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Report on Fieldwork for 'Sustainable Flowers in Vietnam', Part Two, Dalat 26 February- 3 March 2007

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Summary

This report describes the results of fieldwork done by Dutch and Vietnamese experts on the Vietnamese rose sector specifically in the Da Lat region. This field work was done during the period February 26- March 3, 2007. The main objective of the field work was to complete the investigation on institutional arrangements that enable active participation of rose farmers, government agencies and flower companies in enhancing sustainability performance in the Vietnamese flower sector. This report complements the report on fieldwork done for the rose sector in the Me Linh and Sapa regions (Danse et al., 2007). Hands on insights in the current field practices in the Vietnamese flower sector and policy oriented awareness activities pesticide regulation is used to complement the investigation.

In Vietnam the poverty as a whole has declined in the last decade. However, the rate of decline and incidence of poverty varies greatly across regions. The largest difference is between rural and urban areas. Poverty also has a clear spatial and ethnic dimension, with the Central Highlands and the Northern Mountains having poverty incidence rates that are twice as high as the national figure. These differences provide a large incidence for rural households to migrate to urban areas. This results in high urbanization growth rates. To turn the tide, increasing agriculture income for the 62 million people living in rural areas, is a key priority to the Vietnamese government. The Vietnamese Ministry of Agriculture and Rural Development (MARD) has designed a number of development programs in order to improve the sustainability of the agricultural sector. These programs stimulate agriculture research on technology development and extension work for the poor, crop diversification, export commodity development programs and stimulating market structures and trade promotion programs. For this, one of the specific aims is to decrease pesticide use with 20%, as pesticide use is seen as one of the biggest threats to health, environment and export possibilities.

The Vietnamese floriculture sector is growing fast and is expected to make a substantial contribution to an increase of income for the rural population in specific regions, including farmers in cooler higher altitude areas such as the Central Highlands and Northern Mountains. So far the flower sector development has been almost exclusively developed throughout private sector involvement, mostly innovative small farmers. Almost all flower production is destined for the domestic market (van Wijk et al., 2005; Allbritton et al., 2005).

The fieldwork shows that flower producers seem to experiment with different flower varieties and chemical input applications, and these experiments are mostly based on trial and error. Regarding learning for innovation, the producers obtain information about new technological and cultivation practices from a variety of actors. The most important source is neighbouring farmers or rose farmers in other regions, and shopkeepers selling pesticides. In some cases, also information is obtained from local officials at the plant protection department (PPD). This organisation also issues certificates to the pesticide shop owners, and control regularly their performance by surprise inspections. Representatives of

pest control producing companies introduce new products developed in other regions of the world and inform the producers through meetings on the adequate use of these products. At the level of regulation, the Vietnamese government is responsible for tasks such as regulation on the use of pesticides, regulation on the production of pesticides, labelling of products (pesticides), and registration of pesticides. Nevertheless, participatory fieldwork revealed that the solutions applied by these small rose producers to solve pest and disease problems were mostly aggregated solutions from earlier experiences with food crop production. Parts of these practices are not considered to be accurate for flower cultivation.

Technological innovation comes down to adequate selection and adaptation of existing technological packages. The weak vertical linkages of flower producers with public and private research and development organizations can be considered a hindrance in tailoring more disruptive innovation of cultivation practices and the technology solutions used to reach environmentally friendly production methods that apply to the specific conditions in flower producing regions. As with regards to the Vietnamese rose sector, distribution, certification and registration of pesticides importantly constitute vertical interactions between flower producers and other actors. However, at the level of technological innovation, problem solving and incremental technological changes, establishing sustainability in the Vietnamese floricultural sector may benefit from inputs in the sphere of promoting interactions and feed back between flower producers and knowledge generation in public research institutes as well as in private research laboratories. For example, the creation of a diagnose service in the production areas can help the producers in the determination of new, unknown or less commonly occurring diseases and to choose the right fighting method: physical control (plant removal), chemical control, instead of recurring to the trial and error method. For this reason, the introduction of technological innovation in the rose cultivation practices in this case will have to be accompanied by adjustments in the institutional framework, for the producers to be able to establish (stronger) linkages with flower experts so they will obtain new knowledge that will not be found using the current learning practices.

In this report results are presented on the current cultivation and plant health practices used in the Da Lat region as well as the environmental and human health impact of rose cultivation (Chapter 5) the current pest control mechanism applied (Chapter 6). Due to the focus on sustainable development, a brief description is presented on the current market trends and constraints (Chapter 7). In order to be able to respond in an effective way to these market trends, learning processes and innovation are of utmost importance. For this, information is presented on the current practices used by small farmers to collect information, build knowledge and enter into a sharing and learning processes (Chapter 8). Based on these results, the report concludes with a number of key observations and recommendations to be considered in order to help the sector to improve its sustainable development.

1. Introduction

Although poverty as a whole has declined in Vietnam in the last decade, the rate of decline and incidence of poverty varies greatly across regions. The largest difference is between rural and urban areas. Poverty also has a clear spatial and ethnic dimension, with the Central Highlands and the Northern Mountains having poverty incidence rates that are twice as high as the national figure. These differences provide a large incidence for rural households to migrate to urban areas. This results in high urbanization growth rates. To turn the tide, increasing agriculture income for the 62 million people living in rural areas, is a key priority to the Vietnamese government.

To achieve the goal of decreasing rural poverty through increasing agricultural income, being a strategy linked to the Millennium Development Goals, 13 programs are designed in the strategic five year plan (2006-2010) of the Vietnamese Ministry of Agriculture and Rural Development (MARD). The most important programs are focused on agriculture research on technology development and extension work for the poor, crop diversification, export commodity development programs and stimulating market structures and trade promotion programs. One of the mayor goals of the program is to improve the sustainability of the agricultural sector. For this, one of the specific aims is to decrease pesticide use with 20%, as pesticide use is seen as one of the biggest threats to health, environment and export possibilities.

The Vietnamese floriculture sector is growing fast and is expected to be able to make a substantial contribution to an increase of income for the rural population, especially for ethnic minorities in cooler higher altitude areas such as the Central Highlands and Northern Mountains. 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 flower production is destined for the domestic market. 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 (Quang, D., 2005). The emergence of a variety of market channels in Vietnam, partly driven by the rise of modern distribution formats (such as supermarkets, hypermarkets, warehouse clubs and convenience stores) offer a largely uncharted terrain for the sector. Also, new opportunities might be available in nearby Asian markets.

This report describes the fieldwork done in the rose sector of the Da Lat region. This fieldwork was done by Dutch and Vietnamese experts in the period of February 29- March 3, 2007. This report complements the report on the fieldwork done for the Me Linh region and Sapa region in the period September 18- October 2, 2006. Chapter 2, 3 and 4 describe the problem definition, research objective and research limitations of the fieldwork. In chapter 5 and 6 together information is presented regarding the first research objective.

Chapter 5 focuses on the description of the current cultivation methods applied and plant health situation in Da Lat. This chapter also describes the environmental and human health impact of the rose cultivation. Chapter 6 describes the current pesticide control mechanisms used. Chapter 7 shares information on market access and market constraints. After this, Chapter 8 describes the results on the second research objective. In this chapter information is presented on practices used to collect information, knowledge building and learning on sustainable rose production. The report is finished with the presentation of observations and recommendations in Chapter 9.

2. Problem definition

The first analysis made on the development of the floriculture sector being part of the ProPoor program (project report PR-V03), indicated a possible negative effect of pesticides use on the sustainable development of the sector.

Incidence of pesticides use seems to be very high in the sector, causing a negative effect on the environment, the health of the growers and the surrounding community, and also the economic performance of the rose farms (Quang et al., 2005). The dominant attitude seems to be that more pesticides can be used in flower cultivation than fruit and vegetable production, since flowers are not consumed by people.

A risk of these practices is the accumulation of pesticides in surface and groundwater, which in many areas is the main drinking water source. Moreover, many farmers raise and consume fish in surface water. Also, farmers seem to have a lack of knowledge on safe application methods, which might result in health problems. Finally, inefficient pesticides use might result more elevated production costs than necessary and a possible negative impact on the quality of the final produce offered to the market. However, little research and extension is done on analyzing current rose cultivation practices in Vietnam and the opportunities to develop more sustainable production methods (Van Wijck et al., 2005). Farmers seem to experiment with different flower varieties and chemical input applications, and these experiments are mostly based on trial and error.

In 2006, Wageningen University from The Netherlands, Fresh Studio Innovations Asia from Vietnam and The Vietnamese Agricultural Ministry (MARD) initiated an explorative research, to investigate and build institutional arrangements that enable the active participation of rose growers, government agencies and flower companies in enhancing sustainable performance in the Vietnamese flower sector.

As part of this initiative, fieldwork was done during the period September 16 and October 2, 2006 in Me Linh and Sapa and from February 26-March 3 in Da Lat. The aim of this field work was to obtain more specific data on the current pesticide use in small scale farmers rose cultivation and its implication on the sustainable development of the sector.

3. Research objective

The main objective of the field work was to investigate institutional arrangements that enable active participation of rose farmers, government agencies and flower companies in enhancing sustainability performance in the Vietnamese flower sector. Hands on insights in the current field practices in the Vietnamese flower sector and policy oriented awareness activities pesticide regulation, is used to complement the investigation.

3.1 Research questions

The two research questions of the field work were:

1. what rose cultivating practices do Vietnamese rose farmers use currently, and what are the technical aspects of pest and disease management and effects of pesticide use on product quality, environment, health and market access;
2. what information gathering methods do Vietnamese rose growers use on rose production in general and pest and disease management specifically, and how do they use this information for learning and process innovation.

3.2 Research design

As part of the preparation of the stakeholder dialogue, a team of three experts of Wageningen University visited Vietnam from September 16 to October 2, 2006 and February 26-March 3, 2007. These experts were accompanied by three specialists of the Vietnamese consultancy firm Fresh Studio South East Asia. During the fieldwork in Me Linh and Sapa the group was also accompanied by two specialists of the Vietnamese Research Center AGI. During the fieldwork in Da Lat, the group was accompanied by 2 experts from the Potatoes, Vegetables and Flowers Center (PVFC) and 2 experts from the Local Agricultural Institute. Together they created an interdisciplinary and multicultural team and worked together on data collecting throughout field work. This report presents the results obtained during the field work done in Da Lat.

From November until February a multidisciplinary team of experts from Wageningen University The Netherlands (LEI, Alterra, WI and PPO) held several meetings to discuss the preparatory activities and the methodology to be used for the second field work. Based on these meetings, a working schedule was defined (see attachment 1). This schedule was shared with the Vietnamese counterparts Fresh Studio and PVFC in order to double check the feasibility of the working plan and working methods proposed.

In order to enable the feasibility and quality of the work to be done, it was agreed that:

1. The team would make optimal use of work already done. The Pro Poor Horticulture project,[1] a DFID funded project carried out by LEI experts and partners in Uganda and Vietnam, was focused on rose cultivation in Vietnam. The results of this project were taken as a starting point.
2. To obtain a clear overview of the Vietnamese rose sector, the results of the fieldwork in Me Linh and Sapa of September 2006 should be complemented by fieldwork in Da Lat.
3. The fieldwork would focus on completing the results of the first fieldwork by expert observations in the field combined with consultations of a wide range of players in the fields of learning networks and pest and disease management, including growers, governmental workers, and representatives of the pesticide trade sector.
4. For data collection, methods applied would be, amongst others, semi-structured interviews, participatory methods, transect walks, Venn diagram.
5. Before initiating the fieldwork, representatives of the PVFC in Da Lat were informed about the research methods used for data collection in Sapa and Me Linh, and the most important findings of this first fieldwork. At the same time, specialists from the PVFC shared their knowledge and data on the Da Lat flower sector with the research team.

Regarding the methodology, the following agreements were defined:

Team composition:

1. The fieldwork would be headed by 3 WUR specialists: rose cultivation specialist (Nieves Garcia/PPO), pesticide and environment specialist (Floor Peeters/Alterra), and a specialist in sustainable supply chain development and market access (Myrtille Danse/LEI).
2. Three local experts from Fresh Studio South East Asia were assigned to support the team on the application of participatory research methods to small scale farmers in Vietnam.
3. Also, two local experts on Vietnamese horticulture activities from the research center PVFC and the Agricultural Center supported the team intensively before and during their visit organizing the meetings and field visits, and providing feed back on the results obtained.

Area of analysis

1. The rose sector within the Da Lat flower sector. Focus was on small scale farmers, but also bigger farms where visited especially to identify the major differences in cultivation practices when comparing to small scale farmers.

Working method

1. Each morning the three teams visited different areas of Dalat and held meetings with a number of stakeholders involved in the rose sector. The interviews with these experts took place in Vietnamese, summarized in English for the Dutch expert to be

[1] See for more information www.growoutofpoverty.nl.

able to understand the general discussion. Due to language difference, one of the Vietnamese researchers in each group took care of the reporting. In the afternoon each team (Vietnamese facilitator, Vietnamese expert, and the Dutch expert) prepared their daily report in English. At the end of the afternoon/beginning of the evening this information was used to plan the next day field work with the other team members. This research method enabled the team to discuss the findings obtained during the field visit and verify and correct possible misinterpretations due to language problems.

2. The findings of this fieldwork and the fieldwork of September 2006 were used for a power point presentation for a multistakeholder meeting in Hanoi March 7, 2007 (see annex 2).

4. Research limitations/constraints

1. Due to the short time available for the field work, the data collection could not take place based on a big sample of individual growers and other stakeholders involved. In order to obtain a general but representative impression on the diversity of working practices, but also to discover certain patterns, it was decided to collect part of the data by facilitating group discussions.
2. Since the experts from Wageningen did not speak Vietnamese, each team had to translate the least information necessary for the Dutch experts to understand the content of the conversations with the different stakeholders interviewed. This allowed the experts to follow the content of the discussions and to intervene in case necessary. However, the partial translation caused in some cases also confusion and a loss of information.
3. Due to language differences, it was necessary to dedicate every day of the field work considerable time in the afternoon sessions to translate the information gathered during the interviews from Vietnamese to English.
4. During the field work there was no time, nor budget available to make a risks assessment (making use of a combination of pesticide properties and local circumstances such as use patterns, soil, climate etc. to calculate the predicted environmental concentration). For this reason, it was decided to limit the environmental analysis to a hazard assessment.
5. Regarding the meetings with the stakeholders, the logistics and coordination was delegated to representatives from the local PVFC. Their knowledge on the local flower sector and their local network of contacts facilitated the quality of the fieldwork.

5. Research objective one: Rose cultivation and plant health

5.1 Introduction

The flower production area of the Dalat region is about 750 hectares. A great number of different floral products are grown, of which the greatest are Chrysanthemum, gladioli and roses. Although rose cultivation only occupies approximately 15 to 20% of the cultivated area in Dalat, it is the flower variety this research is focused on in order to compare properly with the results of previous research in the areas of Me Lihn and Sapa (Van Wijk et al., 2004, Danse et al., 2006).

The research is performed by means of several semi structured interviews (SSI) with growers, pesticide sellers, flower collectors (traders), flower buyers and by means of farm visits. As in the previous work, a very detailed impression of the cultivation practices in the area was obtained, with special emphasis on all those activities having an influence on crop health and product quality.

The information collected is, just as in the report on the fieldwork in Me Linh and Sapa, structured in three main chapters: general aspects of cultivation, general aspects of commercialization and flower quality, and general aspects of pest management. However, more than an exhaustive review of the cultivations methods, the report concentrates on the main differences with the previous areas.

5.1.1 Da Lat

Da Lat is the most important city of the Lam Dong province, a province located in the south- eastern highlands of Vietnam. In 1984 commercial flower cultivation initiated in this region. Currently flower cultivation takes place in four out the 10 districts at altitudes around 1400 m. Because of the geographical position, the area has an average year round temperature of 17.9 °C, with minimum temperatures of 11.4°C and maximum of 25.4 °C, which allows a reasonably constant year-round production. There is a dry and a rainy season.

At the moment of the fieldwork the province had between 109 and 150 ha of rose production. Besides roses, and the early mentioned chrysanthemums and gladioli, many cut flower varieties are cultivated; Limonium, Lysianthus, carnations, lilies, Anthurium, Cymbidium, Gypsophila and others.

Other than in Me Lihn and similar to Sa Pa, the growers are allowed to trade with and build on the land in which they cultivate. Maybe this is the reason why the average farm size is bigger than in Me Lihn. Farm size varies greatly in Dalat: we have encountered plantations with a cultivated area ranging from less than 3000 m^2 up to 8 hectares, in which sometimes different crops, flowers and vegetables are cultivated. The surface unit used by growers is the 'sao', but unlike in the previous areas, a sao here equals 1000 m^2. Often, the grower's house is part of the plot of land in which the greenhouse is

built. This makes the storage of tools, pesticides and the harvested flowers easier than in the northern areas.

Picture 5.1 Image of the cultivation area around Dalat with the numerous greenhouses

5.1.2 The influence of Dalat Hasfarm

The flower production area in Dalat is very much influenced by the presence of the foreign capital company 'Dalat Hasfarm', established in the area in 1996. This is a big scale farm growing flowers on a surface of 28 Ha (roses on 5 Ha), divided over three locations. They employ 800 workers. Currently they export 70% of the total production, and experience a growth rate of 15% per year. Before Hasfarm settled down in the region the concept of using greenhouses was not present in the area. Nowadays Hasfarm is surrounded by greenhouses (see picture 5.1). Growers try to imitate Hasfarms cultivation practices, use their varieties, and ask its workers for advice. Besides this indirect influence, Dalat Hasfarm is purchasing flowers from local growers. These growers work based on contracts and obtain direct information on growing methods and materials from Hasfarm through the technical assistance program that is part of the contractual arrangements.

This model of growing under subcontract is also applied by the, in their own words 'second best' rose producing farm of the region, 'Phuong Trung Farm'. This farm cultivates 6 Ha of roses and purchases roses from 10 other growers, together good for another 4 Ha of roses, all for the national markets. The subcontracted growers receive all the supplies from Phuong Trung at better rates than at the shop, and receive assistance and information about growing techniques. In return, they have the commitment to supply their entire production to Phuong Trung.

Technologically and in terms of knowledge, there is a big difference between the small farmers and the two mentioned bigger companies. In the description of the cultivation method the emphasis is focused on small scale farmers since they are the object of research of this assignment. Details about the bigger scale farms are discussed

separately within each subject since they provide important information on the possible directions towards which small scale growers could develop in the future. It must be said that the information about Dalat Hasfarm is based on an informal conversation with Mr. Bernhardt Schenke and a quick visit to one of the locations, and not on an exhaustive interview.

5.2 General agronomic aspects of rose cultivation in Dalat

5.2.1 Cultivation period and flower production

As in Me Lihn and Sapa, growers cultivate the rose plants for several years in a row. Until now, the crop replacement time was kept around 5 years, but because of a new tendency to use cuttings instead of seedlings, the life span of the crop will reduce in the future to approximately 3 years.

Rose production has a year round character; although the temperatures are quite stable, during the rainy season (June till November) with the abundant rains and lower radiation, productions must be lower than during the dry season (December till May). The yearly yield varies between 90 and 180 stems per m^2 per year (depending on the variety: lower for the Hybrid T varieties and higher for the sweethearts)[1]. Higher productions were mentioned by the two big scale farms for certain varieties.

The average price growers obtain for good flowers varies between 500 and 1000 VND per flower.

5.2.2 Cultivation method

5.2.2.1 Greenhouse construction

90% or the roses in Da Lat are grown under plastic greenhouses (see picture 5.1); this is the most evident difference with the rose cultivation in Me Lihn and Sapa, where the roses are grown outdoors.

The greenhouses consist of a bamboo or metal structure covered with a plastic roof and insect nets as sidewalls. Bamboo greenhouses usually last as long as the crop, around 5 years, but they are affordable to start with. Often they are replaced together with the old crop by a more durable metal structure. The plastic usually lasts about 2 years. This is material purchased from local producers (the cheapest) or imported from Taiwan, Thailand or Singapore. The last type is of better quality (more durable, although the interviewed growers complained about the actual quality/price ratio of the Thai plastic).

[1] The production numbers mentioned by growers vary greatly; in general it seems higher than in the northern areas, but lower than in production areas in countries in similar climate zones.

5.2.2.1 Soil preparation

Soil preparation is not limited to plowing, but usually some base fertilizing is done before planting (see chapter 5.2.4).

Usually no soil disinfection chemicals are applied by the growers; a few of them spray a herbicide after plowing and before planting.

The plowing results in a system of banks and troughs, although in several of the fields seen, the troughs had compacted almost to the level of the banks.

At some growers it was observed that the soil had been mixed with goat manure (visible in picture 5.5 right), and at others rice husks (picture 5.2), used to improve the soil properties.

Dalat Hasfarm grows part of the roses directly in the soil but has also a greenhouse were roses are being cultivated in substrate (coco peat). In 2007 also Phuong Trung Farm will build a new greenhouse in which coco peat in buckets will be the cultivation substrate.

Picture 5.2 Rice husks are mixed with and cover partly the soil at some plantations

5.2.2.1 Plant densities

Plant densities vary from 8 to 10 plants per m^2; this is almost twice as many plants per m^2 as in the northern areas of Me Lihn and Sapa. The plants seen are all distributed in two row systems.

5.2.3 Irrigation

The water used for irrigation is obtained mostly from surface water (public lakes and streams, and incidentally from about 25 m deep wells drilled specially by growers or by others to obtain drinking quality water. A few growers reported problems in the water

supply provided by public sources. This occurred during this dry season for the first time, because the dry season started earlier than normal. If they would like to use surface water, they have to drill 40 m deep or more. Due to this, they were now obliged to reduce the water supply and even to prune back part of the crop.

Irrigation is not done by inundation of the troughs, like in Me Lihn and Sa Pa but by sprinkler installations (also very unusual in commercial big scale rose cultivation, see further in chapter 5.3) that water by making the crop wet from above (picture 5.3). Some growers prefer to use a hose (shower); they believe the water through the sprinklers is damaging the bamboo of the greenhouse, therefore, if they have the choice, they alternate the sprinklers with the shower hose. There are growers that always use the hose after fertilizing, since they believe that this method increases the solubility of the fertilizers in the soil.

Picture 5.3 Sprinkler irrigation of the roses in a traditional bamboo greenhouse.

Incidentally plots with drip lines for irrigation (picture 5.4) have been seen as a trial at one small farmer (one of the subcontractors of Phuong Trung Farm) but this mode of irrigation is not widespread yet, despite the advantages some growers attribute them in terms of disease prevention (see further on 5.3). The reason seems to be the high costs involved.

About the irrigation frequency, we have found a great variation among growers: from twice a day (maximum mentioned for the dry season) to once per 6 days (minimum mentioned for the rainy season).

Big water reservoirs to collect rain water are built on the premises of Dalat Hasfarm, who irrigates the roses by means of drip lines connected to computerized fertigation equipment from Israel.

Picture 5.4 Mr. Tam experiments with drip irrigation and the branch bending method

5.2.4 Fertilization

Also a great variability in the way growers fertilize was observed. All of them mix some solid fertilizers through the soil *before planting* (*base dressing*). Usually it consists of mixtures of organic fertilizer (chicken, pig and/or goat manure), limestone and chemical complex (NPK) fertilizers.

Top dressing is done several times a year: a group of small growers agreed on manure applications every 6 months and solid NPK applications every 15 days.

The subcontractor of Phuong Trung Farm was using water soluble fertilizers that he applied trough a thin hose once every two weeks, at half height above the crop. This hose is the same as used for spraying pesticides, but without the nozzles. This fertilization is done separately from irrigation by the sprinklers. He also showed us the trial plot with drip irrigation, in which he was applying the fertilizers through the drippers, but due to lack of knowledge and appropriate equipment, this was used sub optimally (only once a week fertilizers, in a composition that changed all the time).

Some farmers apply foliar fertilizers mixed with the pesticides. When asked which ones, the growers told there were many, and they changed them all the time.

The amounts of fertilizers are applied by estimation of concentrations and dosage, based on the indications of the labels. Fertilization is done on a program-like base, and not based on analysis and a set of crop needs. Growers had never done a soil analysis, and never heard of anyone having done so. With the exception of pH samples: there is one local company, that sells soil supplement products. They stimulate their sales by offering pH analysis of the soil. In this way growers pay for the pH analysis and receive advise on the products to be used to correct the pH.

At Phuong Trung Farm, the application of organic fertilizers is always after composting them mixed with lime and the addition of *Trichoderma* fungi.

Dalat Hasfarm sends soil and drainage water samples to The Netherlands to be analyzed. They receive an adjusted fertilization program according to the needs of the plants. This fertilization method by means of adjustment through analysis is the most accurate and commonly used in commercial rose cultivation.

5.2.5 Crop management

Most of the crops seen are grown in a vertical way (no bending of branches). The trial plot of the Phuong Trung Farm subcontractor showed us besides drip irrigation and fertirrigation, also some experimenting with the 'bending' cultivation method, in which the primary stem at the start of the cultivation is bent horizontally and subsequently branches of inferior quality or blind shoots are bent during the whole cultivation period. The bent branches do not carry harvestable stems, but do photosynthesize and contribute therefore indirectly to the flower production.

In general, no radical pruning of the crop is done, only once in a while the high branches are pruned back to avoid the harvestable stems from becoming too thin.

Covering the flower buds, the most labor intensive activity in Me Lihn and Sapa, is not done in Dalat, it is tempting to think that this is because of the indoor growing, but outdoor growers do not cover the buds either.

Disbudding (removing side- sprouts) is here a common practice, which is done normally at one work round with the harvest.

Weeding is done depending on the grower, either manually or by means of a herbicide. Most of the interviewed growers combine both systems; manual weeding in the cultivation bed and by means of herbicides in the troughs between beds and the plot edges.

In his trial plot, Mr. Tam, the supplier from Phuong Trung Farm, was also experimenting with soil covering plastic to prevent weeds and to avoid the bent foliage to touch the soil (see picture 5.5, left). Compared to the beds without this protection, he said to have a lot less weeds, and also fewer problems with red spider mites.

Pictures 5.5 left: Mr. Tam experiments with soil covering plastic to prevent weeds; right, weeds among the rose plants in another greenhouse.

5.2.6 Choice of rootstock and varieties

As in Me Linh, the most common rootstock is the wild variety 'Sweet Briar'. Growers graft it themselves or pay a specialized worker for grafting with a commercial variety. Certain growers buy grafted plants from propagators.
Growers normally do not know which variety they are cultivating, because the young plants are not bought from professional breeders under a license but growers bring a few stems from the market and graft their plants with these varieties. They name them 'Dutch varieties' or 'German varieties' because they have been obtained from flowers sold on the market and grown by Dalat Hasfarm.

Phoeng Trung Farm imports Chinese varieties; the supplier of the varieties has taught them to grow the varieties without using a rootstock (see 5.2.7.)

Dalat Hasfarm is using the Dutch rootstock 'Natal Briar' instead of the 'Sweet Briar', because they are aware of virus problems on the local rootstock. They buy the varieties they grow from Dutch breeders with satisfaction of all the royalties involved.

5.2.7 Propagation methods

As in me Lihn and Sapa, also in Dalat the most used propagation method for small farmers is by means of 'seedlings'. For the grafting, often professional help is contracted (there are workers specialized in grafting techniques).

At Phoeng Trung farm, they are propagating by means of cuttings. At the moment, they propagate their own plants and the plants for their 10 supplying growers. The cuttings are rooted in coco peat plugs which are in a tray, wrapped with plastic (from China) or wrapped in a tissue (like the 'Jiffy plugs', but made locally in Vietnam, see picture 5.6). The pots of non-rooted (failures) plants are recycled.

Picture 5.6 Propagation by cuttings at Phuong Trung Farm

The propagation space is not heated, but because it concerns a low, closed greenhouse with the soil and lower part of the walls covered with a black cloth, and provided with a dark shadow net. It feels very warm as compared to the production greenhouses. The air is made humid by a pulse of mist from the mist-installation (sophisticated system from Israel).

At the moment, they are doing some trials for propagation by means of the 'stenting' technique, consisting of rooting in the same media a rootstock segment on which the cutting of the variety has been fixed by means of a clip. The farm learned about both techniques (cuttings and stent) from its Chinese supplier of the varieties. Compared to the seedlings method, propagation by cuttings or stentlings has the advantage of being very fast (only 6 weeks till planting). In less than three months after planting the first stems are being harvested.

Stents is also Dalat Hasfarm's propagation method. The 'cuttings' technique is widely used in substrate cultivation, but is less suitable for soil cultivation, because the life span of the plant is much shorter (about 3 years).

Smaller farmers using the grafted seedlings have heard about the cuttings but they don't have any clear information about this technique. Some are planning to use the cuttings in the future, but have a lot of prejudices about the quality of imported cuttings from China, and about the quality of the flowers grown from cuttings.

5.2.8 Harvest

Harvest in Da Lat is done once a day to once every two days. We were able to see the harvesting in progress in one of the visited small scale greenhouses. The ripeness of the flower (cut stage) is the most important criterium to decide which flower to harvest. The flowers are collected in the arms and dropped on the greenhouse floor (picture 5.7 right) until the pile is big enough; then the flowers are wrapped in a carpet and transported on the back to the front of the house, a colder, shaded space (outdoors) where the classification is done.

Picture 5.7 Harvest in progress at one of the farms; left harvesting; right, pile of harvested flowers

At Dalat Hasfarm roses are harvested twice a day, to ensure the right cut stage.

5.2.9 Rose post harvest handling and storage

Big differences were found in the way growers treat the roses after harvest. Some growers do not classify, but they cut and tie flowers directly on the field, where the collectors pick them up, usually shortly after harvest, and mostly by motorbike.

Other growers bring the flowers to a cool place after harvest, they make the flowers and the floor on which they lay completely wet with a hose (picture 5.8, left); after that they classify qualities and lengths, and make bunches with the help of a wooden shape (picture 5.8, right). The bunches are then wrapped in a protecting card board, and are collected by small traders that transport them by motorbike, or by a more important collector owing a truck and moving bigger volume of flowers. The small growers do not have a cold storage to store flowers; some collectors do.

Pictures 5.8 Post- harvest in progress at one of the farms; left: wetting; right: bunching

Four of these collectors were interviewed. They are in business for more than 10 year already. The flowers they collect are mostly stored dry until the moment of packing for transport or selling. The boxes with flowers (sometimes reused carton from grocery products) are usually overloaded because transport is paid per package, not per weight. Flowers are mainly sold to wholesalers in Hanoi, Ho Chi Mihn city and other provinces. One of these collectors was exporting flowers to Russia; the flowers for export were treated a lot gentler: he hired workers to harvest at the growers in order to ensure the freshness of the product at the moment of collecting. These flowers were stored in water buckets till packing in the cold room. According to him export boxes were never overloaded. Because he had the facilities and had achieved the habit of placing flowers in water, he was the only of these four traders watering the flowers destined to the local market.

Phuong Trung Farm has a special space for grading and packing (picture 5.9, left) and a cold store (picture 5.9, right). This enables the possibility to carry out three different post harvest processes. Each one depends on the destination market of the flowers, which is determined by quality (see figure 5.1). For the more distant markets (Hanoi), the best quality flowers are treated in the best possible way. The worst flowers receive a less careful treatment, are not cooled nor wrapped in a protective cardboard or cellophane, and are sent to the provincial markets. Surprinsingly, only the new introductions (new varieties that need to earn a market) are watered with a chemical post-harvest treatment. Known varieties - varieties having already a market- do receive no treatment, independently of the destination market. This is an unfortunate situation for the long term, because only a consistent quality will stimulate repeated purchases of flowers.

Pictures 5.9 Post- harvest space at Phuong Trung Farm; right; a glimpse of their dry cold store, where the flowers for the more exigent markets are stored in water buckets till packing for transport

The cold stores seen are not made of concrete, but of coated metal and other than in Me Lihn, they are dry (there is no layer of water covering the floor).

The post harvest process of all the roses grown and purchased by Dalat Hasfarm is very well organized in order to ensure the quality of the flowers till export and beyond. Four big cold rooms ensure there is sufficient cooling capacity for the farm production and the purchased flowers from subcontractors. The farm is making constantly efforts to

improve the process, including hiring experts to audit it step by step and sending data loggers with the flowers to detect gaps in the cold chain.

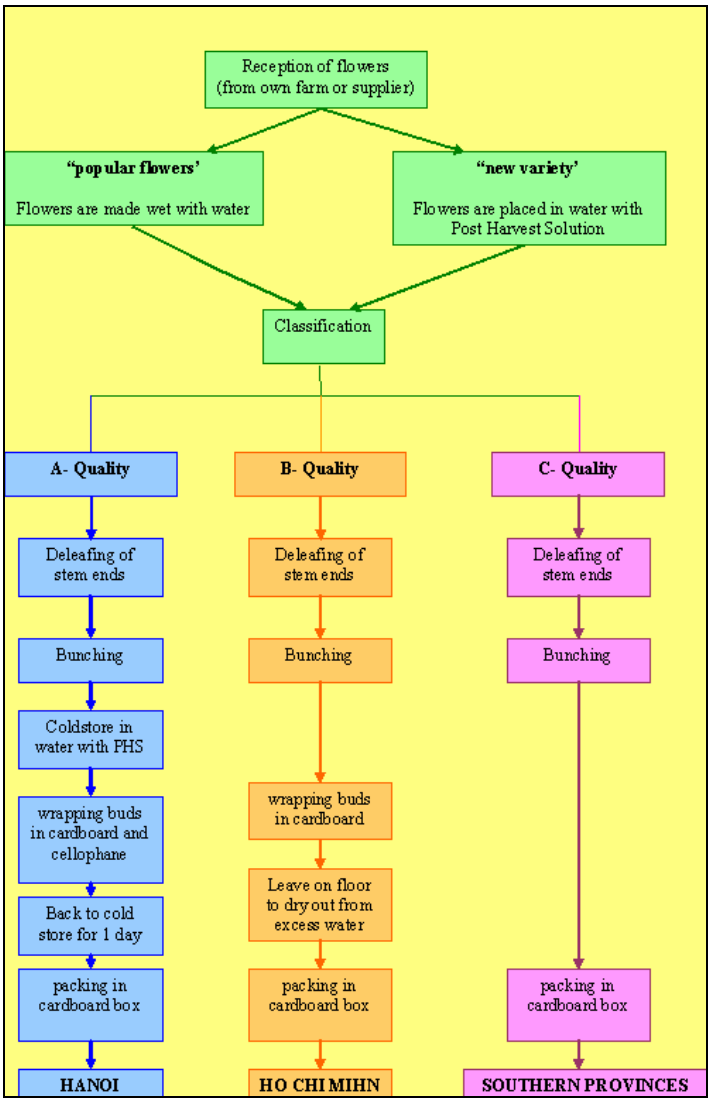

Figure 5.1 The three post-harvest processes at Phuong Trung Farm

5.3 Pest and diseases in rose production in Dalat

All interviewed farmers, pesticide shop owners and agricultural officers agreed that not the number, but the severity of the pests and diseases have increased considerably in the past 5 years. They also agreed upon the most serious pests and diseases affecting the roses in the area (see tables 5.1 and 5.2). The red spider mite (*Tetranynchus urticae*) is the most serious pest and both the grey and white mould (respectively *Botrytis cinerea* and powdery mildew

caused by the fungus *Sphaeroteca panosa*) are the most serious diseases. All of them are very easy to recognize for all growers.

Other insects (thrips, white fly, plant hoppers, caterpillars, flower borers) were mentioned as present, but not so serious, and not by all growers. A few of them also mentioned to have some minor problems with nematodes.

As in Me Linh residue of pesticides was observed on the leaves of the plants of the fields visited. The growers attributed this not to the way they apply the pesticides or the drop size, dispersal agents, etc, but to the fact that they mixed them with fertilizers. One of the growers facing water restrictions attributed the residue to the lack of water for irrigation by sprinklers, which is normally washing out the leaves.

Table 5.1 The pests with the highest incidence in Da Lat area

Importance	*English name*	*Presence*	*The most serious period*
1.	Red spider mite	Dry season	The changing from dry to rainy season
2.	Thrips	Dry season	The changing from dry to rainy season
3.	Plant hopper	Dry season	The changing from dry to rainy season
3.	White fly	Dry season	The changing from dry to rainy season
4.	Caterpillars	Year round	Year round

No other diseases or insects were seen except for the ones mentioned by the growers. In the visited fields, nutrient deficiencies and other disorders as for instance bull heads as well as pesticide damage were observed. The growers were aware of the deviations but did not always know how to avoid them.

Despite their efforts to kill the fungi by means of pesticides, seriously affected plants and harvested stems were seen (picture 5.10); because of this uncontrolled disease, the flowers are classified as the lowest quality, which implicates being sold on the less exigent market and subsequently a lower return.

Picture 5.10 Despite all efforts against powdery mildew, many flowers end up in the in the cheapest qualities due to visible infections on the leaves

Not a single grower mentioned downy mildew or the dead plant among the current diseases (those were among the most serious in the northern areas of Me Lihn and Sa Pa). Only one grower - seedling supplier mentioned the incidental presence of aphids.

One of the district officers and the director of the 'Potato, Vegetable and Flower Research Centre' mentioned the 'yellow leave' as a serious disease. This disease was not mentioned by any of the growers. Although there was no chance to see any affected plants, a description of the symptoms and a discussion with Mr. Schenke from Hasfarm brought up the possibility of these symptoms to be caused by virus.

Table 5.2 The diseases with the highest incidence in Da Lat area

Importance disease	*Local name*	*English name*	*Caused by*	*Present*	*The most serious period*
1.	Nam Phang Trang	Powdery mildew (White fungus)	*Sphaeroteca panosa*	Year round	Dry, sunny, windy period
1.	Rung La	Grey fungus	*Botrytis cinerea*	Year round	Rainy season

5.3.1 Relationship between pest and diseases and growing methods

The possible relationship of the pests with varieties and watering method were discussed with some of the groups. It is the growers' experience that the different varieties show a distinct sensibility to diseases; this difference was clear at one grower, where the red variety (possibly '*First Red*') showed very little infection by powdery mildew, although it was being cultivated next to a very sensitive variety. But of course, not every red variety is less sensitive to powdery mildew; the fact that growers do not really know which varieties they purchase makes impossible to consider the choice of varieties as a primary form of disease prevention.

Interestingly, not all growers agree on the fact that there could be a relationship between the cultivations methods like irrigation by sprinklers and the disease incidence. The grower experimenting with drip irrigation affirmed to have seen a decrease in his fungus incidence, but an increase in his incidence of red spider mite. Drip irrigation was also mentioned by Mr Trung as one of the strategies to reduce the use of pesticides in the future. This opinion was shared by other growers, but at the same time they indicated to have stopped the implementation of this irrigation system due to the high costs involved.

There was also a grower convinced of the relationship between the quality of the water and disease incidence: he had observed a lower incidence of red spider mites when using water from deep wells, and higher when using water from public lakes (it is not clear whether he referred to the water used for irrigation or to prepare the pesticide solutions).

The application of foliar fertilizers makes the foliage dirty, which as it was pointed out before, creates the need of wetting the crop to wash out this residue. However, it is known that most foliar fertilizers are not absorbed by the crop. The contribution of this way of fertilizing to plant nutrition and to disease should be reconsider.

5.4 Pest control strategies by rose farmers

To obtain a broad insight about the pest control strategies several pesticide shop sellers and government officials were interviewed besides the rose growers from small and bigger farms. Very useful information was obtained from the vice manager of the PPD of Lam Dong Province, responsible for monitoring/checking pests and residues in the agricultural products and also from an agricultural specialist of the Dalat Agricultural Center.

Picture 5.11 Semi structured interview of rose growers (left) and a look in the field (right)

5.4.1 Integrated pest management

The term 'Integrated pest management' was often mentioned by the interviewed growers and the agricultural officers in Da Lat area. Some growers have followed training courses and seminars organized by the PPD (see text box 5.2), the extension office, the Agricultural Centre and the pesticide companies, and have obtained certificates. But according to them, they can not use this acquired knowledge, because they believe what they have learnt is general for vegetables and other flowers, but not applicable to roses. Another argument mentioned is that it makes no sense to use natural predators of the pests when the neighbours don't use them; in their opinion, the chemical control by the neighbour would kill their useful insects.

The interviewed farmers do not apply any non chemical methods for pest and disease control. Only Phuong Trung Farm admitted to remove severely affected plants from the field. Although some of the growers indicated to scout for pests, detection of the pest results in reactive spraying of the whole field, sometimes with special emphasis on the affected spots.

As in Me Lihn and Sa Pa, there is space for improvement in the attitude towards pest and disease prevention, the other pillar for integrated pest management. Piles of organic waste are found in and around the greenhouses. Sometimes, this waste is being burnt next to the greenhouse, which can lead to increased ethylene and other combustion gases in the field causing physiological disorders to the crop that can be easily confused with diseases (pictures 5.12). Consequent weeding or weed prevention can also contribute to a lower pest pressure, since weeds are very good hosts for insects, nematodes and other plant pathogens; unfortunately, not all growers pay enough attention to this handling.

Pictures 5.12 lack of hygiene around the greenhouses increases the disease pressure; left: piles of organic waste next to greenhouses; right: waste is burnt very close to the greenhouse

The greenhouse construction by means of the insect nets on the side walls is such, that it could greatly prevent the in flight of insects like trips, provided they have the right mesh size. Unfortunately, not every grower seems to be aware of this, to judge from the state in which some of these nets were observed (picture 5.13): big holes and complete walls and roofs irreparably broken, but not yet replaced.

Pictures 5.13 maintenance of the greenhouses can contribute to disease prevention

The use of drip irrigation is mentioned by some growers and by one of the extension officers as a measure to prevent diseases. One grower indicated to use *Trichoderma* compounds (a fungus antagonistic of certain soil borne pathogens) to make his plants healthier. Other suggestions for disease prevention included the use of bioorganic fertilizers instead of chemicals, which indicates that there is some misinformation or confusion between biological cultivation methods and integrated pest management.

Dalat Hasfarm is not using natural enemies of the pests yet, but it is a good example for local growers when it comes to disease prevention and scouting. And they keep on working in new improvement measures in their newest greenhouses, such as insect nets on

the roof openings, airlock doors and disposable protection clothes to prevent the workers from spreading the pests from their own fields through their working clothes. Against fungal diseases, they evaporate sulphur during the night; this is possible in their greenhouses with closed side walls; the prevention effect in open side greenhouses should be studied, in order to make this technology available for the smaller growers.

PPD gives since 1992 IPM training courses

Crops:
rice, vegetables (from 1996) and tea (from 2000). Not yet for roses.

Working method

1. Field research
2. Develop training materials
3. Train the trainers
4. IPM course for growers: theory (indoor class) and practice (grower field school -FFS). FFS takes the majority time compared to indoor class. FFS is carried out on the grower's field. An IPM club is established to gather growers for the IPM course. The club includes about 25-30 members. The training course takes place once per week and last about 3- 4 months (the season of a certain vegetable crop). Members are selected among good growers who are motivated to learn new techniques.

Contents of the IPM course:

1. Identify pests, natural enemy of pests
2. Combination of IPM methods such as: farming practice, selecting clean varieties, pruning, fertilization and pesticide use.

Text box 5.2 Integrated Pest Management courses organized by the PPD

5.4.2 Chemical control

Apart from the mentioned prevention measures, which are absolutely not generalized yet, the use of chemicals is the only pest control method used by the interviewed growers.

The choice of the chemicals mostly takes place according to indications by other growers or the pesticide shop owners. A lot of the information is gathered by 'trial and error'. This leads to frequent damage to the crop by the use of the pesticides such as burning leaf. Some growers do trial applications in small areas before they spray the whole field, others do rely on the information obtained from colleagues and skip this trial phase, sometimes with disastrous consequences.

Unlike Me Lihn and Sa Pa, the use of wetting agents together with the pesticides is not a rarity in this area.

Calendar spraying is the most frequently encountered way of application.

5.4.2.1 Application methods

Almost all pesticides are diluted with water in a bucket. The application method (back sack pump or a hose, pictures 5.14) varies per grower; some growers alternate both methods.

- For small areas: The pesticides are applied with the spray mast connected to a tank that is carried on the back, and a small engine pump that pushes the fluid out under pressure.
- For big areas: the solution is pumped through a pipe/hose with a nozzle and from this hose the pesticide will be sprayed over the fields (picture 5.15). The hose pump is at some of the visited greenhouses also used for fertilizers, but without the nozzles.

The growers indicated to change the nozzles for both methods approximately once a year.

Picture 5.14 Pesticide application methods: left hose with a nozzle; right back sack pump

Normally men at the age of 20 - 40 year spray the pesticides, if available in the family; if no man are available in the family hired labor or woman will spray the pesticides. In the field, growers spray pesticide on the upper part of the plant and then turn the nozzles up side down to spray the lower parts of the plant. Growers usually follow the wind during spraying. Growers spray pesticide along the plant row, not in the middle of the two rows.

5.4.2.2 Amount of pesticides used

Growers do not register the exact amounts of pesticides they use. Therefore, no objective information about amounts has been provided. The general impression though is that there has been a great increase in the last 5 years. The reasons mentioned are also very divers, but the increase is attributed to the increasing incidence of pests/diseases, especially red spider mite and white fungus. This last one appears nowadays year round while in the past it was only present in the rainy season. The diversity of pesticides has increased as well, which growers explain as a reaction to the number of pests, consequence of the growing diversity of crops.

According to the PPD the use of pesticides has increased in volume in the last two years. Only a few growers mentioned the resistance of pests against pesticides as a reason for the increased volume used.

When asked about their expectations concerning pesticide use in the next 5 years, the growers reacted also contradictorily. Some believe that more pesticides will be required to handle the increasing problems. It is interesting, however, to hear that other growers believe that the pesticide use will remain the same in the next five years: on one hand they expect new pesticides with better efficiency; on the other hand because of the market demand for high quality roses with less residue.

To the question if they believed that it was possible to reduce the use of pesticides by 20%, a group of growers answered that such a reduction is not feasible: less pesticides would mean for them to have to quite the business.

Picture 5.15 A grower spraying pesticides in the greenhouse with the hose

5.4.2.3 Pesticide products used and frequency of application

Around 30 different kinds of pesticides are mentioned by the growers which they use for the rose production.

Growers choose the pesticides they use based on the following criteria:

1. Efficiency
2. Price
3. Products from Reliable companies (Bayer, Syngenta)

The Puong Trung Farm chooses the pesticides based on:

- Efficiency
- Price
- Toxicity (least toxicity preferable, based on label information).

Table 5.3 provides an overview of the most frequently used pesticides at the Puong Trung company according to the director of this company. They are ranked in terms of frequency in use.

Table 5.3 Chemicals used for pest control at Puong Trung Farm

	Trade name	Common name (AI)	Pest/disease	Spraying frequency
1	Score 250 EC	Difenoconazole 250 g/L	WF	2 x/week in dry season. No or rarely use in wet season
2	Kummulus 80 DF	Sulfur 800 g/kg	WF	See above
3	Cuproxat 345 SC	Tri Copper sulphate 345 g/L	WF	See above
3	Zineb bul 80 WP	Zineb 80%	WF	2 x/month in rainy season Once a month in dry season
1	Melody duo 66,75 WP	Iprovalicarb 55 g/kg Propineb 612,5 g/kg	GF	2 x/week in rainy season, fewer frequency in dry season
2	Aliette 800 WG	Fosetyl Aluminum 800 g/kg	GF	See above
3	Ridomil 68 wp	Metalaxyl 40g/kg + Mancozeb 640 g/kg	GF	See above
?	Biobass	?	WF +GF	
A	Nissorum	Hexythiazon 5%	RSM	1x/week in dry season. 2x/week in rainy season. more popular in dry season
A	Sirpon 5EC	Halfenprox 5%	RSM	
A	Comite 73 EC	Propagite 73%	RSM	
A	Vetimec 1.8EC	Abamectin 1.8%	RSM	
	Neem-nim green 0.3 EC	Azadirachtin 0,30%		On trial

(A) = pesticides for red spider mite are rotated over time. WF = White fungus = Powdery Mildew
Rainy season starts from June till November GF = Grey fungus = *Botrytis*
Dry season: December till May RSM = Red spider mite

For all pesticides: the minimum dosage on the label is followed. The amount of diluted pesticide is 400 - 500 l per hectare.

Normally, a spraying program is followed by the company. When a pest/disease is found, the spraying schedule is changed and the interval is shortened. When no pest/disease is present a longer interval is applied.

It was not possible to obtain information on the volume used at an annual basis.

Nematode is sometimes present but this is no considered as a serious problem, it just occurs in small areas. To treat this problem, Furadan-OH 50 WP (copperhydroxide (77%) & Monceren 250 EC (pencycuron 250 g/L) is used and applied on the soil.

Because of the resistance against the pest, the company changes pesticides they use over time.

Trials of new pesticides are done on a small plot of 100 m^2 during 2-3 weeks. If the trial is successful, the product is applied on a bigger area (1 - 2 Ha) and later at the whole

area. On the trials the common products will be tested; the trial do not consider upcoming pests and diseases in the field.

Picture 5.16 three pesticides: Score, Map-Permethrin and Long C.A (Chinese pesticide)

Table 5.4 provides an overview of the most frequently used pesticides by three small growers interviewed. They are ranked in terms of frequency in use.

Table 5.4 Chemicals used for pest control by three small growers

	Trade name	Common name (AI)	Pest/di-sease	Dose per (in 8 L water per 100 m2)	Volume in 2006/1000m2)	Spraying frequency
1	Score 250 EC	Difenoconazole 250 g/L	WF	3-5 ml	0.5 liter	1 x per week; 1 x per 3 days (many incidence)
2	Anvil 5 SC	Hexaconazole 50g/L	WF	Idem	0.5 liter	Idem
3	Calyxin	Not available anymore	WF	3-5 ml	No more available in the shop	1 x per 10 -15 days (max 2 x then change product)
1	Melody duo 66,75 WP	Iprovalicarb 55 g/kg Propineb 612,5 g/kg	GF	20 - 30 g	4-6 kg	1 x per week; 1 x per 3 days (many incidence)
2	Dithane 80 WP	Mancozeb 800 g/kg	GF	30 - 50 g	20 kg	Idem
3	Antracol 70WP	Propineb 700 g/kg	GF	30-50 g	20 kg	Idem
1	Long C.A = A	Abamectine	RSM	1-2 ml		1 x per 10 -15 days (max 2 x then change product)
1	Sumi alpha 5 EC	Esfenvalerate 5%	RSM	8-10 ml	0.6 liter	Mixed with Long C.A.; same spraying schedule
2	Polytrin 440 EC	Profenofos 400 g/kg Cypermethrin 40 g/kg	RSM	15-20 ml	0.9 - 1 liter	1 x per 20 days or month
2	Nissorum	Hexythoazo 5%	RSM, BPH	3 - 5 ml	0.25 liter	1 x per 7 - 10 days
	Lannate 40 SP	Methomyl 40%	Flower borer	10-20g	2 kg	Only in early spring; will be controlled after 2 x (1 x per 7 - 10 days)

WF = White fungus = Powdery Mildew A = Chinese product without label
GF = Grey fungus
RMS = Red spider mite
BPH = blue plant hopper

Table 5.5 provides an overview of the most commonly used pesticides as indicated by 10 small growers. The table is ranked in terms of serious level for the pest and diseases. The growers indicated the serious level based on the problems they experience in the fields with the pests and diseases. In the third column the pesticides are ranked in terms of importance.

Table 5.5 Chemicals used for pest control by ten small growers

Ranking pest/dis.	Pest/disease	Ranking pesticide	Trade name	Common name (AI)	Presence period	Serious period
xxxx	WF/GF		Score 250 EC	Difenoconazole 250 g/L	WF: year round	WF: the weather is dry, sunny, windy. GF: changing period from dry to rainy
xxxx	WF/GF		Anvil 5 SC	Hexaconazole 50g/L		
xxxx	WF/GF		Kummulus 80 DF	Sulfur 800 g/kg	GF: rainy season	
xxxx	WF/GF		Rovral 50 WP	Iprodione		
xxxx	WF/GF		M8			
xxxx	WF/GF		Mancozeb 80 WP	Mancozeb 80%		
xxxx	WF/GF		Tilt super 300 EC	Difenoconazole Propiconazole		
	GF		Melody duo 66,75 WP	Iprovalicarb 55 g/kg Propineb 612,5 g/kg		
	GF		Ridomil 68 wp	Metalaxyl 40g/kg + Mancozeb 640 g/kg		
	GF		Aliette 800 WG	Fosetyl Aluminum 800 g/kg		
	GF		Dithane 80 WP	Mancozeb 800 g/kg		
Xxxx/ xxx	RSM/ thrip	1	Nissorum	Hexythiazox 5%	RSM: dry season	RSM: dry season → rainy season. Thrips: dry season → rainy season.
Xxxx/ xxx	RSM/ thrip	1	Pesticide with abamectine	Abamectine	Thrips: dry season	
Xxxx/ xxx	RSM/ thrip	2/3	Kenthane 18.5 EC	Dicofol 18.5%		
Xxxx/ xxx	RSM/ thrip	2	Sunix			
Xxxx/ xxx	RSM/ thrip	4	Supracide 40 EC	methidathion?		
Xxxx/ xxx	RSM/ thrip	5	Map cypermethrin 50 EC	Cypermethrin 50%		
xxx	thrip	2	Ammate 150 SC	Ammate		
	RSM		Plutel 1.8 EC	Abamectine 1.8%		
	Thrip		Selecron 500 EC	Profenofos 50%		
	thrip		Polytrin 440 EC	Profenofos 440 g + 40% cypermethrin		
xx	PH/white fly	1	Actara 25 WG	Thiamethoxam	Dry season	dry season → rainy season and lack of water
xx	PH/white fly	2	Supracide 40 EC	Methidafion of methidation?		
x	caterpillar	1	Match 50 EC	Lufenuron	Year round	Year round

WF = White fungus = Powdery Mildew
GF = Grey fungus
RSM = Red spider mite
PH = plant hopper

The first group of growers interviewed (see table 5.4) spray with a maximum of 2 times a week. From the second group of growers interviewed (see table 5.5) it can be observed that these growers spray more often (compared with the first group). These

growers spray with a maximum of 4-5 times a week. It can be concluded that different growers in different areas use different spraying frequencies (the amount of times they spray).

5.4.2.4 Mixing of different pesticides

The growers were asked to explain which pesticides they normally mix together.
All kinds of pesticides are usually mixed together, but the different growers gave different reasons for decision which chemicals to mix: while certain growers said to avoid to mix fungicides with insecticides, others said to avoid mixing basic and acid products; other growers mixed everything, unless the label explicitly indicated that a product can not be mixed. Unlike Me Lihn and Sa Pa, the use of wetting agents together with the pesticides is not a rarity in this area.
The reasons to mix pesticides are:

- To save labor
- To increase efficiency
- Based on own experience (growers have tried different mixtures and come up with the mixtures because the mixtures do not result in plant damage with appropriate dosage compared to other mixtures).

The interviewed growers did not learn from any training course how to mix; their knowledge on mixing is partly based on their own experiences. Before they apply a pesticide to the whole field they do trials first on a small plot. If several pests/diseases are found at the same time, they will mix different products based on the efficiency to control the problems.

5.4.2.5 Information from the pesticide shops

In Dalat are many pesticide shops. Two of them were interviewed; one big shop and one small shop.

Interview with the technician of a big pesticide shop.
According to the technician of the big shop he visits the fields himself and advises to the growers on which products and fertilizers to use (based on AI, doses, toxicity and efficiency). Samples of the new products are given for free to the growers. They can try the products for six months on trial plots.

The technician regularly monitors the trials. After six months he concludes if the pesticide is effective and if it should be introduced to the growers through a seminar in Dalat and if it will be available in the shop. If more pesticides are available for one pest or disease the choice between the products will be made based on the AI with quick results. Based on the label and the experiences of the trials they define the recommended doses. Usually he advises to use a lower doses than mentioned on the label; the maximum doses he advises never exceeds the maximum doses recommended on the label.

Instead of advising to use pesticides all the time he prefers to advise to use some fertilizer (Phan Con Voi) because by using this fertilizer the pests and diseases decrease and less pesticides are required.

Based on his knowledge and experiences the technician advises how to mix different products (he said he knows this because he studied chemistry on the Dalat university).

He said that the growers are not very aware of the risks of spraying pesticides. During seminars (when new products are introduced) he advises them to protect themselves while spraying: wear boots; wear gloves, wear masks, wear a hat, in some cases motor helmet (in case the grower wants to protect himself very carefully), spray pesticides following the wind direction, do not smoke during spraying, Follow the instruction on the label according to doses and mixing of different products, take a bath after spraying pesticides and clean the equipment and clothes after spraying pesticides.
According to him the growers are more careful spraying pesticides by protecting themselves after his advises.

The persons in the shop are trained by the PPD; the training course is 10 days a year, annually. They have to pay a fee for the course and they have to pass the exam to get a certificate. After that they have knowledge to advise the growers.

Interview with the owner of a small pesticide shop.
Usually the owner of the shop doesn't provide information related to the use of pesticide because most of her customers are regular ones and they are knowledgeable about the pesticide use. She only gives advise on the new products (AI, doses and efficiency) and she also will give advises to the new customers (old and new products).

If a new product is available the growers will get samples (sometime for free) and they give feedback to her about their experience with the products in the fields. If the result is good, then she will import more amount of the new product. If not, she has to refund the growers (if the growers have paid).

She has attended several seminars organized by the pesticide companies. These seminars are hold to introduce new products.

If more products are available for a pest or disease she will recommend the product from the well known companies (Bayer, Syngenta).

Picture 5.17 overview of pesticides showed during an interview

She is aware of the toxicity level of the products (by color on the label) and provides that information to the growers. Sometimes she invites growers to go to the field school (to introduce new products) organized by the pesticide companies.

According to the owner the growers do not pay attention to protect themselves during spraying.

A lot of products are not registered for roses. According to her this is because it is not possible to register a product for too many different crops. She explained that if a product is against a certain pest or disease in another crop this product can also be used for roses.

She knows which products can be mixed from the course by PPD. She said there is a table with this information but she could not show this to us because she left it at home. She advises the doses based on the recommendation of the company (written on the label).

Table 5.6 presents an overview of the most important pesticides provided by the shop sellers to rose growers. The table also gives an overview of the recommended doses.

Table 5.6 Advised dosage of pesticides in Dalat (2 shops)

Pesticide	*Active ingredient*	*Period*	*Advised dosage to grower (ml product/L water)*	
			(1)	(2)
Judi 5SC	Hexaconazole 5%	Year round	20-40ml/8liter water 320-400l/ha	
Glory	Carbendazim 50%	Year round	8-16ml/8Liter of water	
Cure Supe 300EC	Propiconazole 150g/L + Difenoconazole 150g/L	Year round	0.2 - 0.25L/ha	
Carzole 20WP	Tricyclazole 58g/Kg + Carbendazim 92g/kg	Year round		
Mataxyl	Validamycin 50g/kg	Year round	0.5 - 1kg/ha	
Phantom 60EC	Diazinon 60%	Year round	0.4 - 0.6L/ha 10 - 5 ml/8liter of water	
CammalinSuper 170EC	Profenofos 15%	Year round	20 - 25 ml/8L of water for 250m2	
BM Delta 2.8EC	Deltamethrin 2.8%	Year round	320 - 400 L/ha	
Cyper Map 25EC	Cypermethrin 25%	Year round	5-6ml/8liter of water, 32L/1000m2	
Manage 5WP	Imibenconazole 5%	Year round		20g/8L, 32-40L/1000m2
Bayfidan	Propiconazole 150g/L + Difenoconazole 150g/L	Year round		10cc/8L
Tilt Super	Triadimenrol 250g/L	Year round		5ml/8L (dry season) 10ml/8L (Rainy season)
Sec Saigon	Cypermethrin 500g/L	Year round		20ml/8L
Abatin	Abamectin 1.8%	Year round		10ml/8L
Peran	Permethrin 50%	Year round		10ml/8L
Pegasus	Diafenthiuron 500g/L	Year round		10g/8L

(1, big shop): Shop owner: (2, small shop): shop owner:

Besides these two shops another small shop between the rose fields was very shortly interviewed.

Picture 5.18 A small pesticide shop between the rose fields

The only question we asked the owner of the shop is which pesticides do you usually sell to the rose growers. In Table 5.7 an overview is given of these products. According to him all pesticides have the same importance.

Table 5.7 Overview of chemicals fold in a small shop between the rose fields

Pesticide	*Active ingredient*
Anvil 5 EC	Hexaconazole
Daconil 500 SC	
Map-permethrin 50 EC	Cypermethrin
Selecron 500 EC	Profenofos
Abatimec 1.8 EC	Abamectine
Score 250 EC	Difenoconazole

The three shop owners could not rank the pesticides on importance.
From the tables it can be seen that the three different shops sell different products with different active ingredients to the growers of roses.

The technician of the big shop could give information about the amount of pesticides sold in a year but there is no information available about the area on which these pesticides are used.

Table 5.8 provides an overview of the total amount of volume of pesticides sold in a year.

Table 5.8 Amount of pesticides sold in one year in Dalat (1 shop) to rose growers

Pesticide	*Active ingredient*	*Total amount of product sold in a year*	*Total amount of AI sold in 2005 (kg)*
Judi 5SC	Hexaconazole 5%	300 l	15
Glory	Carbendazim 50%	100 l	50
Cure Supe 300EC	Propiconazole 150g/L + Difenoconazole 150g/L	100 l	15 15
Carzole 20WP	Tricyclazole 58g/Kg + Carbendazim 92g/kg	200 kg	11.6 18.4
Mataxyl	Validamycin 50g/kg	500 kg	250
Phantom 60EC	Diazinon 60%	100 l	60
Cammalin Super 170EC	Profenofos 15%	100 l	15
BM Delta 2.8EC	Deltamethrin 2.8%	50 l	1.4
Cyper Map 25EC	Cypermethrin 25%	200 l	50

The shop owner could not make a ranking of the pesticides based on importance. According to the results of table 5.8 it can be observed that the amount of product sold in a year does not differ a lot between the different products (50 l - 500 kg). Based on AI the differences are bigger; for example: the amount of metalaxyl (AI) sold is 250 kg/year while the amount of deltamethrin sold is 1.4 kg/year.

5.4.2.6 Costs for using pesticides

Cost for pesticides varies from seasons and types of field. The pesticide use is less in the dry season compared to the rainy season and less in the net house relative to the open field, the cost is less accordingly. The percentage of the costs of the pesticides compared to the total input costs is identified as 25 - 50 % by the small growers.
According to the director of the Phuong Trung Farm the costs of pesticides occupies for 30% of the total input cost (incl. labor cost). The input cost is VND 300-400/rose, the price is VND 500 - 1.000/rose.

5.5 Estimated environmental and human health impact of rose cultivation

5.5.1 Label of products

Growers in Dalat were asked to explain how they read the label. When using pesticides, the interviewed growers pay attention to :

1. The toxicity of the product based on color.
2. The description how to use the pesticide.
3. The dose written on the table.

In order to increase the efficiency of the products, the growers sometimes increase the dosage up to 30% compared to the recommendation on the label. This will only be done for open field rose production. In the net house, they use the maximum dose found on

the label when more pests are found. In general, more pesticides are used in open field compared to that in the net house.

5.5.2 Environment

5.5.2.1 General

The growers do not experience negative impact on the environment which they relate to the use of pesticides.

According to the PPD there is no impact on aquatic life noticed because there are few fish ponds in Da Lat. Affected regions may be other ones in lower elevation such as Dong Nai, Ninh Thuan, Binh Thuan provinces.

5.5.2.2 Domestic water sources

By spraying pesticides in the field direct exposure of pesticides to the surface water might take place (see risk for aquatic organisms, chapter 5.6.3) Pesticides also might leach to the groundwater (see chapter 5.6.5)

Drinking water
In Dalat in most areas drinking water for local people is provided from a mineral stream which is under treatment by a factory called Suoi Vang Waterworks funded by Danida. In some suburb areas people are not connected to this water supply but are dependent on the groundwater they collect from deep wells (15 - 40 m). According to the PPD it might be possible that some growers in the suburb areas may be affected by the pollution from using this groundwater as drinking water but this number is quite low (this information is coming from the PPD).

Cleaning and maintenance of equipment
Spraying machines are cleaned with surface water and discharged right on the field not directly to the surface water.

5.5.2.3 Disposal and waste

Disposal
Growers were asked what they do with the diluted left-over's in the tank/bucket. They often finish the pesticide they already mixed by extra spraying of the field. After that they clean the equipment with surface water and spray the rising water also on the field.

Waste:
Compared to Me Linh and Sapa the amount of waste found in the rose fields was smaller. Still there is a lot of waste found in piles round the green houses and open fields.

Growers were asked what they do with the waste. All of them collect waste (empty pesticide bag/bottles) and put it in one big bag for later burning or disposing into the landfill. According to their estimate, most of growers (90%) in the region are quite good at

taking care of the waste because they are well informed by the local government (such as the Dalat Agricultural Center) related to this issue.

According to the PPD each grower takes care of treating agricultural product waste by their own. No official treatment methods have been developed by the government. Domestic waste is collected in one place. No waste treatment plant is present in the region so far. The local government plans to set up such plant for domestic waste in the near future.

5.5.3 Human health

5.5.3.1 Protective clothes

Table 5.9 presents the respondents indications on the protective personnel devices they use while spraying pesticides.

Table 5.9 Percentage of growers using the following personal protection items

Protection device	*Frequency (%)*	*Reason (note)*
Regular mask (cotton)	100	The cotton mask can be used for 3-5 times and will be disposed. Growers always wear masks in the rose production because the plants are higher than most vegetables.
Special mask	20	
Boots	100	Idem
Raincoat	50	Some hot days they don't wear rain coasts because they don't feel comfortable
Hat (sometimes motor helmet)	100	necessary
Glove	50	Most growers only use gloves while mixing the pesticide, not while spraying (they feel uncomfortable - hot)
Glasses	20%	Growers explained the glasses are current not well designed, the water comes from their breath would make it hard for them to see

Picture 5.19 growers showing special mask (left) and standard cotton mask and glasses (right)

Sometimes the growers become totally wet of spraying pesticides (picture 5.20). In 70% of the cases the protective devices (raincoat, mask, hat) are washed after spraying. The remaining 30% leaves the devices to dry and wear them as such during the next pesticide application.

Picture 5.20 getting wet during spraying pesticides

The Phuong Trung Farm always recommends his workers to wear protective devices while spraying. According to the estimation of the director:

- 95% wear raincoat
- 90% wear mask (the regular one only. At first, he advised his workers to wear special mask but they later on don't follow because they don't feel comfortable)
- 50% wear glasses
- 100 % wear boots

The company provides money to his workers to buy these clothes.

5.5.3.2 Side effects of pesticides

The growers were asked to mention health problems and its possible relation with pesticide use. They indicate that there are some direct effects. Symptoms they have experienced themselves are:

1. Dizziness
2. Headache
3. Breathing difficulties when spraying pesticides for more than 4 hours, especially at noon in hot days.
4. Skin problem sometimes
5. Eye alergy (cay mat)

The problems are present more frequently in net or plastic houses than in open fields.

A 5-10 hour interval after spraying pesticides to come back into the net house to work is followed by about 70% of the farm owners. Contract workers usually enter the green house right after spraying.

5.5.3.3 Storage of pesticides

Growers were asked where they store their pesticides. Storage of pesticides and equipment is mostly arranged in a separate barn on the field (picture 5.21 left). Some growers who do not have the financial means to build a barn and keep these items in a specific place just outside of the house (picture 5.21 right). According to the respondents the nozzles are replaced once a year. The Puong Trung company has one separate pesticide store to provide products to every farm.

Picture 5.21 Equipment and pesticides stored in a separate barn on the field (left) and in the greenhouse just on the ground behind the house (right)

5.6 Hazard of pesticide use

5.6.1 Introduction

A *hazard assessment* is done based on the observations and data provided during the field work and using four different hazard indicators (WHO hazard class, leaching potential, and terrestrial and aquatic toxicity index). Hazard estimations are made for crop management practices currently applied by growers in the research area. Hazard estimations are based on pesticide parameters solely and do not take into account site specific aspects, such as climate, soil type and application practices. Also the amounts of pesticides used in the field are not taken into account. Therefore hazard estimations give a relative ranking of the hazards associated with pesticide use patterns. A hazard assessment can be performed in many different ways. In this study four different types of hazards are considered: occupational hazard to human health, hazard to terrestrial and aquatic life, and hazard to groundwater pollution. For each type of hazard a hazard indicator is selected (in part I of the report more information is given concerning each type of hazard).

5.6.2 Hazard to human health using the WHO classification

In Danse et al., 2007a the *WHO Classification by hazard* is explained. In Dalat the respondents mentioned 36 pesticides that are used for the rose production. According to the

shop keepers interviewed some other pesticides are also used by the growers for the rose production. In figure 5.1 these results are not included (only the mentioned pesticides by the growers are included in the figure).

Methomyl and methidathion are ranked as highly hazardous. These active ingredients are used to protect the roses against flower borer, plant hopper and white flies. No other extremely or highly hazardous active ingredients were identified. Remarkable is that 30% of the Active ingredients are not included in the WHO classification. In the annex an is presented overview of the different pesticides, active ingredients and the WHO class to which the active ingredient belongs.

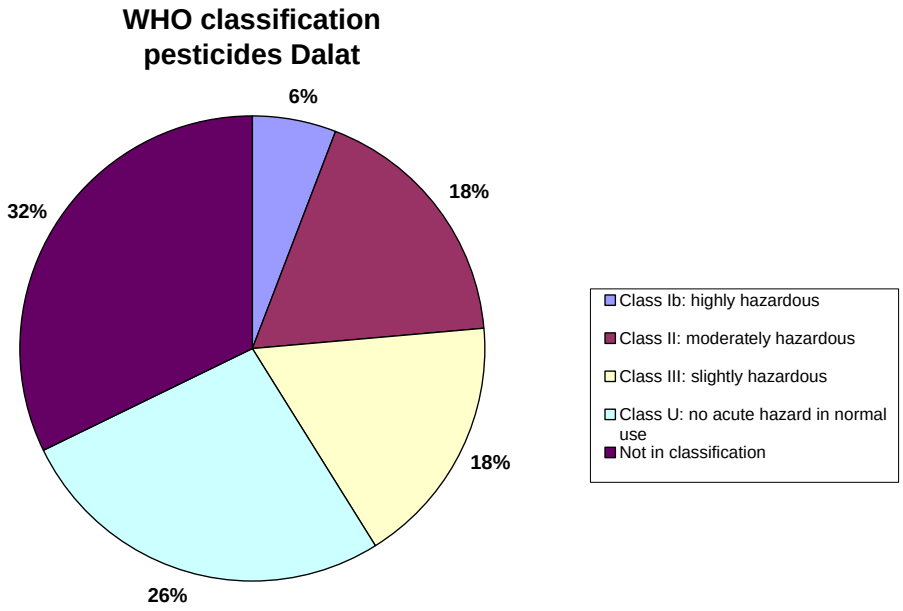

Figure 5.1 Classification of the used pesticides according the to WHO hazard classification

5.6.3 Hazard to aquatic life using the Aquatic Toxicity Indicator

In Danse et al., 2007a the use of the *Aquatic Toxicity Index* (ATI) is explained.

Approximately 50% of the pesticides indicated by the respondents pose a very high hazard for aquatic life (see figure 5.2). Abamectine (LC50 = 0.0003 mg/L), cypermethrin (LC50 = 0.0003 mg/L), esfenvalerate (LC50 = 0.0001 mg/L), halfenprox (LC50 = 0.000031 mg/L) need special attention; these active ingredients are more toxic (< 1 ug/L) than the other very highly toxic active ingredients.

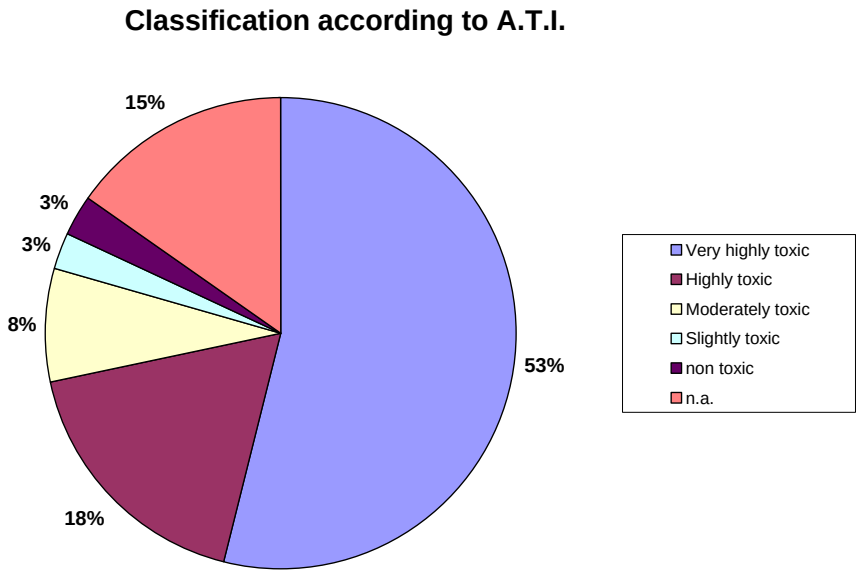

Figure 5.2 Classification of the used pesticides according to the Aquatic Toxicity Index

The potential risk for the aquatic organisms also dependents on the persistence of the active ingredient in the water phase. Extra care should be taken if a pesticide is very toxic for aquatic organisms and if the degradation rate in water is low. In the annex an overview is given of all pesticides, their Aquatic toxicity index and the DT_{50} in the water phase. This appendix shows that dicofol, hexythiazox and esfenfalerate are very highly toxic for aquatic organisms and have a DT_{50} of respectively 29, 11.5 and 30 days.

5.6.4 Hazard to terrestrial life using the Terrestrial Toxicity Indicator

In Danse et al., 2007a the use of the *Terrestrial Toxicity Index* (ATI) is explained.

Pesticides with methiodathion are toxic to terrestrial organisms. Pesticides with abamectine, methomyl, thiamethoxam, dicofol and propargite are moderately toxic to terrestrial organisms.

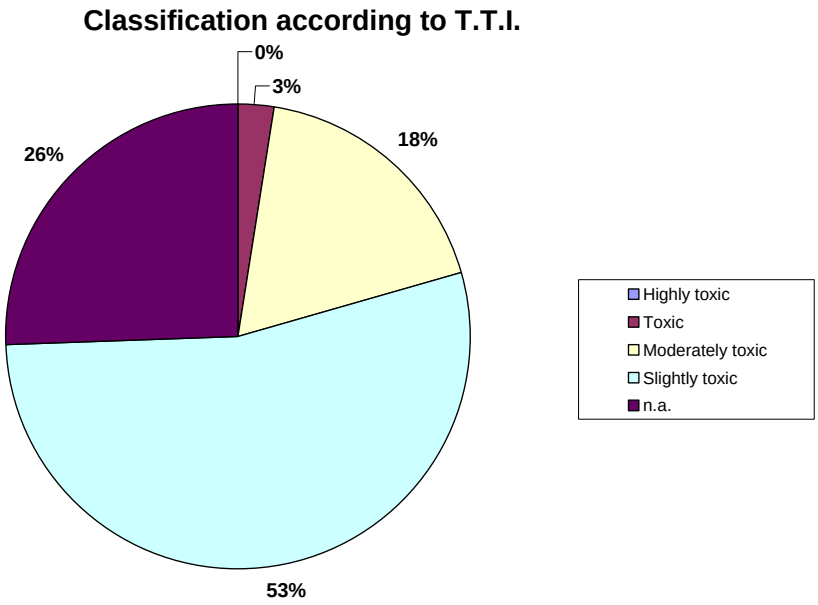

Figure 5.3 Classification of the used pesticides according to the Terrestrial Toxicity Index

The potential risk for the terrestrial organisms also dependents on the persistence of the performance of the active ingredient in the soil. Extra care should be taken if a pesticide is toxic for organisms and if the degradation rate in soil is low. This is not the case for the pesticides used by the growers for the rose production in Dalat.

5.6.5 Hazard to groundwater using the GUS index

In part one of the report the use of the *GUS or Groundwater Ubiquity Score* is explained. Figure 5.4 shows the persistence in soil of the Active ingredients used in Dalat. One active ingredient is very persistent: propiconazole.

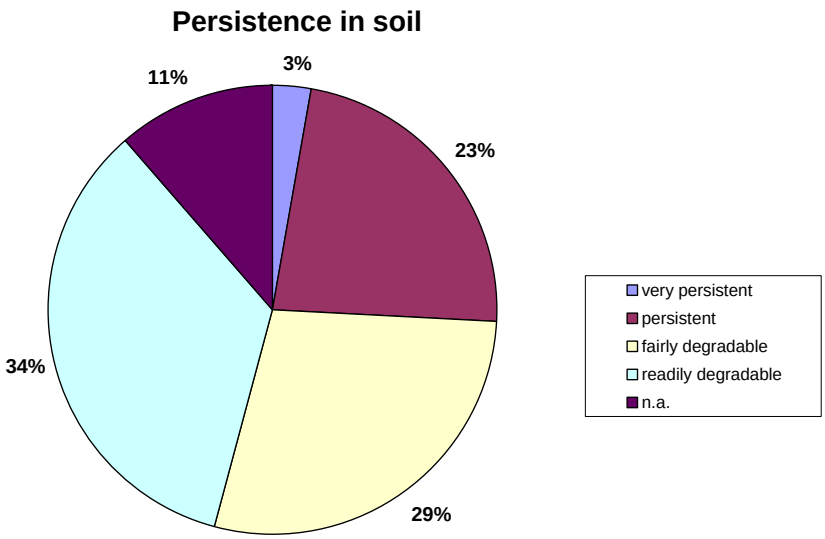

Figure 5.4 Classification of the used pesticides based on persistence in soil

The DT_{50} values used for the classification of the used pesticides based on persistence in soil and the calculations of the GUS leaching index are standardized to a temperature of 20ºC (for the Dalat region).

The half-lives and sorption coefficients used in the study are presented in the annex

The following figure shows the classification of the used pesticides using the GUS leaching index.

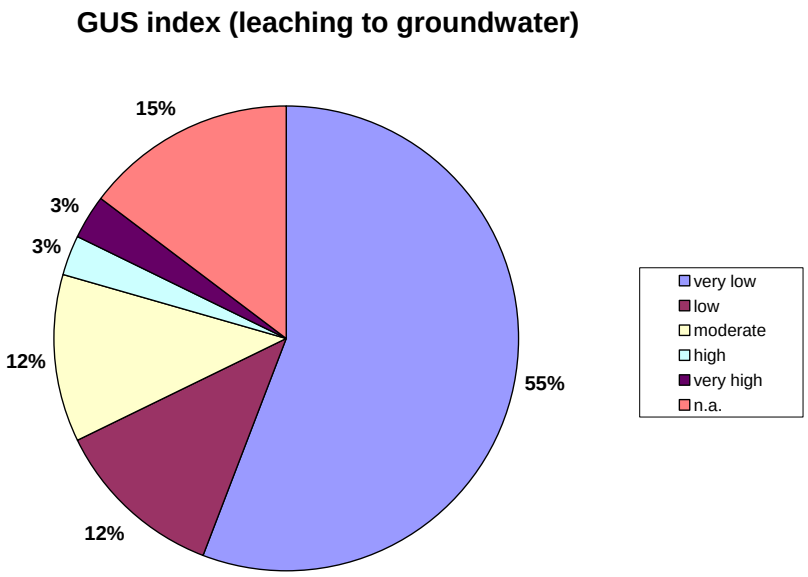

Figure 5.5 Classification of the used pesticides using the GUS leaching index

In Dalat, the active ingredients azadirachtin and methomyl pose a very high and high hazard to groundwater.

5.6.6 Overall results

Table 5.10 gives an overview of the pesticides with a potential high hazard.

Table 5.10 Active Ingredients, formulations and potential high hazard

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	

5.6.6.1 Assessment of hazards to human health

If growers use formulations with hazardous active ingredients that are listed by the WHO classification these poses a potential risk to their health. In Dalat the pesticides with methomyl and methidathion are ranked as highly hazardous. The active ingredients Propiconazole, cypermethrin, profenofos and esfenvalerate are ranked as moderately hazardous. Safe use training with special attention for these pesticides is a suitable intervention.

5.6.6.2 Assessment of hazards to aquatic life

In Dalat further risk assessments should be focused on formulations containing methomyl, methidathion, propiconazole, profenofos, esfenvalerate, propineb, mancozeb, hexythiazox, halfenprox, abamectine, dicofol and lufenuron because these active ingredients are very highly toxic to aquatic life. Special attention is needed for the active ingredients dicofol, hexythiazox and esfenfalerate because these substances are persistent in water! There is a potential risk for the aquatic ecosystem and therefore further risk assessment taking specific site aspects, such as climate and application practices into account is recommended.

5.6.6.3 Assessment of hazard to terrestrial life

In Dalat further risk assessments should be focused on formulations containing methidathion, because this active ingredient is toxic to terrestrial life.

5.6.6.4 Assessment of hazard to groundwater

In Dalat the focus should be on formulations containing methomyl and azadirachtin because there is a potential health risk through the consumption of groundwater and therefore further assessment of the risks of leaching of pesticides to groundwater is recommended.

6. Pesticide control mechanism

6.2 Legislation and registration for roses

Chapter 6.2.4 of part I of the report needs to be updated. Table 6.20 of part I is not totally correct. Table 5.11 provides an adapted overview of the registered pesticides for roses in 2006.

Table 5.11 . Registered pesticides for roses (year = 2006)

LIST OF REGISTERED PESTICIDES IN VIETNAM
(Issued according to the Decision No. 31/2006/QĐ-BNN on April 27th 2006
by the Ministry of Agriculture and Rural Development)

TYPE	ORDER	TRADE NAME	ACTIVE INGREDIENTS	CROP	APPLICANT
Fungicides	6	Bemyl 50 WP	Benomyl (min 95 %)	flower	Công ty CP Nông dược H.A.I
Fungicides	112	Baovil 25 WP	Pencycuron (min 99 %)	flower	Kuang Hwa Chemical Co., Ltd
Fungicides	144	Sameton 25 WP	Triadimefon	flower	Công ty TNHH 1 TV BVTV Sài Gòn
Pesticides	22	Bathurin S 3 x 10^9 - 5 x 10^9 spores/ml	*Bacillus thuringiensis*(var. aizawai)	flowers	Viện Cơ điện NN & Công nghệ sau thu hoạch, Hà Nội
Pesticides	171	Dibaroten 5 WP, 5SL, 5G	Rotenone	flowers	Công ty TNHH nông dược Điện Bàn
Pesticides	172	Dibonin 5 WP, 5 SL, 5G	Rotenone 2.5% + Saponin 2.5%	flowers	Công ty TNHH nông dược Điện Bàn
Growth regulator	1	Vimogreen 1.34 BHN	Acid Gibberellic 1.34% + $ZnSO_4$ + $MnSO_4$ + $CuSO_4$ + NPK + $FeSO_4$ + Borax	flowers	Công ty Thuốc sát trùng Việt Nam
Growth regulator	25	Atonik 1.8 DD	Sodium - 5 - Nitroguaiacolate 0.3% + Sodium - O - Nitrophenolate 0.6%+ Sodium - P - Nitrophenolate 0.9%	flowers	Asahi chemical MFG Co., Ltd
Pesticides	1	Reasgant 1.8 EC; 3.6 EC	Abamectin	rose	Công ty TNHH Việt Thắng
Pesticides	67	GC - Mite 70 DD	Cotton seed oil 40% + close oil 20% + garlic oil 10%	rose	Doanh nghiệp Tư nhân TM Tân Quy
Pesticides	114	May 050 SC	Fenpyroximate (min 96%)	rose	Nihon Nohyaku Co., Ltd
Pesticides	122	Nissorun 5 EC	Hexythiazox (min 94 %)	rose	Nippon Soda Co., Ltd
Pesticides	171	Limater 7.5 EC	Rotenone	rose	Công ty CP Nông Hưng
Fungicides	34	Ketomium 1.5 x 10^6 Cfu/g powder	Chaetomium cupreum	rose	Viện Di truyền nông nghiệp
Fungicides	37	Daconil 75 WP	Chlorothalonil (min 98%)	rose	SDS Biotech K.K, Japan
Fungicides	52	PN - balacide 32WP	Copper Oxychloride 17% + Zinc sulfate 10% + *Streptomycin sulfate* 5%	rose	Công ty TNHH Phương Nam, Việt Nam
Fungicides	57	Stifano 5.5SL	Cucuminoid 5% + Gingerol 0.5%	rose	Công ty TNHH Sản phẩm Công nghệ cao
Fungicides	61	GC - 3 83DD	Dầu bắp 30% + dầu hạt bông 30% + dầu tỏi 23% (maize oil 30% + cotton seed oil 30% + garlic oil 23%)	rose	Doanh nghiệp Tư nhân TM Tân Quy
Fungicides	71	Lilacter 0.3 SL	Eugenol	rose	Công ty CP Nông Hưng
Fungicides	71	PN - Linhcide 1.2 EW	Eugenol	rose	Công ty TNHH Phương Nam, Việt Nam
Fungicides	81	Anvil 5 SC	Hexaconazole (min 85 %)	rose	Syngenta Vietnam Ltd
Fungicides	83	Manage 5 WP	Imibenconazole (min 98.3 %)	rose	Hokko Chem Ind Co., Ltd
Fungicides	84	Bellkute 40 WP	Iminoctadine (min 93%)	rose	Nippon Soda Co., Ltd
Fungicides	157	TP - Zep 18EC	Vegetable oil combination (temple oi, lemongrass oil, rose oil, holy basil oil, lemon oil)	rose	Công ty TNHH Thành Phương
Growth regulator	15	Stinut 5 SL	Gibberellins	rose	Công ty TNHH Sản phẩm Công nghệ cao

LIST OF REGISTERED PESTICIDES IN VIETNAM
(Issued according to the Decision No. 59/2006/QĐ-BNN on August 8th 2006
by the Ministry of Agriculture and Rural Development)

TYPE	ORDER	TRADE NAME	ACTIVE INGREDIENTS (COMMON NAME)	CROP	APPLICANT
Red spider mite	20	Atamite 73 EC	propagite	rose	Công ty TNHH Việt Thắng
powdery mildew	76	Vieteam 80 WP	tricycazole 0.5% + sulfur 79.5%	rose	Công ty CP Thuoc BVTV Việt Thrung
Growth regulator	1	Alsti 1.4 SL	sodium ortho-nitrophenolate 0.71% +sodium para-nitrophenolate 0.46% +sodium 5-nitroguaacolate 0.23 %	rose	Công ty TNHH SP Công Nghe Cao
bio- origin products					
Insecticide (RSM, thrips, aphids)	33	Plutel 1.8 EC, 3.6 EC	abamectine	rose	Guizhou CVC INC.
Insecticide (RSM, thrips, aphids)	41	Susupes 1.9 EC	emamectin benzoate	rose	Công ty TNHH San pham Công nghe cao
Fungicide (underdeveloped roots)	1	Bio-Humaxin Sen Vang 6 SC	Trichoderma spp 10+05 CFU/ml 1% + K-Humate 5%	rose	Công ty TNHH An Hung Truong
Fungicide nematode/root spot	4	Etobon 0.56 SL	cytokinin (Zeatin)	rose	Công ty TNHH An Hung Phat
Fungicide, Black spot, rust, powdery mildew	5	Fulhumaxin 5.65 SC	Trichoderma spp 10+06 CFU/ml 1% + K-Humate 3,5% + fulvate 1% + Chitosan 0.05% + vitamin B1 0.1%	rose	Công ty TNHH An Hung Truong

According to table 5.11, 33 pesticides are registered for roses currently. The pesticides Nissorun 5, EC Anvil 5 SC and Plutel 1.8 EC, 3.6 EC were mentioned by the growers in Dalat as pesticides they use in the rose fields. In almost all the cases growers use pesticides which are registered for other crops. This is also the case in Me Linh and Sapa. Growers use these pesticides registered for other crops. According to them they know how to use these pesticides for roses.

6. Market access and market constraints

6.1 Introduction

The field work allowed us to assess at a general level the current status of marketing chains between small rose growers from Dalat and their most important final market, being Ho Chi Minh and decreasingly Hanoi. In this region there are also a number of companies present that initiated export activities, but they do not include roses. The most important flowers for export are chrysantum and lilies.

The research team interviewed different combinations of actors related to different levels of the rose chain; small growers, managers of larger cultivation and trade companies and their workers, wholesalers, flower shops, flower stalls, hawkers and final consumers. Due to the short time available it was not possible to survey in a systematic way these different chain actors. But based on semi structured interviews, site visits and participatory observations useful information was collected, that helped to reconfirm and up date information already collected as part of the ProPoor Horticulture program (Quang et al., 2004).

The Lam Dong area, where Dalat is situated at, is the main flower cultivation area of Vietnam. The total flower production area in Da Lat is approximately 400 ha, and is estimated to have an output of 250 million stems per year [7]. The local government development policy has projected an increase to a total production area of 500 ha by 2010. A high percentage of flower producers in Da Lat are small family enterprises. Very few growers sell their products directly to the final consumer. Most flowers are sold through traders and wholesalers. There have been recent moves to establish flower grower cooperatives in Da Lat to better support farmers. The majority of produce is transported to Ho Chi Minh City for sale or distribution to other cities, while some is transported directly to other major cities Nha Trang, Da Nang and Ha Noi. In Da Lat flowers are sold in the central city retail market where there are 30 permanent stall holders, and in many small town markets. Local shops also sell bunches of flowers, especially on lunar special days.

6.2 Flower collection

Information about flower collection was gathered by a visit to one collectors/traders home followed by a SSI with 5 invited rose collectors. Only the collector were the interview took place had installed a cold store in the collectors area. The others did not consider the investment necessary. The owner of the visited cold store started this activity to comply with the requirements of the export of lilies. The collectors interviewed are also rose sellers and rose growers themselves. Besides their own production, they also buy roses from other farmers and work together with the transporters to bring the flowers to the markets outside of the region.

Criteria for them to buy flowers include:

- Big bud
- Thick and long stem
- Straight stem, without branch
- Having many leaves.
- Green, greasy leaves.
- No spots (due to pests and diseases) on the leaves

One collector indicated the presence of residue on the leaves as one of the quality criteria that would cause rejection by some of the buyers in the Ho Chi Minh market.

However, when there is less supply than demand, they are prepared to accept flowers that do not meet these quality criteria, which is the case in periods of important holidays such as Tet. As in the Me Linh and Sapa region, the flowers of different suppliers (all regular suppliers, selected because of their quality) are mixed together to be classified into 3 categories:

- First class (criteria not specified)
- Second class (criteria not specified)
- Third class (criteria not specified)

6.3 Market access constraints

The price that collectors pay to rose farmers depends on the daily market price. Information on price is provided by collectors and whole sellers in Ho Chi Minh, Dalat and Hanoi or at the commune market, and the demand-supply relation on markets. Collectors offer prices based on the actual market price of flowers in their final market destination. For flowers of higher quality they would offer higher price and vice versa. The collectors observe a change of selling to the whole sale markets towards sales to the retail sector. These consist mainly of flower shops. Supermarkets represent still a small market segment.

Red rose is still considered the most popular flower among consumers and the best flower to be sold, but in recent years there has been an increasing demand for roses of other colors such as white, yellow, and pink roses. Besides roses, customers are more and more interested in other flower variety such as lily, chrysanthemum and orchids. In the Hanoi market Dalat roses compete with cheaper Me Linh roses and flowers coming from other regions, partially also outside of Vietnam. For this reason, the sales from Dalat to Hanoi have decreased the last ten years, and sales have become more concentrated to the Ho Chi Minh market, and in some cases to foreign markets, such as Russia, Malaysia, and even in some cases Japan.

The Dalat flower sector enjoys some geographical benefits for flower cultivation, such as the climate conditions, altitude and availability of sufficient water. Besides that, the local growers have significant experience with commercial farming activities, which shows by the way the farmers search for cultivation practices and post harvest techniques that help them to comply with the market requirements. Most farmers have implemented green house techniques on their farms, which helps to protect the flowers against some pests and diseases. Also, most collectors store the flowers after harvesting in water buckets and

classify the flowers by size and other criteria in order to be able to sell the different flower qualities to the different possible market segments.

However, an important condition that affects the Dalat flower sector is its long distance to attractive markets. Besides the local Dalat market, the most important market in its region is Ho Chi Minh city. This city is located at a 4-5 hours distance by truck. Currently there is no air transport for cargo available which implies that all transport has to be done over the road. The conventional mean for road transport is using small trucks over loaded with cardboard boxes full of flowers (picture 6.1). This transport mean affects in a very negative way the quality of the flower offered to the market, and limits the possibilities of the growers and the intermediaries to comply with requirements of growing market segments, such as the retail sector.

An exception to the above mentioned transport problems is Dalat Hasfarm. This company, currently exporting a great deal of their production, owns refrigerated trucks that bring the flowers to the airport of Ho Chi Minh City.

Picture 6.1 Conventional transport meant to bring flowers from Da Lat to its markets

7. Research objective 2: Information, knowledge, and learning on sustainable rose cultivation

7.1 Access and availability of information on pesticide use and environmental friendly cultivation

7.1.1 Relevant actors

Da Lat Commune

As in Me Linh and Sapa, also in Da Lat growers, local district officials and representative of the local agricultural research institutes were invited to indicate the relevant actors that provide information to local rose farmers on cultivation practices. Figure 7.1 presents the actors indicated by 3 rose growers. Two of them grow flowers since 1994, one of them since 1978. Each of them started first with roses, but are now also involved in growing gladioli, gerbera, baby's breath, and carnation. Nevertheless, the rose is the most profitable flower of their assortment. Lilly is also very profitable but the bulbs come from The Netherlands and are very expensive. The growers deliver their flowers directly to local whole sellers, whom transport the flowers to Ho Chi Minh city. The flowers are sold in three districts, being: Ho Thi Ki, Dam Sen and Hau Giang markets. In most of the cases, high quality flowers go to HCMC. Lower quality flowers are sold at the local market in Da Lat. The whole sellers pay the growers after the sales. The growers have the impression the whole sellers pay less than they really receive at the market.

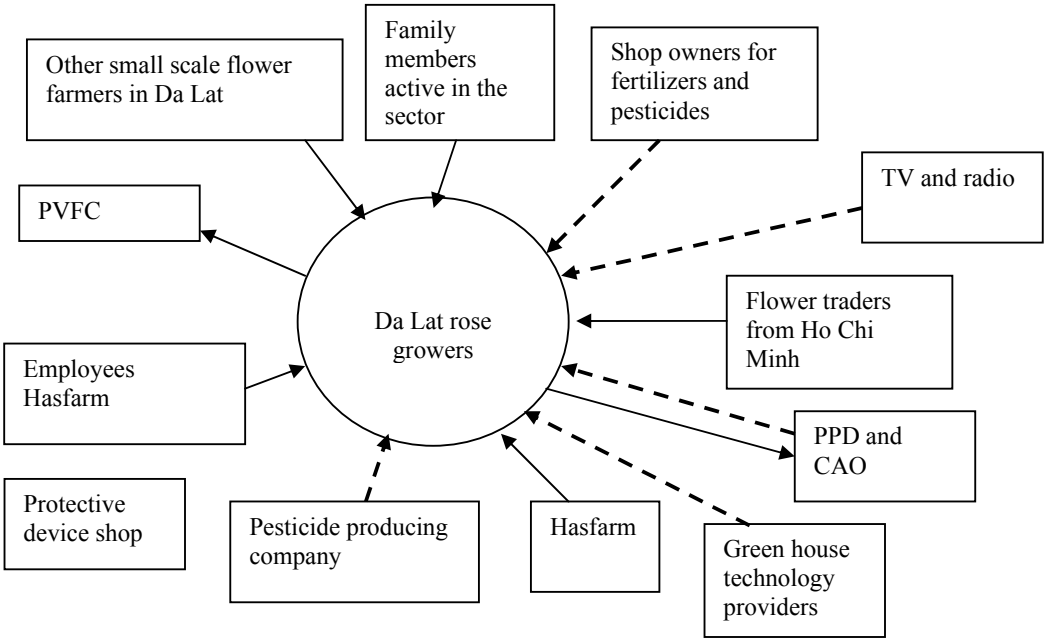

Figure 7.1 Perception of Dalat rose growers on actors providing information and support towards the sector

The most important direct source of information for these growers is exchanging experience with other farmers, and then especially family members. The information they obtain through these linkages is related to cultivation practices, green house installations and market opportunities. Besides that, they receive information through the traders whom visit the region periodically. The information they obtain from them is related to price, quality requirements (length, bulb size and freshness), bulb color, and market acceptance of new flower varieties.

The most important indirect source of information is Hasfarm (see also chapter 5.1.2). This company is leading in the region the introduction and use of new cultivation techniques, the use of new varieties, and creating access to new markets, especially export. Until recently Hasfarm did not provide local farmers the opportunity to visit and learn about their cultivation practices. Nevertheless, since the presence of Hasfarm in the region local farmers obtain information through the workers of Hasfarm. Also some workers started working as technical advisors for local companies after having worked for some year in Hasfarm. Recently Hasfarm has opened up the company and initiated with the support of the Danish development agency Danida a technical assistance program, which enables 10 farms to become subcontracting farms of Hasfarm. These farms will receive training and technical advice on cultivation and post harvest practices from Hasfarm and will be able to sell their flowers through Hasfarm.

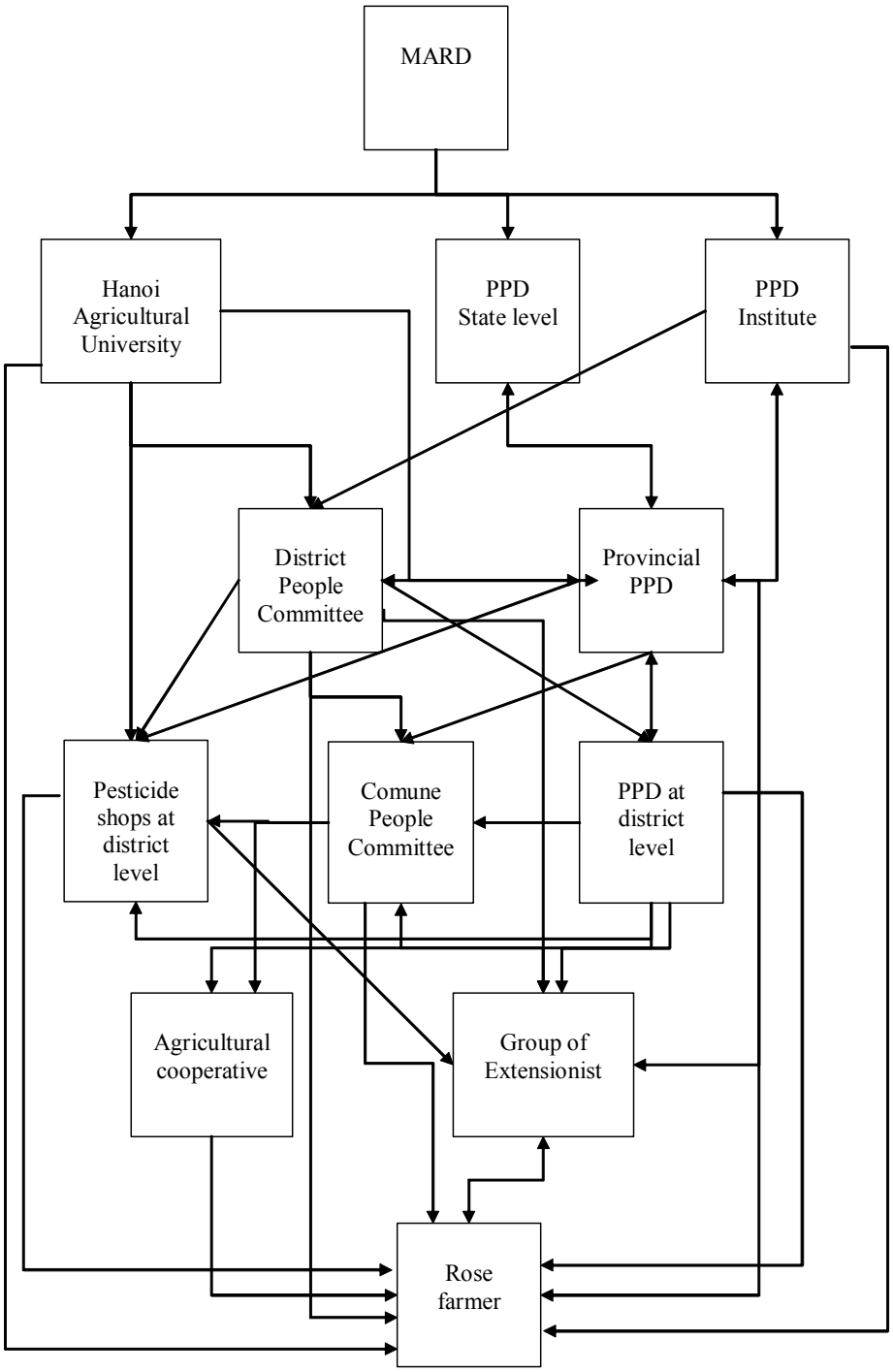

Figure 7.2 Indication of local authorities and growers on public actors providing information to rose farmers in Me Linh commune

With regard to public technical assistance, the growers recognize the presence of local governmental entities providing support to the agricultural sector. The available structure on public services is comparable to the structure present in Me Linh (see figure 7.2.). Their support consists of training, technical assistance, and conducting applied research. However, the information and knowledge available in these institutes are not considered useful, since they perceive a lack of specialized knowledge on flower cultivation within the staff available. And in some cases growers even feel that they provide them information and teach them instead of the other way around (see arrow in figure 7.1.).

With regard to the information on crop protection methods, there are local pesticides shops present, and local representatives of pesticides producing companies sometimes organize meetings to introduce a new product. The growers perceive the knowledge and experience of pesticide shop owners regarding pests and diseases and crop protection methods as limited. Their information on new products is useful, but the pesticides producing companies do not use the opportunities of local meetings to provide information on other crop protection methods but the application of chemical products.

Growers are aware of the importance to protect themselves against inhaling and direct skin contact with pesticides. They have learned about risks and personal protective devices through the television. In Da Lat there is a specialized shop on personal protective devices. However, in practice they use only textile masks and rain coats, since they consider the more professional equipment offered as too expensive and uncomfortable in use.

Regarding their knowledge on irrigation systems and green house construction (see also chapter 5.2.2), they have learned from looking at the technology used by Hasfarm, but build the infrastructure themselves. There are local companies present that sell the materials and install the infrastructure, but the growers consider them too expensive. Information on the design of the irrigation infrastructure is obtained from local vegetable farmers and adjusted to the conditions of flower cultivation (not necessarily roses). The greenhouse design is copied from the Hasfarm model, but built with local materials and poorly maintained, due to which the structure is sub optimal in comparison to the infrastructure at Hasfarm.

The farmers have access to internet, but they hardly use this to obtain information about cultivation practices, since there is no useful information available in Vietnamese and most of the information they would like to know about is provided in English.

The growers indicated that they have a need to access better information on cultivation techniques, especially on pest and disease control methods and post harvest treatment. (Note author: It is interesting that they mentioned this issue, since earlier they had answered they are not doing any post harvest treatment because the flowers go directly from the farm to the whole seller and then to the market).

An important difference between the institutional framework present in Da Lat and the other two regions analyzed, is the recent establishment of the flower growers association. This association is a public private initiative meant to be a platform to represent the interests of the sector towards local public institutes. Besides that, it is expected that the Association will also help to collect and make available market information. The opinions about this initiative resulted to be diverse. Some farmers and

representatives of public entities consider the Association an opportunity to improve the negotiation power of the sector towards different external entities, and a good vehicle to collect and organize market information. Others feel it as an extra bureaucratic entity of which not too many results should be expected. This last opinion is logical, since the Association is a very new initiative, that formalized its institutional settings at the end of 2006. The practical activities to support the sector still have to be initiated. The development of the platform receives aid from the Danish development agency DANIDA.

The director of the Phuong Trung Farm gets his knowledge related to plant protection from books, newspapers, internet, and based on his own experience. The director has also gained knowledge after some trips to China. He also learns from his friends in Australia and Israel. He has been supported by the provincial government to attend a training course in China. He got this support because he provides a lot of jobs

The small growers get information related to pesticides from neighbor growers, from shop keepers, workshop by pesticide companies and newspapers. The interviewed growers indicate that not only them but also other growers are willing to share information related to pesticides, pesticide use, and even varieties. However, based on their experience, different growers have different ways to use pesticides depending on their land properties, fertilization and watering regime.

They get the information related to how to spray pesticides:

- Self learning (own experience)
- Update from the available equipments in the market. For instance, they used to use tank for pesticide spraying. When the motor with pipe is introduced to the market, they buy and keep using this as its effectiveness over the tank. Usually, the nozzle is replaced with the new one once per year.

Sometimes samples of new products are introduced by the pesticide companies and/or the pesticide.

According to the PPD they provide the following information to the growers and flower association in terms of plant protection:

- Training course
- Seminar
- Mass communication means: TV, newspapers, etc,. PPD in cooperation with other institutes such as DAO, University, agricultural office to develop solutions for plant protection and provide this information to growers through Agricultural Office.
- Recommend 4 A (Appropriate pesticide, appropriate timing, appropriate method, appropriate dose).

7.1.2 Information flows and sources

Based on the interviews with representatives of local authorities and representatives of local research institutes, the flows of information between the different public and private actors are comparable to the situation in Me Linh and Sapa (see Danse et.al, 2007a). Also for this area one can identify three different levels of linkages and flows of information, being: planning, research and development, identification and control of pests and diseases, and the control of pesticides use and new pesticide product introduction. The main

difference in this area is related to the presence of local planning, research and development capacity. In Da Lat there is a number of research institutes present that provide research and technical assistance on the development of breeding and cultivation techniques. As a result of a national policy that stimulates the development of local varieties all institutes have initiated the last 5 years breeding programs and propagation through tissue cultivation techniques. Nevertheless, none of the institutes has been able to develop a profitable business activity out of this. On one hand, the legislation allowing a breeder to register a variety requires that a certain variety is cultivated at surfaces beyond the reality of the intensive horticultural crops. Therefore, the variety must be given to growers to allow registration. On the other hand, the growers are not prepared to pay royalties for the new local varieties, when they can buy the flowers on the market and propagate them 'for free'.

Although there are floricultural crops that benefit from propagation by tissue culture, roses are world wide mostly propagated by other, faster techniques.

7.1.3 Information availability and accessibility

As indicated already before, the most important source of information Da Lat farmers use to learn about cultivation practices is information obtained from other farmers in the region and by copying the cultivation practices of Hasfarm. The information on cultivation techniques and practices from Hasfarm is not easily accessible for small farmers. Hasfarm limits its training activities to their own workers. Recently they became involved in a Business Development Services program of DANIDA. As part of this program they initiated working relations with small scale rose farmers. The cooperation agreement includes the training of these farmers by Has farm experts. Other farmers in the region obtain their information through family members or acquaintances working for Hasfarm and through former employees that have started their own commercial technical assistance initiatives. Nevertheless, what can be observed is that the access to information is mainly obtained by observing and copying, without receiving the related knowledge needed to understand the reasons behind these techniques. Due to this lack of real knowledge transfer, small farmers apply the copied techniques in a sub optimal way. Evidences for this are the illicit use of the varieties for which Dalat Hasfarm pays royalties, and the inappropriate use and maintenance of the green house structure and sub optimal irrigation systems (good for Chrysanthemum, the main crop of Dalat Hasfarm, but not suitable for roses). For further information see chapter 5.3.1.

Picture 7.1 locally adjusted rose cultivation techniques

7.1.4 Existing initiatives on adjustments of production methods

Dalat rose growers were asked to indicate the most important adjustments that the rose production and trade had experienced since the establishment of Hasfarm in 1995. Table 7.1 presents the information collected.

Table 7.1 Inventory by rose growers of most important adjustments made to flower cultivation and post harvest activities in Da Lat before and after 1995

Cultivation activity	*1995*	*2007*
Rose variety	French rose variety	French, German and Dutch variety
Flower variety	Roses, local gladioli	Roses and other flowers
Site planning	Lower plant density (5 plants/m^2)	Higher plant density (10plants/m^2)
Cultivation method	Open field	Green house
Irrigation	Sprinkler irrigation, no change	
Pesticides application	Formula ?	Increase use of mixtures ?
Pesticides amount	Lower dosage	Higher volumes
Frequency of pesticides application	1-2 times a week	3-4 times a week
Fertilizer application	Cow manure	Cow, goat, fish manure
Protective devices	Limited	Mask, raincoat
Post harvest treatment	No special treatment given/In most of the farms nor collectors sites is cold storage available	
Market segments	Ho Chi Minh city and Hanoi	Ho Chi Minh City and middle provinces
Market linkages	Direct sales, or via local collectors	Direct sales, local collectors and out grower schemes with bigger intermediary farms.

One can observe from the list of changes indicated, that the production chain has experienced some changes towards functional specialization. New actors got involved, providing business development services, which help the rose growers to improve their

negotiation position in the market. Also, adjustments have been made to the production methods, partially to improve the quality of the flower and to comply better to market requirements. But also adjustments have been made, to reduce costs for the growers to be better able to cope with a continuous decrease of sales prices and increase of competition.

An important difference between the situation for small rose farmers in Dalat in comparison to the growers in Me Linh and Sapa, is the fast change they have experienced in the cultivation techniques applied. This is due to the introduction of new techniques by Hasfarm. This example shows that the introduction of market conform process innovations can be accepted and assimilated by small farmers in a relative short period. In this case, the knowledge and experience of public entities is far behind and has great difficulties to recuperate the knowledge gap created.

Another important difference between Dalat and Me Linh is the introduction of out grower schemes. This scheme has also been introduced by ATI in the Sapa region and seems to be an attractive solution for bigger farms to expand their production capacity without becoming the owner of all the land. And for the small scale farmers involved it is a great opportunity to learn from the buyer about improved cultivation practices and market requirements.

To change the pesticide use toward the environmental friendly way, the director of the Phuong Trung Farm proposes to:

1. Grow roses in substrate
2. Grow roses in modern glass house because glass house can reduce pests, hence, reduces pesticide use
3. Reduce waste and reuse waste. Dead rose plants can be reused as compost.
4. post harvest technology improvement
5. use of sulfur gas for diseases.

According to the PPD a plan for prevention includes:

- Apply IPM on rose production
- Implement research to set up standard technical procedure on every crop product
- Improve growers' awareness of pesticide use
- Improve management capacity

8. Observation and recommendations

8.1 Observations on the problem definition

The general problem definition of this field work can be summarized as:

- The abundant and incorrect use of pesticides limits the sustainable development of the rose sector in the Da Lat region

Based on the interviews with different stakeholders involved in the rose sector in this region, it can be observed that:

- The vast majority of small scale rose growers in Da Lat are not aware of the negative impact of pesticides use on sales opportunities.
- The bigger growers that started export activities have been confronted with the negative relation between pesticides use and market opportunities based on the feed back received from foreign potential buyers.
- At an institutional level, representatives of the Agricultural Institute and the local agricultural research centers observe the need to improve knowledge on the safe use of products to decrease the negative impact of pesticides use on human health. However, they do not observe a clear relation between pesticides use and market opportunities.
- Representatives of local research institutes observe a negative relation between pesticides use, plant growth and flower quality, and confirm the need to improve the knowledge on integrated pest management methods but also the use of new varieties, better adapted to the local climate and geographic conditions.

For this reason, it can be concluded that a number of stakeholders related to the by small growers dominated Vietnamese rose cultivation sector, reconfirm the importance of doing more research on the relation between pesticides use and market development, and the importance of exchanging information and experiences regarding more sustainable cultivation practices, since this can help the small growers to improve their production, market opportunities, health and environment.

8.2 Observations Dalat rose production area

8.2.1 Cultivation practices and their relation with pest and disease incidence

- Great differences are encountered among the Dalat growers concerning the level of knowledge, technology and equipment. Therefore, not all of these observations apply for all the companies visited.
- The current cultivation practices are in general more advanced compared to the areas of Me Lihn and Sapa. Still, there are a lot of opportunities for improvement in

hygiene, irrigation, fertilization and post harvest practices that can directly lead to a reduced use of pesticides, increased production and quality.

- In the current cultivation practices, plant health is seen as a synonymous for abundant pesticide use. Too little attention is paid to prevention of diseases by correct fertilization (healthier plants), correct irrigation (less fungal diseases), precedence and health of plant material (the seedlings and cuttings).
- There is a serious lack of hygiene in and around the field and too little awareness on the effect of hygienic measures on the prevention of plant diseases.
- There is a serious lack of maintenance of the greenhouse structure and equipment, which has a direct effect on the pest pressure.
- The number of pests and diseases the growers have to deal with seems to be smaller than in the previously visited areas of Me Lihn and Sapa.
- As in previous areas, plant nutrient deficiencies are not recognized as such, which potentially leads to the unnecessary use of pesticides.
- Damage caused by pesticides is not always identified as such, but it is sometimes attributes to fungi, which leads to unnecessary pesticide application.

8.2.2 Integrated pest management

- Integrated Pest Management is not yet a feasible possibility to combat pests and diseases in most of the visited Dalat farms, but it is certainly closer to become a reality than in the northern areas. There are however exceptions to this observation: provided they would receive the appropriate support, Dalat Hasfarm is definitely prepared to start experiencing with IPM; they are probably not the only ones, as farms supplying Phuong Trung Farm could make some small steps towards IPM soon.

8.2.3 Chemical control

- Chemical control is the only pest and disease control method used by growers at this moment.
- Pesticides are chosen without a proper diagnose and mostly by trial and error.
- Pesticides are mostly chosen, alternated and mixed without a resistance management plan.
- Growers are not aware of the negative effect of pesticide applications on production, which increases indirectly the costs of every application.
- The maintenance of the spraying equipment is limited to cleaning the spray tank and parts are replaced only when broken; this can lead to excessive pesticide use.
- All growers interviewed spray the whole field in case of a pest or disease; even if the pest or disease is found in a small area (except the Phuong Trung company). The impact on the human health and environment increases by doing this. It is also a waste of money and time since more pesticides are used.

- The presence of pests and diseases has increased over the last 5 years. It is unclear if the amount of pesticides used has increased over the last 5 years. Different growers have different opinions about this
- According to the small growers the costs of the pesticides is 25 - 50 % of the total input costs.
- 30 different kinds of pesticides are mentioned by growers in Da Lat which they use for the rose production. Some of the pesticides are the same as mentioned by the growers of Me Linh and Sapa like: Score 250 EC, Alliette 800 WG and Mancozeb 80 WP. In Da Lat also some pesticides are used which are not used in the other regions like, Melody duo 66.75 WP, Sumi alpha 5 EC and Kummulus 80 DF .

8.2.4 Estimated environmental and human health impact of pesticide use in rose cultivation

Environment

- Growers do not experience negative impact on the environmental which they relate to the use of pesticides.
- According to the opinion of the growers they are quite good in taking care of the waste. But during the fields visits a lot of waste was found in piles around the green houses and open fields.
- Due to the way of irrigating and spraying by the growers there is drift to the ditches. All the surrounding water in the communes will be polluted by pesticides. This will cause a potential environmental risk for aquatic organisms, birds and mammals.

Human health

- Growers do experience problems with their health which they relate to the use of pesticides. Dizziness, headache, breathing difficulties are mentioned as most problematic side effects.
- Growers often wear protective clothes like mask, boots, raincoats, hat and gloves. Glasses are used in 20% of the times because the growers believe that the current glasses are not well designed.
- Sometimes during spraying of pesticides (especially in the green houses) the growers become totally wet which can be more risk full for health.

8.2.5 Hazard assessment of pesticide use to human health and environment

- When farmers use formulations with hazardous active ingredients according to the WHO classification it poses a potential risk to their health.
- Risks for human health and environment are estimated by hazard assessment on the basis of farm monitoring and the use of different hazard indicators. Hazard estimations are based on pesticide parameters solely and do not take into account site specific aspects, such as climate, soil type and application practices. Based on the hazard assessment it can be observed that there is a potential health and

environmental risk due to the current use of pesticides in the rose production in Da Lat.

- Special attention is required for those pesticides which are ranked hazardous according to the WHO classification; very toxic and highly toxic according to aquatic or terrestrial toxicity indicator; high according to the GUS leaching index.

8.2.6 Pesticide Control Mechanism

- 33 pesticides are officially registered for roses. The pesticides Nissorun 5, EC Anvil 5 SC and Plutel 1.8 EC, 3.6 EC were mentioned by the growers in Dalat as pesticides they use in the rose fields. In almost all the cases growers use pesticides which are registered for other crops.

8.2.7 Commercialization and pesticides use

- The absence of pesticide residue on the leaves is not a quality requirement used by buyers.
- Vase life is not a buyer requisite, but a certain awareness of its importance is present, since most of the growers mentioned it as one of the criteria for classification (the best flowers are sent to the most distant market) and was and as one of the subjects they would like to improve on.
- For the only rose exporting company visited, pesticide residue and vase life are certainly part of the relevant market requirements.
- A lack of knowledge on the importance of post harvest treatment methods harms the produce considerable during the temporary storage and transport to the market. A big part of their efforts to produce a good quality flower in the field, is lost due to the post harvest activities for which farmers do not receive the price they should receive.
- The majority of the local traders sell to a variety of market segments, such as whole sale, street hawkers, flowershops and even supermarkets.
- Some have been able to export to neighboring countries, especially chrysanthemum and lilies.
- The governmental program has stimulated the last years the development of local varieties. Due to this, the majority of the local research and development institutes have made great efforts in this (and even tried commercial activities selling seedlings). However the regulations for variety registration hinder the protection of new varieties. Moreover, due to this effort concentration there is not enough capacity left for research on cultivation practices, technological innovation/adaptation/market information. It could be because the government has not invested in making a good value chain analysis of the sector to identify the diverse constraints.

8.2.8 Findings learning and innovation

- The most important stimulator for learning and innovation of small scale rose cultivation in Da Lat has been the establishment of Hasfarm.

- Farmers learn about cultivation methods mostly through other farmers, and especially through the exchange of information with (former) technicians of Hasfarm.
- The local institutions currently lack the required knowledge and capacity to support small scale farmers with entrepreneurial attitude to apply the required practices and technology to be able to compete.
- Farmers have been able to copy certain important cultivation practices from Hasfarm, but lack the real knowledge to understand the optimal use of it, which results in a semi optimal development of the competitiveness of their produce.
- With the support of development cooperation, a flower association was created recently. This could help the farmers, managers of private companies, and officials to exchange knowledge and experience on cultivation practices and markets. However, it has not been clear yet how they are going to bring in the required knowledge.
- Due to the higher level of development of the sector in comparison to Me Linh and Sapa and the more commercial focus (explain better), respondents of the private sector, farms and officials in Dalat are more aware of the importance to obtain information and learn about market requirements and market opportunities.
- The introduction of outgrower schemes has created private sector learning networks that link in an effective way market demand with production capacity.
- Due to the introduction of out grower schemes, small farmers growing chrysanthemum and lily have been able to comply with export market requirements. Out grower schemes are also being applied by rose growers, but have not resulted yet in successful export.
- It might be difficult to develop certain Business Development Services needed by small scale farmers (such as protective personal devices, drip irrigation) due to the lack of awareness and knowledge on the importance of these services for the development of the sector.
- The public institutional framework is comparable in the three regions. Nevertheless, the local research and agricultural assistance offices in Da Lat have more difficulties to offer services that comply to the needs of the farmers, due to the rapid changes the sector has experienced during the last ten years, which are difficult to deal with in a public environment since there is a lack of money and capacity.

8.3 Recommendations Dalat rose production area

- There is a lot to gain on pesticide use reduction by the implementation of elementary hygienic measures and maintenance of the greenhouse equipment that contribute to a lower pest and disease pressure in the greenhouse.
- The creation of demonstration and training plots in which the relationship between the irrigation method and the disease pressure becomes clear for all the growers is recommended.

- The effects and feasibility of the use of preventive measures against f.i. powdery mildew in the existing greenhouses should be studied.
- The exemplary value of the more advanced farms should be encouraged and supported (the DANIDA business development project is an good example!)
- The development of a pest control guide for farmers is recommended. This guide should contain information on (i) all pests and diseases occurring in the area, (ii) how to recognize them; (iii) all growth abnormalities not caused by pests or diseases; (iv) which IPM strategies can be followed; (v) which active ingredients are effective; (vi) which formulations contain this active ingredient (only formulations with clear and sound use instructions on the package should be mentioned) and (vii) for each solution a simple indication of the environmental and health risks should be given.
- The creation of a diagnose service in the production areas would be recommended, to assist growers in the determination of new, unknown or less commonly occurring diseases and to choose the right fighting method: physical control (plant removal), chemical control, instead of recurring to the trial and error method.
- Attention should be paid to the use of varieties with special emphasis on pest and disease resistance. For this, awareness on the knowledge gaps derived from the illegal use of varieties needs to be created.
- More emphasis should be put on creating public private partnership for local capacity building on market conform cultivation practices. The state of the art knowledge and experience should not only be shared between bigger farms and their sub contracting farms, but also with local representatives of public entities so they can share this knowledge with the rest of the sector.
- The upgrading of process and product innovation of the entire sector, might help to improve the entire image of the Da Lat flower sector and improve the access to higher market segments in main local urban areas and attractive export markets in the region.
- There is a number of techniques and services that could be provided as a commercial business development services, such as soil analysis, diagnose services, drip irrigation, fertilization equipment, personnel protective devices and pest scouting methods. However, the demand for these commercial activities has to be stimulated by organizing awareness and capacity building activities.
- Training of growers in how to read the labels and symbols is recommended.
- Training of the growers in how to deal with waste is recommended.
- Training of farmers in understanding the importance of wearing protection clothes can improve the health situation of the growers.
- Training of growers and their family in safe storage is recommended.
- Training of growers on how to use pesticides in general is recommended and can improve the health situation for the growers. Safe use training should focus on the use of safety equipment, safe storage, prevention and treatment of pesticide poisoning, disposal of containers, and regulation.
- Hazard estimations are based on pesticide parameters solely and do not take into account site specific aspects, such as climate, soil type and application practices. Based on the hazard assessment it can be observed that there is a potential

environmental risk through the current use of pesticides in the rose production in Da Lat. Further assessment of the risks including mentioned site specific aspects is recommended.

- It is unclear why the growers do not use the registered pesticides, especially because the registered pesticides often have the same active ingredients as the pesticides the growers use. Further research to understand this topic is recommended.

Annex X: Overview of the WHO classification of the pesticides used in Dalat

Trade name	Common name (AI)	WHO classification
Score 250 EC	Difenoconazole 250 g/L	III
Kummulus 80 DF	Sulfur 800 g/kg	U
Cuproxat 345 SC	Tri Copper sulphate 345 g/L	Not found
Zineb bul 80 WP	Zineb 80%	U
Melody duo 66,75 WP	Iprovalicarb 55 g/kg	U
	Propineb 612,5 g/kg	U
Aliette 800 WG	Fosetyl Aluminum 800 g/kg	Not found
Ridomild 68 wp	Metalaxyl 40g/kg +	III
	Mancozeb 640 g/kg	U
Biobass	?	
Nissorum	Hexythiazox 5%	U
Sirpon 5EC	Halfenprox 5%	Not found
Comite 73 EC	Propagite 73%	III
Vetimec 1.8EC	Abamectin 1.8%	Not found
Neem-nim green 0.3 EC	Azadirachtin 0,30%	Not found
Anvil 5 SC	Hexaconazole 50g/L	U
Calyxin	Not available anymore	-
Dithane 80 WP	Mancozeb 800 g/kg	U
Antracol 70WP	Propineb 700 g/kg	U
Long C.A (A Chinese product without label)	Abamectine	Not found
Sumi alpha 5 EC	Esfenvalerate 5%	II
Polytrin 440 EC	Profenofos 400 g/kg	II
	Cypermethrin 40 g/kg	II
Lannate 40 SP	Methomyl 40%	Ib
Rovral 50 WP	Iprodione	U
M8	?	
Mancozeb 80 WP	Mancozeb 80%	U
Tilt super 300 EC	Difenoconazole	III
	propiconazole	II
Pesticide with abamectine	abamectine	Not found
Kenthane 18.5 EC	Dicofol 18.5%	III
Sunix		
Supracide 40 EC	methidathion	Ib
Map cypermethrin 50 EC	Cypermethrin 50%	II
Ammate 150 SC	Ammate	Not found
Plutel 1.8 EC	Abamectine 1.8%	Not found
Selecron 500 EC	Profenofos 50%	II
Actara 25 WG	thiamethoxam	III
Match 50 EC	lufenuron	Not found

Total amount of different products: % of AI in following WHO classification
Ib: 2
II: 8
III: 6
U: 9
Unknown: 11 (not found)

Annex X: Overview of the properties of the Active ingredients of the pesticides used in Dalat

A.I.	*LC50 aquatic (Mg/L)*	*DT50 in water phase (d)*	*LC50 earthw. (mg/kg)*	*DT50 soil (d)*	*Source*
Abamectin	0.0003	4	33	30	Database Alterra
Ammate	-	-	-	-	
Azadirachtin	0.48	-	-	26	Footprint
Cypermethrin	0.0003	3	100	68	Database Alterra
Dicofol	0.075	29	43.1	80	Database Alterra
Difenoconazole	0.77	3	610	140	Database Alterra
Esfenvalerate	0.0001	30	212.5	44	Footprint
Fosetyl Aluminum	5.9	4	1000	0.1	Database Alterra
Halfenprox	0.000031	1	218	10	Footprint
Hexaconazole	1.7	112	414	122	Database Alterra
Hexythoazo?? Hexythiazox	0.04	11.5	105	30	Footprint
Iprodione	0.66	30	1000	84	Footprint
Iprovalicarb	10	54	1000	15.5	Footprint
lufenuron	0.0013	?	1000	22798	Database Alterra
Mancozeb	0.044	0.5	299	0.1	Database Alterra
Metalaxyl	36	47.5	830	20	Database Alterra
methidathion	0.0064	6	5.6	10	Footprint
Methomyl	0.0076	2.9	19	14.8	Database Alterra
Profenofos	0.08			1169	Database Alterra
Propargite	0.1	-	62	56	Footprint
propiconazole	0.011	6	686	214	Footprint
Propineb	0.4	4	700	3	Database Alterra
Sulfur	1.35		100		Database Alterra
thiamethoxam	100	?	1000	?	Database Alterra
Tri Copper sulphate	-	-	-	-	
Zineb	0.51	-	-	30	Footprint

Appendix x Overview of Pesticides, A.I, the A.T.I and the DT50 in the water phase

Pesticide	*A.I.*	*Aquatic Toxicity Index*	*DT50 in water*
Score	Difenoconazole	Highly toxic	3 d
Kummulus	Sulfur	Moderately toxic	?
Cuproxat	Tri Copper sulphate	?	?
Zineb bul	Zineb	Highly toxic	?
Melody duo	Iprovalicarb	Moderately toxic	54 d
	Propineb	Very highly toxic	4 d
Aliette	Fosetyl Aluminum	highly toxic	4 d
Ridomild	Metalaxyl + Mancozeb	Slightly toxic	47 d
		Very highly toxic	0.2 d
Biobass	?	?	?
Nissorum	Hexythiazox	Very highly toxic	11.5 d
Sirpon	Halfenprox	Very highly toxic	1 d
Comite	Propagite	Highly toxic	?
Vetimec	Abamectin	Very highly toxic	4 d
Neem-nim green	Azadirachtin	Highly toxic	?
Anvil	Hexaconazole	Moderately toxic	112 d
Calyxin	Not available anymore	-	-
Dithane	Mancozeb	Very highly toxic	0.2 d
Antracol	Propineb	Very highly toxic	4 d.
Long C.A	Abamectine	Very highly toxic	4 d
Sumi alpha	Esfenvalerate	Very highly toxic	30 d
Polytrin	Profenofos	Very highly toxic	?
	Cypermethrin	Very highly toxic	3 d
Lannate	Methomyl	Very highly toxic	4 d
Rovral	Iprodione	Highly toxic	30 d
M8	?	?	?
Mancozeb	Mancozeb	Very highly toxic	0.2 d
Tilt super	Difenoconazole	Highly toxic	3 d
	propiconazole	Very highly toxic	
Chinese pesticide with abamectine	abamectine	Very highly toxic	4 d
Kenthane	Dicofol	Very highly toxic	29 d
Sunix	?	?	?
Supracide	methidathion	Very highly toxic	6 d
Map cypermethrin	Cypermethrin	Very highly toxic	3 d
Ammate	Ammate	?	?
Plutel	Abamectine	Very highly toxic	4 d
Selecron	Profenofos	Very highly toxic	?
Actara	thiamethoxam	Practical non toxic	?
Match	lufenuron	Very highly toxic	?

Appendix x Overview of Pesticides, A.I, the T.T.I and the DT50 in the soil

Pesticide	*A.I.*	*Terrestrial Toxicity Index*	*DT50 in soil*
Score	Difenoconazole	Slightly toxic	140 d
Kummulus	Sulfur	Slightly toxic	?
Cuproxat	Tri Copper sulphate	?	?
Zineb bul	Zineb	?	30 d
Melody duo	Iprovalicarb	Slightly toxic	84 d
	Propineb	Slightly toxic	3 d
Aliette	Fosetyl Aluminum	Slightly toxic	0.1 d
Ridomild	Metalaxyl	Slightly toxic	20 d
	Mancozeb	Slightly toxic	0.1 d
Biobass	?	?	?
Nissorum	Hexythiazox	Slightly toxic	30 d
Sirpon	Halfenprox	Slightly toxic	10 d
Comite	Propagite	Moderately toxic	56 d
Vetimec	Abamectin	Moderately toxic	30 d
Neem-nim green	Azadirachtin	?	26 d
Anvil	Hexaconazole	Slightly toxic	122 d
Calyxin	Not available anymore	?	?
Dithane	Mancozeb	Slightly toxic	0.1 d
Antracol	Propineb	Slightly toxic	3 d
Long C.A	Abamectine	Moderately toxic	30 d
Sumi alpha	Esfenvalerate	Slightly toxic	44 d
Polytrin	Profenofos	?	7 d
	Cypermethrin	Slightly toxic	68 d
Lannate	Methomyl	Moderately toxic	7 d
Rovral	Iprodione	Slightly toxic	84 d
M8	?	?	?
Mancozeb	Mancozeb	Slightly toxic	0.1 d
Tilt super	Difenoconazole	Slightly toxic	140 d
	propiconazole	Slightly toxic	214 d
Chinese pesticide with abamectine	abamectine	Moderately toxic	30 d
Kenthane	Dicofol	Moderately toxic	80 d
Sunix	?	?	?
Supracide	methidathion	toxic	10 d
Map cypermethrin	Cypermethrin	Slightly toxic	68 d
Ammate	Ammate	?	?
Plutel	Abamectine	Moderately toxic	30 d
Selecron	Profenofos	?	7 d
Actara	thiamethoxam	Slightly toxic	51 d
Match	lufenuron	Slightly toxic	82 d

Annex Input data of AI for calculating leaching to groundwater

A.I.	*Kom (L/kg)*	*Koc (L/kg) Koc = Kom x 1.7*	*A = 4 - log (Koc)*	*DT50 soil (d at 20 °C)*	*B = log Dt50*	*GUS index = BxA*	*Source*
Abamectin (in 4 pesticides)	8235	13999	-0.14	30	1.48	-0.2	Database Alterra
Ammate	-	-		-	-	-	
Azadirachtin		6.5	3.19	26	1.42	4.5	Footprint
Cypermethrin (in 2 pesticides)	50336	85571	-0.93	68	1.83	-1.70	Database Alterra
Dicofol	3567	6064	0.22	80	1.90	0.41	Database Alterra
Difenoconazole (in 2 pesticides)	2392	4066	0.39	140	2.15	0.84	Database Alterra
Esfenvalerate	-	5300	0.27	44	1.64	0.44	Footprint
Fosetyl Aluminum	1000	1700	0.77	0.1	-1	-0.77	Database Alterra
Halfenprox	-	-	-	10			Footprint
Hexaconazole	611	1040	0.98	122	2.08	2.04	Database Alterra
Hexythiazox	-	6188	0.21	30	1.47	0.31	Footprint
Iprodione	-	37	1.43	84	1.92	2.75	Footprint
Iprovalicarb	-	106	1.97	15.5	1.19	2.34	Footprint
lufenuron	22798	387566	-0.58	82	1.91	-1.11	Database Alterra
Mancozeb (in 3 pesticides)	586	996	1	0.1	-1	-1	Database Alterra
Metalaxyl	388	660	1.18	20	1.3	1.53	Database Alterra
methidathion	-	400	1.4	10	1	1.4	Footprint
Methomyl	7	12	2.92	14.8	1.17	3.4	Database Alterra
Profenofos (in 2 pesticides)	1169	1987	0.7	7	0.84	0.59	Database Alterra
Propargite	-	56500	-0.75	56	1.75	-1.3	Footprint
propiconazole	-	1086	0.96	214	2.33	2.23	Footprint
Propineb (in 2 pesticides)	10	17	2.87	3	0.47	1.37	Database Alterra
Sulfur	?	?	-	?	?	?	Database Alterra
thiamethoxam	51	86.7	2.06	?	?	?	Database Alterra
Tri Copper sulphate	-	?	-	-	?	?	
Zineb	-	1000	1	30	1.47	1.47	Footprint