrator specialized in conducting applied research in the field of Sustainable Chain Development and Market Access strategies at the Agricultural Economics Research Institute/ Wageningen University and Research Centre.

Sietze Vellema is a senior scientist and program leader Chains, Innovation and Development. He is involved in policy research at the Agricultural Economics Research Institute and in academic research and teaching at the Technology and Agrarian Development group of Wageningen University and Research Centre.

Floor Peeters is an environmental scientist, involved in research in the field of responsible pesticides use within the agricultural sector, and pesticides registration procedures at Alterra/ Wageningen University and Research Center.

Nieves García Victoria is a biologist involved in applied research on floricultural cultivation and post harvest practices, with emphasis on roses, at the Wageningen University and Research Centre Glasshouse Horticulture.

ABSTRACT

Deregulation policies and globalisation of economic activities altered the views on public involvement in development, and have led to strategies placing private sector development in the centre. An implicit assumption seems to be that these types of linkages will also enhance the technological capacities of smallholder producers by way of cost-efficient technologies trickling down through the value chain or by quality requirements inducing best practices in performance.

The argument put forward in this paper is that sustainable non traditional agricultural chain development requires purposeful actions and institutional transitions, both in the public and private spheres, targeting improved innovative capacities. For the argumentation of the paper empirical findings of a Dutch-Vietnamese partnership on sustainable horticulture development are used. Research has been focused on mapping the institutionalization of technological learning for innovation in the Vietnamese smallholder floriculture sector, specifically with respect to pest and diseases control and sustainable cultivation practices.

Research revealed that the pest and disease control solutions applied by smallholder rose growers are incremental adaptations of experiences obtained in former food crop cultivation practices, while floriculture require drastic adaptation of local cultivation practices to apply the appropriate technological package for this crop. This implies knowledge and skills currently not present in the local context of these farmers. An important hindrance in tailoring this knowledge and skills appears to be the existing weak vertical linkages between flower growers and public and private research and development organizations.

INTRODUCTION

Since 1996 the floriculture sector in Vietnam has grown fast. It is a sector that is expected to be able to make a substantial contribution to an increased rural income, especially for ethnic minorities in cooler higher altitude areas such as the Central Highlands and Northern Mountains (Allbritton, Van Wijk and Quang, 2004). The labor intensive nature of flower production and high returns per hectare make it an interesting commodity to stimulate rural development in these areas and to reduce poverty. So far the flower sector development has been almost exclusively developed throughout private sector involvement, mostly innovative small farmers. Almost all flowers produced are destined for the domestic market. The rose is the most popular variety sold. An estimated 285 million roses are supplied to costumers in Hanoi per year, which generates income for an estimated 12610 people with a gross value of US$25 million (Van Wijk et.al., 2005). The variety of market channels within the domestic markets is growing, partly driven the growing wealth of the local population, and the rise of modern distribution formats (such as supermarkets, hypermarkets, warehouse clubs and convenience stores). This offers a largely uncharted terrain of market opportunities for the sector. Also, new opportunities might be available in neighboring countries. However, the question is if smallholders are ready to meet the requirements of these new market opportunities. A rapid value chain analysis of the rose chain conducted in 2005 revealed findings on deficient cultivation practices (Van Wijk et. Al, 2005). Pesticides use seem to be very high, causing health risks but also threats for the sustainable development of the sector. The initial ambition of the partnership is to facilitate a dialogue on how to enable the exchange of skills and knowledge between growers, shop keepers, florists, extension services and R&D organizations, in order to maximize the potential of both spheres for reducing pesticide use and enhancing the sustainability of the flower sector. For this, it was decided to focus further research within the Dutch-Vietnamese partnership for sustainable horticulture development on an in depth analysis of crop protection practices used in cultivation and post harvest activities, as well as the local institutional framework that enables smallholder growers technical learning.

This paper reports on findings from field research conducted in Me Linh and Sapa in September 2006, and Dalat in February 2007. The aim of this research was to assess the impact of the institutional aspects of technological learning in the Vietnamese floriculture sector on the sustainable development of the sector, especially caused by pest control strategies applied by smallholder growers. An important finding of this research is that the current crop protection practices are incremental adaptations of practices learned through traditional vegetable cultivation, while commercial floriculture cultivation requires incremental innovations of the current technological packages to comply to the crops' special cultivation characteristics (Danse, García and Peeters, 2007a and 2007b). This implies knowledge and skills currently not present among the smallholder growers in Vietnam. For the argumentation of the paper, empirical findings are presented on current pest control practices, the hazard of active ingredients currently used, and the existing enabling environment of learning and innovation on good flower cultivation practices by smallholder flower growers.

Even though a number of local research institutes have initiated the development of research program to build up more advanced knowledge and skills on floriculture practices, these are still limited in scope and outreach, especially since the level of connectivity of flower producers and institutionally remote R&D is very limited. The argument put forward in this paper is that stimulating non traditional agricultural activities is indeed instrumental in arranging market access for smallholder farmers, but that realising pro poor sustainable economic development of smallholder activities within these sectors requires purposeful actions and institutional transitions, both in the public and private spheres, to create institutional arrangements that stimulate learning and acquisition of innovative technological capacities.

MATERIALS AND METHODS

The Dutch- Vietnamese partnership for the sustainable development of the Vietnamese floriculture sector aims to establish a common local agenda for R&D and institutional cooperation in the field of applied research system for the flower sector, linking extension services, the private sector and the Vietnamese education system. The main objective of the field work was to investigate institutional arrangements that enable active participation of smallholders, government agencies and flower companies in enhancing sustainability performance in the Vietnamese flower sector. To facilitate the design process of the agenda, data were collected through value chain analysis and participatory field research. This research was done in the main flower cultivation regions of Vietnam, being MeLinh, Sapa and Dalat. The research was focused on rose growers, since this is by far the most important crop grown in two of the three analyzed regions. Besides that, it is the most popular flower traded at local and international markets.

All the fieldwork activities were done by a multidisciplinary team of Vietnamese and Dutch experts. The scientific areas covered by the team, were business administration, floricultural practices, environmental sciences, pesticide regulation, and agricultural economics. The fieldwork consisted of expert observations through field visits combined with semi structured interviews of a wide range of players including growers, governmental workers, and representatives of the pesticide trade sector. The interviews were mainly focused on questions regarding availability and access to information on cultivation practices and market developments, and pest and disease management. This paper presents the most important findings regarding the effects of current pesticides use, and the existing enabling environment for learning and innovation by small scale flower growers.

To measure the negative effects of current pesticide use, a hazard assessment was done based on the observations and data collected during the field work. For the analysis four different hazard indicators were used: WHO hazard class, leaching potential, terrestrial and aquatic toxicity index. Hazard estimations were made for crop management practices currently applied by growers in the research area. These estimations are based on pesticide parameters solely and do not take into account site specific aspects, such as climate, soil type and application practices. Therefore hazard estimations give a relative ranking of the hazards associated with pesticide use patterns. For the data collection to analyze the enabling environment on learning networks, a variety of participatory research methods were used, amongst others, semi-structured interviews, and Venn diagram.

RESULTS AND DISCUSSION

General description of the research area

The first rose cultivation activities of Vietnam started in the South Eastern region Dalat in the 1980s. Currently, the flower cultivation area in this region occupies 750 ha. Rose was the first product introduced in this area, but in time, other crops have become more important, due to which only 150 ha are used now for rose cultivation. The most important flowers grown now in this area are; chrysanthemum and gladioli, and the cultivation of lily is growing fast, due to its good results in export. Farm size varies greatly in Dalat: there are plantations with a cultivated area ranging from less than 3000 m^2 up to 8 hectares, where sometimes different crops, both flowers and vegetables, are cultivated. The flower sector in this region consists of 7 bigger companies and many small scale farms. Also the bigger companies cultivate flowers still mainly for the local markets, but a growth can be observed of export activities to neighboring countries. Me Linh is the second important rose cultivation area of Vietnam, located near Hanoi. Here rose cultivation started in 1993. In this region the sector is characterized by many small scale growers, using open field cultivation, and the plots are scattered around among vegetable and rice fields.One of the biggest areas in this region is Me Linh Commune with 250 ha of rose cultivation, accounting for 63% of the total area cultivated. Additionally, growers from Me Linh Commune, rent 30 ha. of land for rose cultivation from other communes. In Me Linh commune, 95 % of the households work in rose cultivation. The average area per household is 1.500 m^2. Sapa is the youngest rose cultivation area of the three. This region is located in North West Vietnam, a mountainous area near the Chinese border. Rose cultivation started here in 2000, and occupies now about 55 Ha, consisting of two larger scale rose farms, 6 cooperatives (each with 3-7 growers), and 26 independent rose growers. Also, in this area rose cultivation dominates the sector, but first initiatives have started cultivating orchids and other species.

Pest and disease control practices

An important difference between the rose cultivation practices of smallholder growers in the three regions analyzed, is the use of green houses in Dalat while in Me Linh and Sapa open field cultivation is still common practice. Dalat growers were confronted with this and other disruptive innovations to their cultivation practices after the commencement of Dutch- Vietnamese company "Dalat Hasfarm" in the region in 1995. This farm introduced foreign greenhouse structures and cultivation technologies such as drip irrigation. Part of these cultivation practices have been copied by the smallholder farmers, such as locally built green houses. Nevertheless, the limited access to the knowledge behind the design of these technologies, results currently in a less than optimal use. For instance, smallholder growers prefer the use of sprinkler installations, but none of the respondents seems aware of the possible relationship between this methods used for irrigation and disease incidence. Nevertheless, the cultivation methods used are much more adequate for the crop produced, than the practices used in Me Linh and Sapa.

The growers' identification of insects (thrips, red spider mite) is rather accurate, but not for fungal and bacterial diseases. The presence of diseases not mentioned by growers, such as tumours caused by the bacteria *Pseudomonas tumefaciens* could indicate that either growers do not know them, or that they are not aware of the severity of the diseases. Plant nutrient deficiencies are confused with diseases, which leads to the unnecessary use of pesticides instead of improved fertilization. Non curable diseases are also tried to be beaten by means of chemicals, while mechanical removal of affected plants is the only efficient pest control method

The pesticide residue on the leaves are tell-tale signs of the quantity of pesticides used, but also of the way pesticides have been applied: wrong size of the drops, broken or obdurate nozzles, no use of dispersion agents, wrong moment of application. All these practices do not only lead to higher than necessary production costs but also contributes to the development of pest resistance, affects plant health, but implies also a threat for human health. This treat is even bigger due to the risky practices farmers use applying pesticides without the appropriate protective devices, and storing chemical products and their spraying equipment inside or near the house without considering the appropriate safety instructions (Danse, García and Peeters, 2007 a and 2007b) .

Hazard of pesticides use

Growers in the three areas depend on pesticides provided by local pesticides shops. In the case of Sapa, most pesticides are still bought at the shops in Me Linh, due to the absence of a good local pesticides shop service in the own region. In each of the regions small groups of growers and representatives of the pesticides shops were interviewed. Based on these interviews an inventory was made of the most common used pesticides, their active ingredient (AI) and the frequency of use. These data were compared with the already mentioned indicators. Table 1 presents the classification of moderate to highly hazardous AI for each environmental indicator.

1. Hazard to human health

The WHO classification by hazard is used to set out a classification to distinguish between the more and less hazardous forms of selected pesticides based on the acute risk to human health (that is the risk of single or multiple exposures over a relatively short period of time). It is based on the acute toxicity of the chemical compound and on its formulationTherefore, allowance margins are defined, where solids are considered less hazardous as compared to liquids. The classification is primarily based on the acute oral and dermal toxicity to the rat. Provision is made for the classification of a particular compound to be adjusted if, for any reason, the acute hazard to man differs from that indicated by the LD_{50} assessments alone (WHO, 2004).

Of the pesticides used by the Vietnamese flower growers, the active ingredients methomyl and mehtidathion are ranked as highly hazardous for human health. As presented in table 1a and 1b, the active ingredients used that are highly toxic for human health are: diazinone, esfenfalarate, propiconazole, profenofos and cypermethrin are ranked as moderately hazardous. In Me Linh Commune also imidacloprid is used which is ranked as moderately hazardous.

The use of the appropriate personal protective devices as well as the safe handling and use of these products would help growers and other people in the direct surroundings of the rose fields to protect themselves for health problems. This is not common practices currently. Safe use training with special attention for these pesticides is a highly recommended and should not limit itself to new product introduction, but focused on the current products used and their related risks. Also the introduction of adequate personal protective devices should be stimulated actively both by the private sector (especially pesticides producing companies) and public entities (Ministry of Health, Ministry of Agriculture, Extension Offices among others).

2. Hazards to aquatic life

The *Aquatic Toxicity Index* (ATI) is used to classify the pesticides according to their acute hazard to aquatic life. Dissipation rate in water is not taken into account. Narrative descriptions of toxicity were assigned based on the LC_{50} of the most sensitive standard species (fish, daphnia or algae) according to the guidelines in M. A. Kamrin (1997). These criteria are also used by the Pesticide Action Network (PAN) and are similar with the criteria descript in the Manual for summarizing and evaluating the environmental aspects of pesticides (RIVM, report no. 679101022). The hazard assessment relates high hazards to high toxic compounds. It does not take into account the dissipation rate of the compound. Highly toxic compounds with high dissipation rate can pose a lower risk to aquatic life than persistent compounds with lower toxicity.

The risk of judging pesticides on the basis of toxicity only is that growers are stimulated to use compounds with lower toxicity that could persist in the environment for a long time and pose risks to downstream areas. Whether high toxicity results in a real risk to aquatic life in the analysed area depends on the quantities applied, the presence and distance to surface water bodies, the vulnerability of the ecosystem, etc. These factors were not taken into account for this research. Therefore this assessment can only be used to decide whether follow-up risk assessments are required and for which situations (formulations, physical conditions). Real risks are expected in situations were highly hazardous compounds are used in areas near valuable surface water bodies. A surface water body can be valuable from an ecological point of view or because the water is used for domestic purposes.

At least 50% of the pesticides being used in the three regions pose a very high hazard for aquatic life. Table 1a and 1b present the list of highly toxic pesticides for aquatic life already identified during the fieldwork. In the case of Me Linh, mancozeb requires special attention since here 26.8 kg of the average 28.6 kg of AI used by small scale rose farmers per hectare per year is mancozeb! Also the AI imidacloprid and propiconazole require special attention since these substances are persistent in water!

3. Hazard to terrestrial life

The *Terrestrial Toxicity Index* (TTI) is used to classify the pesticides according to their acute hazard to terrestrial life. Dissipation rate in soil is not taken into account. Narrative descriptions of toxicity were assigned based on the LC_{50} of the earthworms. Toxicity values of terrestrial plants and soil micro-organisms are not taken into account. The criteria are according to the Manual for summarizing and evaluating the environmental aspects of pesticides (RIVM, report no. 679101022). The assessment ranks pesticides according to toxicity to terrestrial life (with earthworms as its representative). The hazard assessment relates high hazards to high toxic compounds. It does not take into account the dissipation rate of the compound. Highly toxic compounds with high dissipation rate can pose a lower risk to terrestrial life than persistent compounds with lower toxicity. The risk of judging pesticides on the basis of toxicity only is that growers are stimulated to use compounds with lower toxicity. Whether high toxicity will result in a real risk to terrestrial life in the research area depends on the quantities applied, the presence and distance to surface water bodies, the vulnerability of the ecosystem, etc. These factors are not taken into account in this research. Therefore this assessment can only be used to decide whether follow-up risk assessments are required and for which situations (formulations, physical conditions). Real risks are expected in situations were highly hazardous compounds are used in areas near important surface water bodies.

Table 1a and 1b present the active ingredients used in the three regions and their ranking regarding hazard to terrestrial life. For the Vietnamese flower sector further risk assessments should be done on formulations containing abamectine, imidacloprid, and propiconazole applied to roses. Special attention is needed for the active ingredients imidacloprid and abamectine since these substances are persistent in soil (DT_{50} > 90 d)! There is a potential risk for the terrestrial ecosystem and therefore further risk assessment taking specific site aspects, such as climate, soil type and application practices into account is recommended.

4. Hazard to groundwater

The *GUS or Groundwater Ubiquity Score* (Wauchope et al., 1992) is used to rank pesticides for their potential risk to move towards groundwater. GUS is an empirically derived value that relates pesticide persistence (half-life) and absorption in soil (sorption coefficient, K_{oc}). The GUS index is calculated as follows

$$GUS = \log\ (DT_{50})\ x\ [4 - \log (K_{oc})]$$

The assessment of hazard to groundwater takes into account mobility and dissipation in soil, but not toxicity. Therefore low mobile compounds with quick dissipation rates will rank lower than high mobile compounds with slow dissipation rates. It provides an indication whether the compound is likely to reach groundwater before it is degraded. Whether it is a risk to groundwater depends on the toxicity of the compound and the use of the groundwater. Therefore, also for this assessment, the presence of real risks is only expected if toxic compounds with high hazard indication are used in vulnerable scenarios. Areas with (a combination of) low groundwater tables, high rainfall, sandy soils with low organic matter are vulnerable to pesticide leaching.

Table 1a and 1 b present the active ingredients identified through the fieldwork. For the Vietnamese flower sector, formulations containing methomyl and imidacloprid require special attention. Since these AI pose a potential health risk through groundwater consumption, further assessment of the risks of leaching of pesticides to groundwater is recommended.

Enabling environment for technological learning on good cultivation practices

The question raised is how, in an era of deregulated agricultural research, independent smallholder flower producers can access knowledge and skills, which may contribute to complex problems in controlling pests and diseases. The analysis of the current institutional framework that relates to the rose sector, allows to identify different levels of information flows on cultivation practices in general and pest and disease control methods specifically (Vellema and Danse, 2007). It appears that each level manages a different type and quality of information, and the availability and access of smallholder farmers to it is very limited. Semi structured interviews and the participatory drawing of Venn diagrams with smallholders, public officers of local authorities, representatives of pesticides producing companies and representatives of development cooperation agencies, resulted in the identification of three levels of institutional linkages and flows of information regarding pest control practices. These are; 1. planning, research and development, 2. identification and prevention/ control of pests and diseases, and 3. control of pesticides use and new pesticide product introduction.

1. Planning, research and development for the agricultural sector.

Figure 1 shows the structure of the scientific and political level of information exchange regarding planning and the development of the sector. The Ministry of Agriculture and Development (MARD) is responsible for the design and budgeting of annual policy plans regarding activities to be developed for the agricultural sector. The different supportive institutes such as research institutes and the Plant Protection Department (PPD) present annually their project proposals. Based on these proposals, MARD decides which projects will receive funding. In 2005 MARD defined a 5 year policy plan, focused on the sustainable development of the agricultural sector. As part of the program it stimulates the development of new initiatives, provides financial support for the development of new knowledge and technology and searches for new partnerships.

At this institutional level information on cultivation practices is exchanged between the Ministry of Agriculture and Development, Research Institutes, the PPD at state and provincial level, the Plant Protection Research Institute, and the District People Committee. Regarding pesticides control, MARD publishes every March the list of state approved products, which indicates the crop the product should be used for. Every September an additional list is published with products that have been added to the list during the year. The Plant Protection Research Institute conducts research projects throughout the country. Most research has been done on improving cultivation practices for important commodities guaranteeing food safety, such as rice, vegetables, fruit, but also industrial crops such as soy bean, coffee, tea, pepper and sugar cane.

Flowers are new crops in the region and for this its still very limitedly considered in research and education programs of agricultural research institutes. Regarding research institutes and their relation with the rose sector, the Agricultural University of Hanoi and the Agriculture and Genetic Center were mentioned by some respondents. Sometimes also farmers are involved in learning about field research through small field visits. In Dalat some research centers develop trials on local plant breeding and alternative irrigation systems, but the results of these projects are hardly shared with smallholders in the region.

2. Identification, prevention and control of pests and diseases

Figure 2 shows the institutional linkages and information exchange on pests and diseases control. Regarding the relation between pesticides use and agricultural activities, one could state that the mandate of the PPRI is to find solutions for problems caused by pests and diseases. The knowledge collected is especially shared with MARD. Besides that, the PPRI has also made protocols and developed training programs to guide extension officers and (mainly) vegetables farmers on pesticides use. Though, hygiene and disease prevention are not very important subjects in these programs. Besides that, these programs do not apply and are not offered to flower growers.

The role of the Plant Protection Department on the other hand is more focused on the management and control of activities related to the presence of pest and diseases. This identification is done by the extension officer. This officer has mainly experience with fruit and vegetable cultivation. Once a week local authorities broadcasts his information on the appearance of pest and diseases and recommended pesticides by provincial television and radio. In case of a pest and disease emergency situation, the communication is faster and more direct. Then extension officers visit the farmers directly and inform them on the advised actions to be taken.

3. Information flows on the use of legally approved pesticides and new product introduction

Figure 3 shows the institutional linkages and information flows related to the legal control on pesticides use and the introduction of new pesticides in rose production areas. In this case, PPD at state level together with MARD defines annually the list of approved pesticides. This information is accessible to all relevant stakeholders, including the local pesticide shops. Besides that PPD at district level organizes periodically training activities for the shop owners. Once or twice a year the owners of the local pesticide shops might expect a surprise visit by PPD officials at district level to check the legal status of the products sold. The pesticides shop owners receive a certificate to operate for a three year period based on the results of the shop inspection and their satisfying participation in the training. The shop owners have to participate in an annual refreshment course, based on which they receive an annual renewal of the certificate.

Regarding the introduction of new pesticides, the PPD at district level, local authorities, and representatives of pesticides producing companies together organize meetings for growers. In most cases these are products developed and registered for vegetable cultivation, but flower growers use them anyway for their crop, interpreting its use based on the pest or disease the products was developed for. This practice results in the use of unsuitable pesticides, which can cause quality and production problems, contributing to pest resistance. Pest resistance is one of the reasons why growers indicate to use currently 1,5 to 2 times more pesticides than 5 years ago (Danse, García and Peeters, 2007a and 2007b). These meetings take place in the production region. During the meeting the representative explains the characteristics of the new product introduced, its application guidelines, and the instructions for safe use. After this, growers in Me Linh and Dalat are sometimes visited by the company’s representative after the new product has been introduced to evaluate its results. In Sapa this is not the case, because the experiments are mostly done near to Hanoi. Additionally to these meetings, the PPD sometimes organizes meetings themselves to inform farmers about some agricultural practices, such as the safe use of pesticides. Rose growers consider these activities hardly informative, since they are general and focus more on food crops produced in the region.

4. Informal network to access information for technological learning

Some growers and authorities in Me Linh indicated the existence of research activities by the Agricultural University of Hanoi, the Agriculture and Genetics Institute and the Potato, Vegetable and Flower Institute in Dalat. However, the growers interviewed responded that research findings are not shared with them. The officials of the extension office and the representative of the PPD office informed that reports are made, but it did not become clear if these reports were shared with the local stakeholders. There were no indications found of the existence of an active role by researchers to share the results of their research and possible suggestions for improvements directly to the growers. It could be that these results are shared at a higher institutional level, and that the suggestions for changes become available to the growers in a more practical way through the visits and meetings organized by the extension officers. Most of the growers confirmed having frequently contact with the extension officer. However, the information shared between them is mainly limited to the identification or forecast of pest and diseases and suggestions on the required use of pesticides. This linkage could be very effective to introduce information on more sustainable cultivation practices.

The findings in this research show that smallholder flower growers use peer-to-peer learning and contact with traders as the most important ones to acquire knowledge and new skills. the traders share information regarding market trends. In various occasions sellers and buyers were asked if pesticides use and residue were considered to be selection criteria. In the case of the Northern area, just one representative of a cooperative in Sapa related pesticides use with flower quality, and indicated to be careful applying products shortly before the harvest. In the case of Dalat, different growers indicated to receive sometimes complaints about white residue on the leaves. These complaints originate mainly from higher quality market segments such as exclusive flower shops. It could be expected that pesticides residue will influence consumer willingness to buy certain flowers, which could motivate growers to search for adjustment in their cultivation practices.

With regard to peer-to-peer learning, growers in Me Linh and Dalat learn from growers in their direct surrounding, while the ones in Sapa learn from growers in Me Linh. Both in Dalat and Sapa, smallholders have the opportunity to learn from bigger scale farmers, that have the intention to produce for export markets. This practice has hardly been developed yet in Sapa, while Hass farm has been the initiator of leap frog innovations in local flower cultivation practices. Smallholders learned through observation about the construction and use of green house. They obtain the information about modern cultivation practices by talking to Hass farm employees, or they receive advice from former employees whom have become independent advisors. However, the lack of local institutional capacity to support the embedding process of these innovative cultivation practices by smallholder growers, shows its negative impact. There is a lack of exchange on the knowledge that is behind these new practices introduced. Due to this, technological learning has been limited to the existing level of understanding of the growers, which has caused less than optimal use of the practices put in place.

Recently development cooperation programs have started to stimulate the integration of supply chains through the introduction of out grower schemes. These schemes allow smallholder growers to establish trade relations with the big scale growers. In this way, the first ones share their production capacity and cheap labor, while the last ones provide professional knowledge on good cultivation practices and access to more attractive market segments. Nevertheless, the establishment of these new vertical linkages have only been developed due to the intervention of external public entities.

CONCLUSIONS

This research revealed that the pest and diseases control solutions applied by smallholder rose producers in Vietnam are incremental adaptation of experiences obtained in former food crop cultivation practices or learned during seasonal employment at larger commercial farms. Floriculture requires more drastic innovations of the locally known cultivation practices to become environmentally benign, to ensure occupational health of producers and workers, and to enable growers to access new market segments. The research indicates that technological learning mainly by peer-to-peer learning leads to incremental innovations and trial and error practice that seems to be insufficient to cope with natural variability and the hidden mechanisms of bacterial and fungal diseases. For this there is an urge for the acquisition of knowledge and skills currently not available in the local context of floricultural production.

However, even though these knowledge and skills would be available, an important hindrance in tailoring knowledge and skills to the conditions of small scale rose producers appear to be the weak vertical linkages between flower growers and public and private research and development organizations. Also, the current fixation on seed related technological trajectories and the generic nature of information on pest control strategies that can be observed in Vietnamese agricultural research may even jeopardize the processes of technological learning because there is no defined demand for the proposed technological recipes. This suggests that the introduction of new technological solutions can better be combined with institutional interventions promoting an iterative process between technology suppliers and users. Exploring the role of the private sector, which may opt for an economic interest in meeting the demand for technological solutions in the low-income market composed by rose producers, may be worthwhile.

However, the experiences in Dalat is a clear example of the fact that these linkages do not develop automatically. There should be a clear economic objective before big scale growers become interested in sharing their experiences and market linkages. Also, commercial business development services do not develop naturally based on market principles in the case of the development of non traditional horticulture activities. This since the absence of specific knowledge and experience of smallholder farmers with the newly introduced crop, influence their perception on demand for business services on specific practices and technologies (Danse & Vellema, 2007).

Nevertheless, the development of the floriculture sector in the Dalat region demonstrates that the introduction of process and product innovation through private sector development, can lead to a leap frog innovation of locally used cultivation practices. It can be expected that the impact of the enabling environment, e.g. public research institutes, on the performance and technological capacities of downstream actors in value chains, will improve when resources and opportunities are provided for interactions governing the innovation processes public and private actors are involved in. Eventually, this may lead to joint agenda setting and priority selection in technological innovation. On the long term this could lead to the institutionalisation of feed back mechanisms between micro and meso levels which will improve the capacity of the public and private R&D infrastructure in supplying a choice of technological solutions, to be used and adapted by value chain actors, linking short term actions, offering real solutions to day-today challenges in market environments and value chains, with institutional settings involved in open-ended experimentation and long-term searches for technological innovation.

Allbritton, A., van Wijk, M.S. and Dang V. Q. 2004. *Quantitative assessment of the impact of the rise of the rose sector on poverty in North Vietnam*. Pro Poor Horticulture project report no. PR-V-05, 2004. Published on: http://www.growoutofpoverty.nl/

Dang, V. Q., Maarten Siebe van Wijk, Pham Tien Dung, Vu Thi Thao, Pham Thi Mai Huong, Le Thi Thanh Phuong and Amanda Allbritton. 2005. *Qualitative assessment of the impact of the rose sector on poverty in North Vietnam: the case of Me Linh District*. Pro Poor Horticulture project report no. PR-V-04, 2005. Published on: http://www.growoutofpoverty.nl/

Dang Viet Quang, Pham Thi Mai Huong, Le Thi Thanh Phuong, Nguyen Phuong Lan, Maarten Siebe van Wijk and Amanda Allbritton. 2005. *Qualitative assessment of the impact of the rose sector on poverty in North Vietnam: the case of Sapa District*. Pro Poor Horticulture project report no. PR-V-03. Published on: http://www.growoutofpoverty.nl

Danse, M.G., García, N., and F. Peeters, (2007a), Report on Fieldwork for 'Sustainable Flowers in Vietnam': Me Linh and Sapa, 18 September- 2 October 2006, internal report LEI, Project code 4043400
.
Danse, M.G., García, N., and F. Peeters, (2007b), Report on Fieldwork for 'Sustainable Flowers in Vietnam' Part Two: Dalat, 26 February- 3 March 2007, internal report LEI, Project code 4043400

Danse, M.G. and S. Vellema (2007), "Small scale farmer access: to international agro-food chains: a BoP based refelection on the need of social embedded innovation in the coffee and flower sector", IN: An explanatory journey towards the research and practice of the "Base of the Pyramid", Greener Management International, Issue 51, June 2007.

Kamrin, M.A. (1997), *Pesticide Profiles: Toxicity, Environmental Impact, and Fate,* Lewis Publishers Boca Raton, p. 8

RIVM, 679101022.

Scott, S, F. Miller and K. Lloyd, *Doing Fieldwork in development geography: research culture and development and research spaces in Vietnam*, Geographical Research, march 2006, 44 (1): 28-40, 2005.

Van Wijk, M.S., Allbritton, A. and Dang, V.Q.. 2005. *The economic development impact of rose value chains in North Vietnam.* In proceedings of the: Making Markets Work Better for the Poor conference, 31/10-4/11/2005, Hanoi, Vietnam. Asian Development Bank.

Vellema, S. and M.G. Danse (2007), "innovation and development: institutional perspectives on technological change in agri-food chains", Policy paper #2 of the DGIS funded programme: Markets, trade and sustainable rural development, March 2007, Wageningen University, The Netherlands.

WHO (2004), *De WHO recommended classification of pesticides by hazard and guidelines to classification*. WHO. 56 p. ISBN 92 4 154663 8, 2005.

Zhang, X and J. van Meggelen, *Institutional mapping and capacity assessment of agricultural health and food safety institutions in Vietnam*, internal LEI publication, 2005.

List of tables and figures

Table 1a. Active Ingredients, formulations and potential high hazard of pesticides used in the flower sector of Me Linh and Sapa

AI	Class	Formulations
Potential high hazard to humans (using WHO Classification)		
Methomyl	High	Lanate 40 SP
Cypermethrin	Moderate	Sec Saigon 50 EC Visher 25 ND
Propiconazole	Moderate	Bumper 250 EC Tilt 250 EC
Imidacloprid	Moderate	Mire tox 10 WP
Diazinon	Moderate	Bazudin
Potential high hazard to aquatic life (using ATI)		
Diazinon	Very highly toxic	Bazudin
Cypermethrin	Very highly toxic	Sec Saigon 50 EC Visher 25 ND
Imidacloprid	Very highly toxic, persistence in water	Mire tox 10 WP
Mancozeb	Very highly toxic	Mancozeb 80 WP Forthane 80 WP
Methomyl	Very highly toxic	Lanate 40 SP
Propiconazole	Very highly toxic, persistence in water	Bumper 250 EC Tilt 250 EC
Propineb	Very highly toxic	Antracol
Potential high hazard to terrestrial life (using TTI)		
Abamectine	Highly toxic	Tap ky 1.8 EC
Imidacloprid	Highly toxic	Mire tox 10 WP
Propiconazole	Highly toxic	Bumper 250 EC Tilt 250 EC
Potential high hazard to groundwater (using GUS index)		
Imidacloprid	High	Mire tox 10 WP
Methomyl	Moderate	Lanate 40 SP

Table 1b. *Active Ingredients, formulations and potential high hazard of pesticides used by rose growers in the Dalat region.*

Formulation / pesticide	*Active ingredients*	*Potential hazard according to WHO*	*Potential hazard to aquatic life*	*Potential hazard to groundwater*	*Potential hazard to soil (persistence)*
Lannate	methomyl	High	Very highly toxic	high	
Supracide	methidathion	High	Very highly toxic		
Tilt super	Propiconazole	Moderate	Very highly toxic	Moderate	Very persistent
Polytrin	cypermethrin, propenofos	Moderate	Very highly toxic		persistent
Map cypermethrin	Cypermethrin	moderate	Very highly toxic		persistent
Selecron	profenofos	Moderate	Very highly toxic		
Polytrin	Profenofos	Moderate	Very highly toxic		
Sumi alpha	esfenvalerate	Moderate	Very highly toxic		
Melody duo	Propineb		Very highly toxic		
Antracol	Propineb		Very highly toxic		
Ridomild	Mancozeb		Very highly toxic		
Mancozeb	Mancozeb		Very highly toxic		
Dithane	Mancozeb		Very highly toxic		
Nissorum	Hexythiazox		Very highly toxic		
Sirpon	Halfenprox		Very highly toxic		
Vetimec	Abamectin		Very highly toxic		
Plutel	Abamectine		Very highly toxic		
Long C.A	Abamectine		Very highly toxic		
chinese pesticide	abamectine		Very highly toxic		
Kenthane	Dicofol		Very highly toxic		persistent
Match	lufenuron		Very highly toxic		persistent
Super Tilt	Difenoconazole				Persistent
Anvil	Hexaconazole			Moderate	Persistent
Rovral	iprodione			Moderate	persistent
Melody duo	iprovalicarb			Moderate	
Neem-nim green	azadirachtin			Very high	

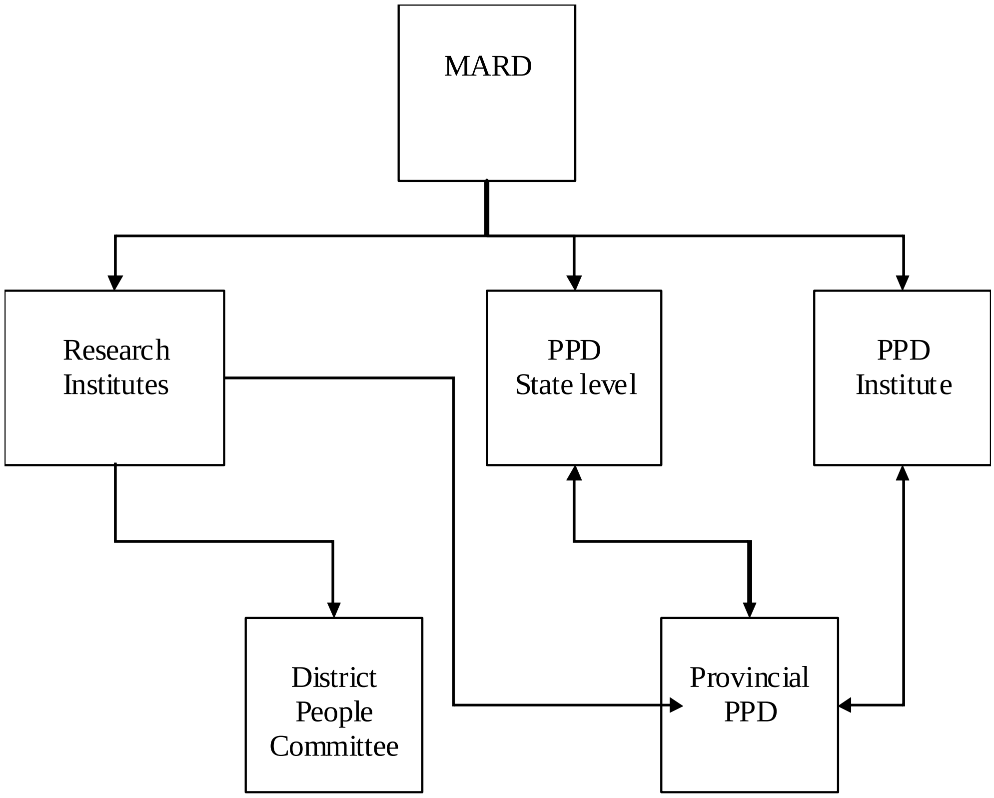


Figure 1: Institutional linkages and information exchange on planning, research and development of cultivation practices

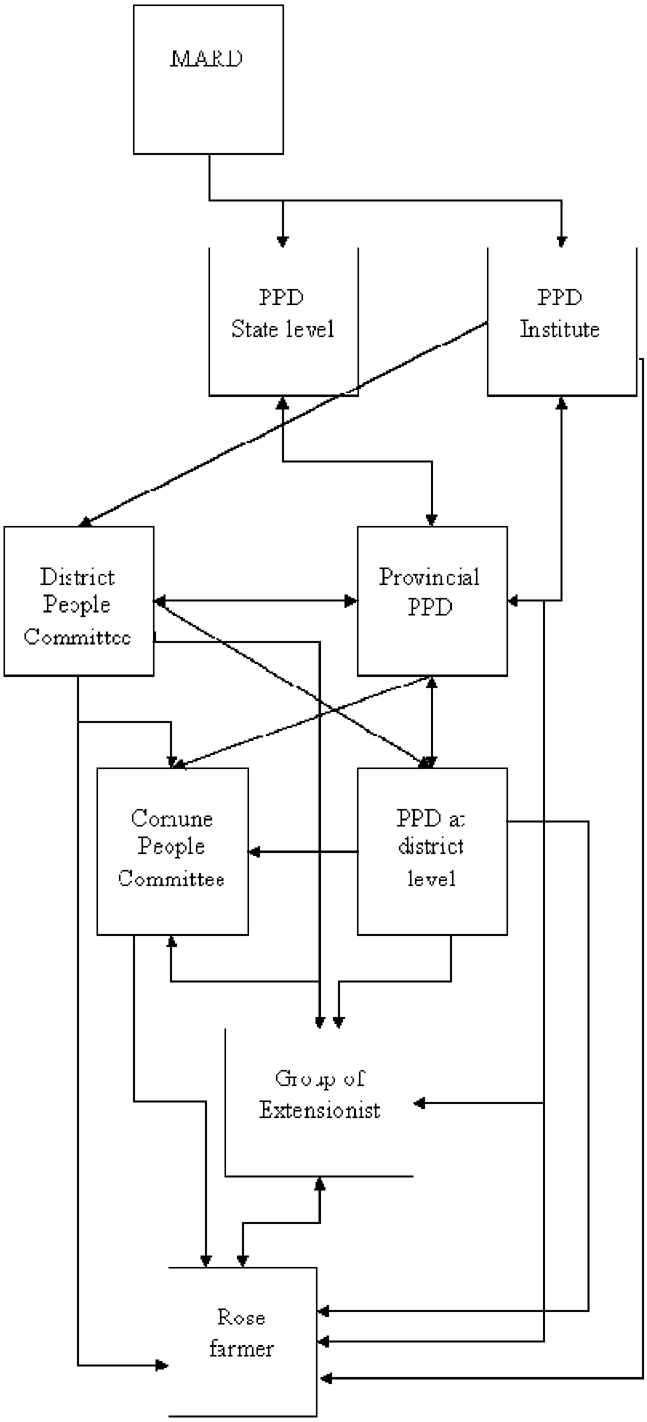
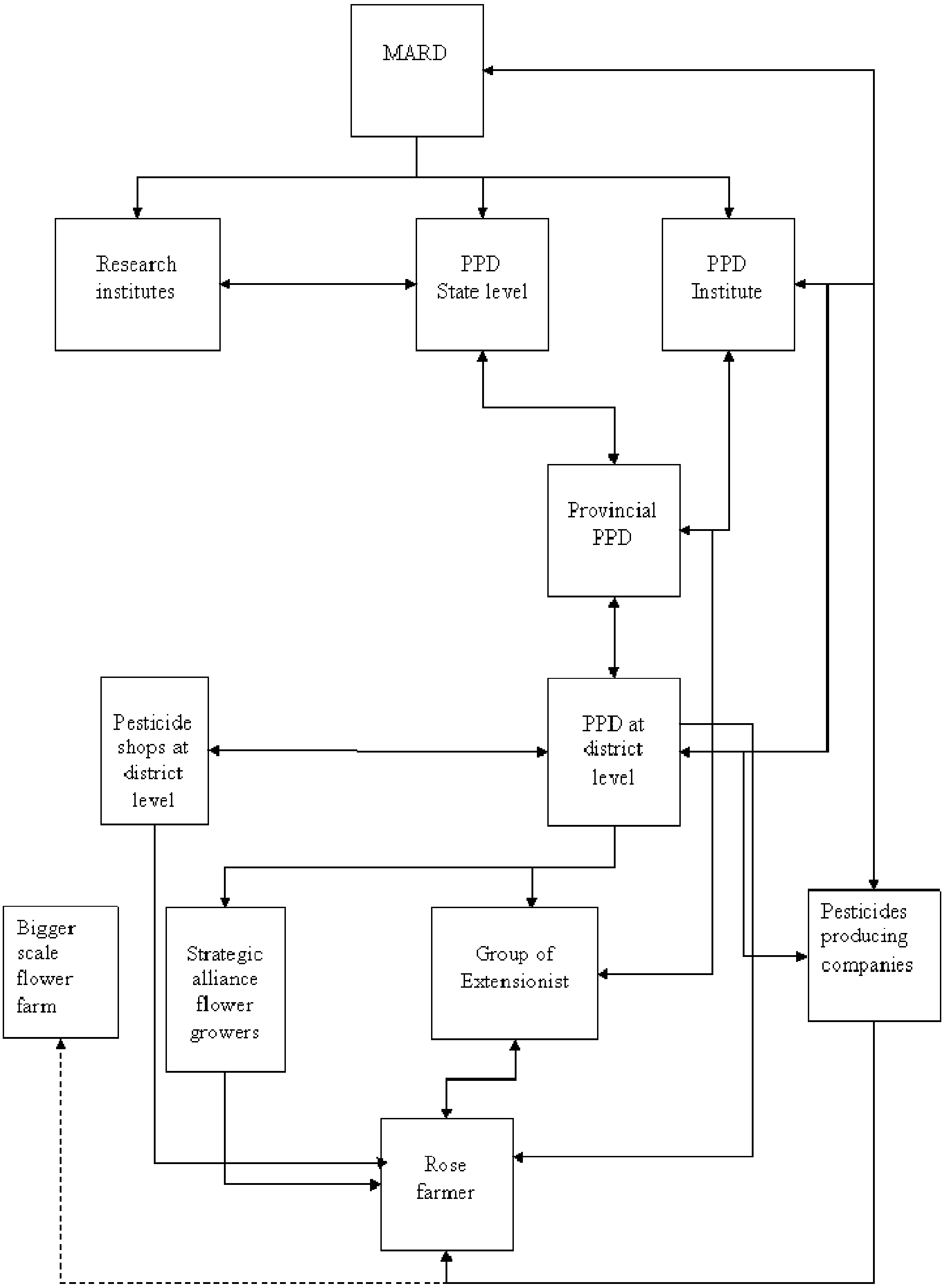


Figure 2: Institutional linkages and information exchange on the identification, prevention and control of pests and diseases



(dotted line only applies to Dalat)

Figure 3: Institutional linkages and information exchange on pesticides registration, and new pesticides introduction.