Technological Learning for Innovating towards Sustainable Cultivation Practices: the Vietnamese Smallholder Rose Sector

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Abstract

Deregulation and globalisation has altered the views of public involvement in development and led to strategies focusing on private sector participation. An implicit assumption seems to be that these linkages will enhance the technological capacity of smallholder producers by way of more cost-efficient technologies trickling down through the value chain or by quality requirements inducing best practices. The argument put forward in this paper is that sustainable non traditional agricultural chain development requires more purposeful actions and institutional transitions, both in the public and private spheres, targeting improved upstream innovative capacities. Empirical findings from a Dutch-Vietnamese partnership on sustainable floriculture development are used. Research revealed that the pest and disease control solutions applied by smallholder rose growers were incremental adaptations of experiences obtained in former food crop cultivation practices. Floriculture however may require more drastic changes in cultivation practices to make the sector more environmentally benign. In the case of smallholder Vietnamese flower producers, this implies adaptation of knowledge and skills currently not present. An important hindrance in promoting this knowledge and skills appears to be the weak vertical linkages between flower growers and public and private research and development organizations.

INTRODUCTION

Since 1996, the floriculture sector in Vietnam has grown rapidly, mainly to supply the domestic market. The diversity of market channels is growing, mainly stimulated by the growing wealth of the local population and the rise of modern distribution formats. Furthermore, export opportunities are emerging, particularly in neighbouring Asian countries. In the last decade, the sector made a substantial contribution to increased rural income in specific regions, due to its labour intensive nature and high returns per hectare (Allbritton et al., 2004).

A major challenge for the sector is its vulnerability to non sustainable cultivation practices, which may hinder entering new markets with higher performance requirements (Van Wijk et al., 2005). In particular, the use of pesticides is high, causing health risks and threatening the sustainable development of the sector. To explore the technical and institutional conditions for an environmentally benign smallholder floriculture sector, research within a Dutch-Vietnamese partnership made an in-depth analysis of the threats related to crop protection in rose cultivation and mapped the local institutional framework that enables learning by smallholder growers (Danse et al., 2007a,b).

The research indicates that environmentally friendly crop protection in roses requires capacity and knowledge to make correct diagnoses and to select suitable recipes. In a non-traditional crop such as roses, this usually requires institutional linkages that provide smallholders with access to external knowledge and skills. In Vietnam, the level of vertical connectivity between smallholders and institutionally remote R&D appears to be limited. Learning is usually based on peer-to-peer interaction and incremental changes

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building on existing knowledge or borrowing from neighbours or corporate farms. This suggests that the Vietnamese floriculture sector may benefit from institutional arrangements that stimulate learning and the acquisition of innovative technological capacities.

MATERIALS AND METHODS

The field research was done in the most important existing flower cultivation regions of Vietnam: Me Linh, Sapa and Dalat. The first rose cultivation activities in Vietnam started in Dalat. Currently, roses, chrysanthemum, gladioli and lily are cultivated. Farm sizes vary from less than 3,000 m^2 up to 8 hectares. Sometimes flowers and vegetables are cultivated in the same plot.

Me Linh is the second most important rose cultivation area, and is located near Hanoi. One of the biggest areas in this region is Me Linh Commune (250 ha), accounting for 63% of the total area cultivated. Some 95% of the households work in rose cultivation. The sector consists of only smallholder growers, using open field cultivation, with an average area per household of 1,500 m^2. The plots are scattered among vegetable and rice fields.

Sapa is the youngest rose cultivation area, a mountainous area near the Chinese border. Rose cultivation started in 2000 and now covers about 55 ha, consisting of two large scale rose farms, 6 cooperatives (each with 3-7 growers), and 26 independent rose growers. In Sapa, rose cultivation dominates, but now the cultivation of orchids and other flower crops has commenced.

This research focused on rose growers, since this is by far the most important crop grown in two of the three analysed regions, and roses are the most popular flower traded in local and international markets. The fieldwork was done by a multidisciplinary team of Vietnamese and Dutch experts with expertise in business administration, floricultural practices, environmental sciences, pesticide regulation and agricultural economics. The research consisted of expert observations through field visits, combined with semi-structured interviews with growers, governmental workers and representatives of the pesticide trade. To analyse the enabling environment on learning networks, a variety of participatory research methods were used, amongst others, semi-structured interviews, and Venn diagrams. The interviews mainly focused on the availability of and access to information on cultivation practices and market developments, and pest and disease management.

To measure the negative effects of current pesticide use, a hazard assessment was done based on the observations and data collected during the field work. For the analysis, four different hazard indicators were used: WHO hazard class, leaching potential, terrestrial and aquatic toxicity index. Hazard estimations were made for crop management practices currently applied by growers in the research area. These estimations were based on pesticide parameters solely and did not take into account site specific aspects, such as climate, soil type and application practices. Therefore hazard estimations give a relative ranking of the hazards associated with pesticide use patterns.

RESULTS

This paper presents the most important findings regarding the vulnerabilities attached to current plant protection practices and the existing enabling environment for learning and innovation on crop protection methods by small scale flower growers.

Pest and Disease Control Practices

Within the three regions, the research team observed that the growers' identification of insects (thrips, red spider mite) was quite accurate. However, this seemed not to be the case for fungal and bacterial disease. For instance, some present diseases were not mentioned by growers, such as tumours caused by the bacteria *Pseudomonas tumefaciens*, which shows a lack of knowledge by growers. Plant nutrient deficiencies were often confused with diseases, leading to the use of pesticides instead of the required fertilizers. Non curable diseases were treated with chemicals, while mechanical removal of affected plants realistically provides the only effective pest control method.

At all farms, leaves showed significant pesticide residues. This indicates not only the high amount of pesticides used, but the way pesticides had been applied: wrong size of the drops, broken or obdurate nozzles, limited use of dispersion agents and wrong moment of application. All these practices lead to extra production costs, the development of pest resistance and present a threat for human health. This threat is even bigger due to the practices farmers use in applying pesticides without the appropriate protection and storing chemical products and their spraying equipment inside or near the house.

In Me Linh and Sapa, open field cultivation and irrigation by flooding is still common practice. In Dalat, growers changed these practices after the Dutch-Vietnamese company Hasfarm started activities in the region in 1995. This farm introduced foreign produced greenhouse structures and cultivation technologies such as drip irrigation. Many of these cultivation practices have been copied by the smallholder farmers and many built their own greenhouses.

However, there seems to be a lack of knowledge about the design and use of these technologies. For instance, smallholder growers prefer the use of sprinkler installations, while the respondents seem aware of the possible relationship between this irrigation method and disease incidence. Nevertheless, the cultivation methods used in Dalat are much more adequate for flower cultivation than the practices used in Me Linh and Sapa.

In sum, a number of cultivation practices affect sustainable development in the smallholder rose sector. Most of the environmentally unfriendly practices continue to exist due to ignorance, but may change with adequate technical assistance and knowledge sharing.

Hazard of Pesticides Use

In each of the three areas, growers obtain their pesticides at local retail shops. Based on interviews with growers and shop owners, an inventory was made of the most commonly used pesticides, their active ingredient (AI) and the frequency of use. Table 1 presents the classification of moderate to highly hazardous AI for 4 different environmental indicators. It is important to mention that the risk of judging pesticides on the basis of toxicity only is that growers prefer to use compounds with lower toxicity that persist in the environment for some time. Whether high toxicity results in a real risk depends on the quantities applied, the presence and distance to surface water bodies, the vulnerability of the ecosystem, etc. These factors were not taken into account in this research. Therefore, this assessment can only be used to decide whether follow-up risk assessments are required and for which situations (formulations, physical conditions).

Hazard to Human Health

The WHO hazard classification is used to establish a classification based on the acute risk to human health (being the risk of single or multiple exposures over a relatively short period of time). It is based on the acute toxicity of the chemical compound and its formulation. Allowance margins are defined, where solids are considered less hazardous than liquids. The classification is primarily based on the acute oral and dermal toxicity to the rat. Provision is made for the classification of a particular compound to be adjusted if for any reason the acute hazard to man differs from that indicated by the LD_{50} assessments alone (WHO, 2004). Table 1 shows highly toxic active ingredients in the pesticides used by Vietnamese rose growers as: methomyl, mehtidathion. Moderately hazardous chemicals include: diazinone, esfenfalarate, propiconazole, profenofos and cypermethrin. In Me Linh Commune, imidacloprid is used which is ranked as moderately hazardous.

Hazards to Aquatic Life

The Aquatic Toxicity Index (ATI) is used to classify the pesticides according to their acute hazard to aquatic life. Dissipation rate in water is not taken into account.

Narrative descriptions of toxicity were assigned based on the LC_{50} of the most sensitive standard species (fish, daphnia or algae), according to the guidelines in Kamrin (1997). These criteria are also used by the Pesticide Action Network (PAN) and are similar with the criteria described in the Manual for Summarizing and Evaluating the Environmental Aspects of Pesticides (Mensink et al., 1995). The hazard assessment relates high hazards to highly toxic compounds. It does not take into account the dissipation rate of the compound. Highly toxic compounds with high dissipation rates can pose a lower risk to aquatic life than persistent compounds with lower toxicity. Table 1 indicates that at least 50% of the pesticides used in the three regions pose a very high hazard for aquatic life. In the case of Me Linh, mancozeb requires special attention since 26.8 kg of the average 28.6 kg of AI used per hectare per year is mancozeb. Also the AI imidacloprid and propiconazole require special attention since these substances are persistent in water.

Hazard to Terrestrial Life

The Terrestrial Toxicity Index (TTI) is used to classify the pesticides according to their acute hazard to terrestrial life. The criteria are based on the Manual for Summarizing and Evaluating the Environmental Aspects of Pesticides (Mensink et al., 1995). Narrative descriptions of toxicity were assigned based on the LC_{50} of earthworms. The dissipation rate in soil, toxicity values of terrestrial plants and soil micro-organisms are not taken into account. Highly toxic compounds with a high dissipation rate can pose a lower risk to terrestrial life than persistent compounds with lower toxicity.

Table 1 shows that further risk assessments should be done on formulations containing abamectine, imidacloprid and propiconazole applied to roses, since these AI are highly toxic for terrestrial life. Special attention is needed for the active ingredients imidacloprid and abamectine, since these substances are persistent in soil ($DT_{50} > 90$ d). There is a potential risk for the terrestrial ecosystem and therefore further risk assessment taking specific site aspects such as climate, soil type and application practices into account.

Hazard to Groundwater

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

The GUS index is calculated as follow: $GUS = \log\ (DT_{50}) \times [4 - \log (K_{oc})]$.

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

Table 1 shows that of the pesticides used by the Vietnamese flower sector, methomyl and imidacloprid require special attention, since these AI pose a potential health risk through groundwater consumption. Further assessment of the risks of pesticides leaching to groundwater is recommended.

Enabling Environment for Technological Learning on Good Cultivation Practices

After observing current crop protection methods and the toxicity risks involved, the question is how smallholder growers can access the knowledge and skills required to improve these cultivation practices. Semi-structured interviews and the participative drawing of Venn diagrams with smallholders, officers of local authorities, representatives of pesticide producing companies and representatives of development cooperation agencies, resulted in the identification of three levels of institutional linkages and flows of knowledge and information. These are: (1) planning, research and development; (2) identification and control of pests and diseases; and (3) control of pesticides use and new pesticide product introduction. Figures 1, 2 and 3 show the institutional framework at each of these levels. However, the research indicates that most important in the learning process for smallholder rose producers are the informal networks used for borrowing or exchanging skills and knowledge.

Planning, Research and Development for the Agricultural Sector

Figure 1 shows the structure of the scientific and political level of information exchange regarding planning and the development of the sector. The Ministry of Agriculture and Development (MARD) is responsible for the design and budgeting of annual policy plans regarding activities to be developed for the agricultural sector. Research institutes and the Plant Protection Department (PPD) receive annual budgets for their projects.

In 2005, MARD defined a 5 year policy plan for the sustainable development of the agricultural sector. As part of this program, it stimulated the development of new initiatives, provided financial support for the development of new knowledge and technology and searched for new partnerships. Most research has been done on improving cultivation practices for staple crops and food safety such as rice, vegetables, fruit and export commodities such as soy bean, coffee, tea, pepper and sugar cane.

Flowers are new crops in the country and local agricultural research institutes have little opportunity to develop research and education programs tailored to floriculture. Regarding research institutes and their relation with the rose sector, the Agricultural University of Hanoi and the Agriculture and Genetic Centre were mentioned by some respondents, mainly because farmers were sometimes involved in field trials. In Dalat, some research centres develop trials on local plant breeding and alternative irrigation systems, but it seems that results from these projects are seldom shared with smallholders in the region. The Plant Protection Research Institute (PPRI) suggested that more research and capacity building should be developed for the flower sector, because the cultivation practices and pesticides used by flower growers affect food crops cultivated in the neighbouring fields and impact upon food safety.

Identification, Prevention and Control of Pests and Diseases

Figure 2 presents the institutional linkages on knowledge and information exchange for pests and disease control. The mandate of the PPRI is to find solutions for problems caused by pests and diseases. The knowledge collected is mainly shared with MARD officials. The role of the Plant Protection Department is more focused on the management and control of activities related to the presence of pests and diseases. This identification is done by the extension officers, who have mainly gained experience with fruit and vegetable cultivation. Local authorities communicate their findings to the community.

Information Flows on the Use of Legally Approved Pesticides and New Product Introduction

Figure 3 shows the institutional linkages and information flows related to the legal control of pesticide use and the introduction of new pesticides in rose production areas. PPD, together with MARD, defines and publishes every year, the list of registered pesticides. Once or twice a year, the owners of the local pesticide shops can expect a surprise visit by PPD officials at a district level to check the legal status of the products sold. The pesticides shop owners receive a certificate to operate for a three year period based on the results of the shop inspection and their participation in training. Regarding the introduction of new pesticides, the PPD, at the district level, local authorities and representatives of pesticide producing companies, collectively organize meetings for growers. In most cases, these are products developed and registered for vegetable cultivation, but flower growers use them, based on the pest or disease the product was developed for. This practice results in the use of unsuitable pesticides, which could cause quality and cultivation problems and contribute to pest resistance. Pest resistance is one of the reasons why growers currently use 1.5 to 2 times more pesticides than 5 years ago. In addition to these meetings, the PPD sometimes organize meetings themselves to inform farmers about some agricultural practices, such as the safe use of pesticides. Rose growers consider these activities hardly informative, since they are too general and focus more on the food crops produced in the region.

Informal Network to Access Information for Technological Learning

Smallholder flower growers use mainly peer-to-peer learning and contact with traders as important sources to acquire knowledge and new skills. In the case of Dalat, a number of growers sometimes received complaints about white residues on the leaves, which originate from higher quality market segments such as exclusive flower shops. Growers in Me Linh and Dalat learn about cultivation practices from growers in their immediate surroundings, while in Sapa, they learn from growers in Me Linh. In both Dalat and Sapa, smallholders have the opportunity to learn from bigger farms, which also produce for export markets. A good example in Dalat is the presence of Hass farm which saw innovations leap-frog in local flower cultivation practices. Smallholders learned through observation about the construction and use of green houses. They obtained the information about modern cultivation practices by talking to Hass farm employees or by seeking advice from former employees that became independent advisors. However, the lack of local institutional capacity to support the process embedding these innovative cultivation practices creates a negative impact. This also limits technological learning to the existing level of understanding of the growers, which in most cases, results in inappropriate applications.

CONCLUSIONS

This paper analyses the crop protection practices of smallholder rose growers in Vietnam essentially as incremental adaptations of practices learned through traditional vegetable cultivation. The research reveals that technological learning mainly by peer-to-peer learning leads to incremental innovations and trial-and-error practice that seems to be insufficient to cope with natural variability and the hidden mechanisms of bacterial and fungal diseases in non traditional crops. The current learning mechanism is not sufficient to enable the sustainable development of commercial floriculture cultivation, because this sector requires disruptive innovations to the current technological packages to make the sector more environmentally benign; to ensure occupational health and safety of producers and workers; and to respond adequately to stringent performance requirements in new market segments. It seems reasonable to anticipate that pesticide residues may influence consumers' appreciation of flowers, which can motivate growers to search for adjustments in their cultivation practices. Hence, there is some justification for finding the right institutional modalities that enable the acquisition of knowledge and skills currently not available in the local context.

Even although this knowledge and skills may be available, an important obstacle in tailoring knowledge and skills to the conditions of small scale rose producers are the weak vertical linkages between flower growers and public and private research and development organizations. Moreover, the current fixation on seed related technological trajectories and the generic nature of information on pest control strategies may even jeopardize the processes of technological learning because there is no defined demand for the proposed technological recipes. This suggests that the introduction of new technological solutions can be better combined with institutional interventions promoting an iterative process between technology suppliers and users (Vellema and Danse, 2007).

The experiences in Dalat prove a clear example of the fact that these linkages do not develop automatically (Danse and Vellema, 2007). It seems more likely that large scale growers become interested in sharing their experiences and market linkages with smallholders in their region when a clear economic incentive is apparent. Commercial business development services do not develop naturally. The novelty of the crop, i.e. roses, and the limited knowledge and experience of smallholder farmers specific to flower cultivation, hampers their capacity to articulate a clear demand for technological services tailored to their conditions.

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

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Tables

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

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	
Sec Saigon 50EC	Cybermethrin	Moderate	Very highly toxic		
Visher 25 ND	Cybermethrin	Moderate	Very highly toxic	Highly toxic	
Bumper 250 EC	Propiconazole	Moderate	Very highly toxic		
Tilt 250 EC	Propiconazole	Moderate	Very highly toxic, persistent in water	Highly toxic	
Mire tox 10 WP	Imidacloprid	Moderate	Very highly toxic, persistent in water	Highly toxic	High

Bazudin	Diazinon	Moderate	Very highly toxic		
Mancozeb 80 WP	Mancozeb		Very highly toxic		
Forthane 80 WP	Mancozeb		Very highly toxic		
Lanate 40 P	Mancozeb, methomyl		Very highly toxic		Moderate
Tap ky 1.8 EC	Abamectine			Highly toxic	
Antracol	Propineb		Very highly toxic		

Figures

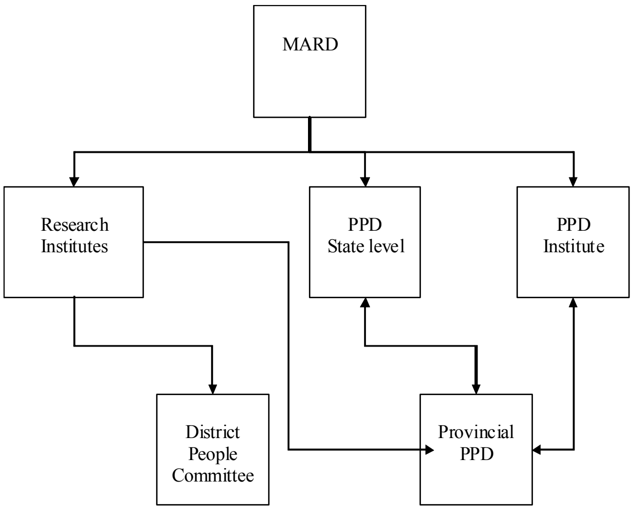

Fig. 1. Institutional linkages and information exchange on planning, research and development of cultivation practices.

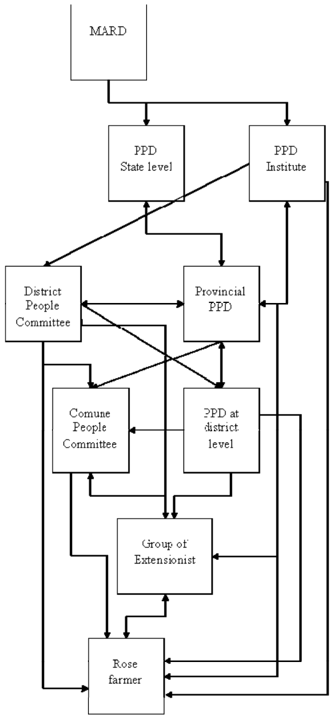

Fig. 2. Institutional linkages and information exchange on the identification prevention and control of pests and diseases.

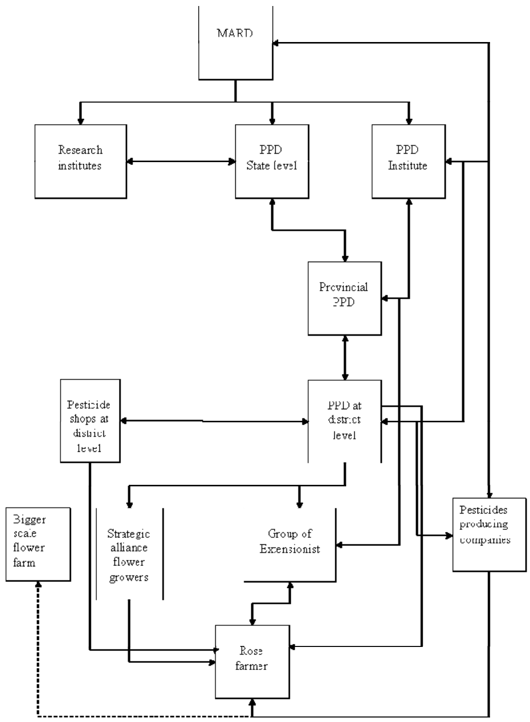

Fig. 3. Institutional linkages and information exchange on pesticides registration and new pesticides introduction.