IMPLEMENTATION OF BIOLOGICAL CONTROL IN GLASSHOUSE HORTICULTURE IN THE NETHERLANDS

Ellen A. M. BEERLING[1] and Abco J. DE BUCK[2]

[1] Applied Plant Research, Division Glasshouse Horticulture
Wageningen-UR, Linnaeuslaan 2a
1431 JV Aalsmeer, the Netherlands
ellen.beerling@wur.nl

[2] Applied Plant Research, Division Glasshouse Horticulture
Wageningen-UR, P.O.Box 8
2670 AA Naaldwijk, the Netherlands
abco.debuck@wur.nl

INTRODUCTION

The use of biological control in Dutch glasshouses has increased tremendously in the second half of last century. Integrated pest management (IPM) is practiced on a large scale in all main vegetable crops. In glasshouse ornamentals IPM is more complicated, but at the end of last century biocontrol was applied in more than 10% of the area with ornamental crops (LTO Nederland, vakgroep Glastuinbouw 2003; van Lenteren 2000). The expansion of the glasshouse area subjected to biocontrol has, however, now come to a halt. In some crops, like gerbera, the number of biocontrol species released is even declining seriously. In general growers mention the following reasons for discontinuing biocontrol: disappointing results with natural enemies, new pesticides which made biocontrol 'unnecessary', the lack of selective pesticides against new pests and the restriction of other selective pesticides.

There are many different factors determining the degree of success of biocontrol measures and the composition of an IPM strategy. Implementation of IPM is complex not only in technical, but also in socio-economic sense (for an overview of motives for growers whether or not changeover to IPM, see de Buck and Beerling, in press). Hence, custom-made IPM strategies are required.

The traditional co-operation between Research, Extension and Education took care of the development and implementation of (new) knowledge, but this so-called triptych fell apart in the nineties due to changes in the market (see de Buck and Beerling, in press). Stakeholders are now following their own strategies and there is a lot of disagreement between for instance growers, environmental organizations and supply chains. This hampers the transition to a sustainable production system.

The traditional 'trend-setter model' is not helpful in the diffusion of complicated innovations without a clear value to growers, such as biocontrol and IPM. A new system of knowledge transfer is needed that meets the interests, visions and strategies of the stakeholders.

Recently in the Netherlands two types of networks have been developed based on the principle of collaboration of all parties: 'growers' networks' and 'socio-technical networks' (STNs). Both types of networks aim to generate interactive knowledge and are formed in order to speed up the innovation process. These networks are discussed hereafter, but first the role of the Dutch government in the transition to sustainable horticulture is described.

LEGISLATION

The Dutch government aims to make crop protection more sustainable: by 2010 the environmental 'burden' should be reduced by 95% when compared to 1998. The government regards IPM as the approach to achieve this reduction and proposes that all growers have switched to IPM by 2010. She has taken on the responsibility to promote knowledge on and implementation of IPM (Dutch Ministry of Agriculture, Nature and Food Quality 2004).

By funding a research program the government facilitates the development and implementation of IPM. This program comprises fundamental and applied research, in which not only solutions to single pest problems are sought, but also interactions of control measures and the integration into complete control strategies are taken into account (see e.g., Dik *et al*. 2004; Pijnakker *et al*. in press). Furthermore, much attention is given to the implementation of (new) knowledge and to the process of transition to sustainable agriculture, for which growers' networks and socio-technical networks have been developed (see hereafter).

GOOD CROP-PROTECTION PRACTICE

In 2003 the government, the growers' organization (LTO), the association of crop protection suppliers (Agrodis), the association of the Dutch agrochemical industry (Nefyto), and organizations for drinking water (VEWIN) and water boards (UvW), reached an agreement whereby they all will be working on reducing the environmental pollution caused by pesticides with at least 95 per cent by 2010 (Agreement on Crop Protection). As a consequence, a Royal Ordinance on the principles of IPM was drafted, which determines that all growers should work according to the principles of 'good crop-protection practice' and that the use of pesticides is reduced to the very minimum necessary to control pest populations below the economic-damage threshold (Besluit beginselen geïntegreerde gewasbescherming 2004). The definition of good crop-protection practice depends on the feasibility of crop-protection measures for 80-90% of the growers of a particular crop, and may change in time. Growers working according to EUREP-GAP guidelines of the European retailers and their suppliers will meet the demands of the Ordinance without difficulty.

Insight into measures of good crop-protection practice must be given in a crop-protection plan and a logbook. The crop-protection plan should address measures with respect to prevention, establishment of the necessity of control, non-chemical control measures, and chemical control measures. Deviations to the plan should be written down in a crop-protection logbook. The plan and logbook are mandatory from 2005 onwards, but at present growers are not yet forced to comply with the crop-protection plan or implement specific crop-protection measures. The aim of a crop-protection plan is to raise consciousness and induce behavioral change in growers.

BEST CROP-PROTECTION PRACTICE

Due to new knowledge and understanding the transition into an even more sustainable crop protection should be a continuous process. To stimulate this process, the government requested researchers to draw up so-called 'best practices' of crop-protection (for glasshouse horticulture: Dik and De Haan 2004). 'Best practices' are the most important crop protection measures that will potentially contribute to a reduction in the environmental burden. Examples are the use of natural enemies for pest control, more efficient pesticide application techniques and screening windows to keep pests out. 'Best practices' are not yet generally implemented and practical experience is often lacking. Almost all 'best practices' face obstacles that need to be removed before implementation is possible, or need further study. Therefore, 'best practices' are not mandatory for the growers, but this set of potential measures is a guide for research funding organizations (like the government) and growers' organizations. Both 'good practices' and 'best practices' will change over time due to advancing possibilities and understanding, thus accomplishing a stepwise improvement of IPM.

IMPLEMENTATION OF IPM BY NETWORK FORMATION

Recently in the Netherlands two types of networks have been developed based on the principle of collaboration of all parties: 'growers' networks' and 'socio-technical networks' (STNs). Both networks mobilize all decisive stakeholders for the implementation of sustainable horticulture. These parties include growers themselves, suppliers and buyers, knowledge workers (from Wageningen University and Research) and advisors (private extension service and crop protection suppliers), sector organizations, producers' organizations and government. Growers' networks have a practical approach and are focused on the changeover to IPM and the awareness of the necessity to implement the latest feasible 'best practices'. The socio-technical networks aim at a practical implementation of an innovation agenda for sustainable development. This agenda is fully decided on by growers and other stakeholders, without a specific focus beforehand.

GROWERS' NETWORKS (FARMING WITH FUTURE)

The heart of the network. The heart of the growers' network (project 'Farming with future') is formed by a group of 6 to 8 growers who meet several times a year (Fig. 1). These groups are lead by researchers (crop protection specialists), trained in managing processes of change. At the moment there are five crop-related networks: for cucumber, for tomato, for rose, for chrysanthemum and for potted-plants. Each group consists of different types of entrepreneurs, *i.e.* growers with different attitudes towards biocontrol and choice of crop protection strategy, but with a common awareness of the need to change to IPM. The growers are from different regions of the country and are an authority within their crop, although not only trend-setters are chosen. The choice of growers is made in consultation with the growers' organization LTO. Within the group discussions about 'best practices', (new) control measures and strategies are stimulated, giving special attention to biocontrol and natural pesticides. In this way growers learn from each other and also get acquainted with new strategies. The flow of information is not directed in one way, *i.e.* to the grower, only. The growers'-networks project ('Farming with Future') is embedded within the governmental research pro-

gram mentioned before, which facilitates feedback to research. Questions and information on obstacles for 'best practices' for example, flow back to research institutions, thus stimulating new research and demonstration projects.

Before the start of the crop (or a year) the grower, assisted by his regular crop protection advisor (private extension service or crop protection supplier) and using input of the latest knowledge from the researcher, designs a crop protection plan. The crop-protection strategy and corresponding plan remain the choice of the grower and will therefore differ between growers. At the end of the cropping season (or a year) the plans are evaluated individually and within the group. To help the evaluation of the chosen strategy, growers register the input of chemical and natural pesticides, natural enemies, and also costs involved (in time and money), as well as output, *i.e.* yield. Using these figures the researcher calculates the environmental impact and the economic results. For the following year, a new plan is made, based on the experiences of the previous year and with new input from research and consultants, thus accomplishing a stepwise implementation of 'best practices'.

Other growers. Next to coaching the individual growers and the networks, much effort is put into the dissemination of results to other growers and convincing them to also implement the strategies that prove to be feasible. For this purpose co-operation (in communication) is sought with stakeholders surrounding the growers (see Fig. 1), thus creating a solid basis for the implementation of new knowledge. Focus is on distribution of technical information as well as on increasing acceptance.

Communication with growers outside the networks occurs in numerous ways and often in co-operation with the extension division of the National Sector Organization 'LTO', which started a communication project called 'Strategist' for IPM in glasshouse ornamental crops. Communication involves leaflets with information about the major pests and diseases for each crop, publications and interviews in growers' magazines, an internet site, presentations at national and regional meetings organized by growers' association, and excursions to participating growers.

As stated before, the implementation of IPM is complex. Straightforward facts, like the efficacy of a (microbial) pesticide, are picked up easily by growers and find their way quickly via study groups and other contacts with and between growers. Knowledge about natural enemies, and more particularly IPM strategies, are never straightforward and require guidance when implemented. In the first place, this means that stakeholders surrounding the growers, in particular the advisors should acquire knowledge. For the large group of 'followers' amongst the growers, crop advisors are even the main knowledge providers in crop protection and play an important role in the crop-protection strategy the grower chooses. The advisors may be independent (e.g., the privatized extension service 'DLV'), but more often they represent a crop-protection supplier. These companies vary in state of knowledge and have their own - more or less sophisticated - IPM strategies. A complicating factor is that the natural aim of these companies is to sell as many products (biological or chemical) as possible to as many customers as possible.

Participation of crop-protection suppliers in this innovation process is sought in several ways (Fig. 1). Advisors from different companies advice the growers within the network. These advisors are directly involved in the compilation and evaluation of the crop-protection

plan of 'their' grower. Also, bilateral meetings of research and crop-protection suppliers and other companies involved in advising growers are organized to discuss strategies and research results. The advantage of this one-to-one approach is that the companies then discuss their strategy with the researchers more openly than when competitive companies are present. Awareness of these important stakeholders of the necessity and feasibility of IPM enhances the adoption of biocontrol and a custom-made IPM strategy.

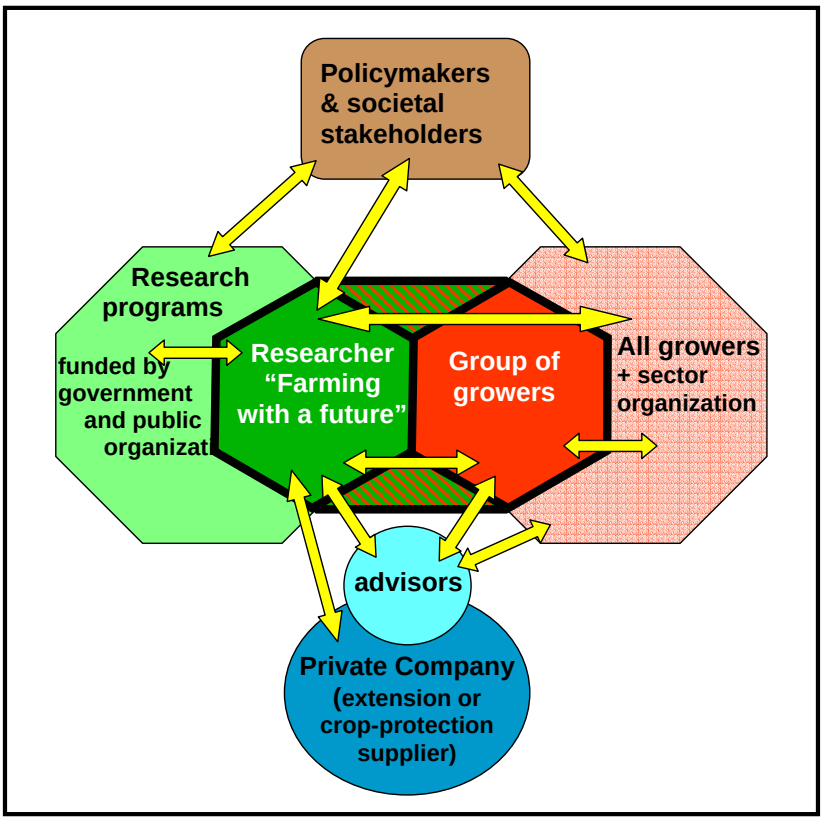

Figure 1. Schematic presentation of a growers' network in glasshouse horticulture and the direct and indirect interactions between the project 'Farming with Future' and stakeholders.

Policymakers and societal stakeholders. Policymakers and societal stakeholders also play an important role in the changeover to a more sustainable crop protection because they can stimulate the changeover, set the goals and determine the framework in which it should take place. In a low-lying country full of waterways and lakes like The Netherlands, regional water boards, drinking water companies and environmental organizations highly influence the present regional and national policy on crop protection. Policy officials and politicians are also influenced by discussions with growers' organizations and organizations of biocontrol producers, chemical industries and suppliers, for instance as in the Agreement on Crop Protection.

The project 'Farming with future' aims to provide policymakers and societal stakeholders a realistic view of the present and future (im) possibilities of biocontrol and IPM and to stimulate discussion among the stakeholders. For this purpose policymakers and societal stake-

holders regularly receive a newsletter and also bilateral meetings as well as round-table discussions are organized.

SOCIO-TECHNICAL NETWORKS

A socio-technical network (STN) is another method to speed up an innovation process by collaboration of stakeholders. The aim of an STN is 1) to intelligently use the forces of sustainability (also called 'People, Planet and Profit') for speeding-up the innovation process to sustainable plant production, and 2) better utilize 'surrounding partners' to induce entrepreneurship. The 'technical part' of a STN consists of one or more specific innovations in the field of technical, knowledge, (consumer-) product or sector development. In addition to Profit, the innovations should improve the aspects of Planet and People.

A STN is primarily based on the capacity of growers to innovate. Growers and stakeholders can be activated by meeting their interests, strategies and visions. The participants formulate a common vision on sustainable development of the sector and the problems that they want to work on themselves. They decide on an innovation agenda for sustainable development, without a specific focus beforehand. Hence, in a STN, the development (for instance of knowledge) is driven by demand.

Secondly, a STN aims at a consensus within the intermediate groups, such as producers' organizations, NGO's and government. Without consensus of intermediates from the start, there is an evident risk that the development and the dissemination of the innovation will become frustrated.

A methodology has been developed to create a STN (Buurma *et al.* 2003; De Buck and Buurma 2004). It comprises three consecutive steps: 1) interviewing stakeholders, 2) identifying potential coalitions between stakeholders, and 3) composing a collaboration agreement. These steps are explained hereafter and illustrated with the case of formation of a STN in the second largest cut-flower sector in the Netherlands: the cut-chrysanthemum sector.

Interviewing stakeholders. A STN requires participation of supporters of values that are related 1) with market (to generate Profit), 2) with society (to care for People and Planet) and 3) with human resource (to induce entrepreneurship and innovative power). A value triangle (Fig. 2) is a tool to identify the mutual positions of the stakeholders. Firstly, stakeholders professionally involved in the innovation are identified for each of these values. These stakeholders are interviewed in-depth, focusing on four items: 1) the values of the respondents, 2) their position in the professional environment, 3) their vision on strategic development and the relevance for themselves and 4) the barriers that hamper its implementation. The interviews do not just focus on a specific theme, *i.e.* IPM, but address the inter-relationships with other important issues as well.

From the interviews of stakeholders within the cut-chrysanthemum sector and during a workshop (see later) four developmental pathways for transition towards sustainable production were apparent, which were visualized in a mind landscape (Fig. 3). Adherents of development 1 urged on the transition from chemical pest control to biocontrol and IPM.

Further knowledge has to be developed on IPM strategies suitable for cut-chrysanthemum. Pest control practices need to be revised, as organisms increasingly become resistant. The decrease in the number of registered pesticides is a result of severe government regulations with respect to environmental protection, combined with the relatively small market demand for pesticides in Dutch glasshouse horticulture as a whole.

Another group believed that cropping systems on mobile benches in artificial substrate are indispensable for a sustainable chrysanthemum sector (development 2). Firstly, the new system increases production efficiency and secondly the use of artificial substrate would eliminate problems with soil-borne pests and diseases. The use of mobile benches offers possibilities for pest management and product development (small, separately manageable units). Results (a better productivity) should be available on the short term, as economic continuity of the chrysanthemum sector is at stake.

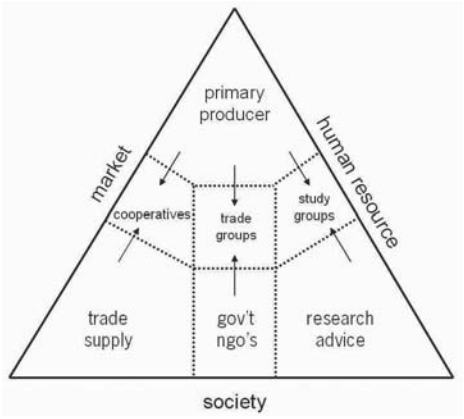

Figure 2. Value triangle: the position of stakeholder groups in the agricultural sector between values that are related with market, human resource and society.

Some stakeholders urge the necessity of more collaboration in the knowledge system: the private companies, research and extension organizations and sector organizations need each other to develop and disseminate IPM in the chrysanthemum sector. This point of view can be considered as network development (development 3).

Adherents of development 4 believe that the market position of the product (the chrysanthemum flower) needs to be improved. The negative image of chrysanthemum as a 'poisonous flower' and its character of cheap mass produce hamper this.

Identifying potential coalitions. Based on the interviews, the next step is the identification of potential coalitions in the mind landscape. Some conditions for a successful coalition are: compatibility of individual strategic solutions, innovative power and a balanced set of individuals' values. The coalition is formed around a central person (like the formation of a cabinet, headed by a Prime Minister) with authority, goodwill, having the willingness and the ability to co-operate. This central person has the mandate of intermediate groups.

In the cut-chrysanthemum sector, changing over to a cropping system in artificial substrate on mobile benches looked promising for development towards profitability and ecological sustainability. Representatives of this developmental pathway operated with confidence, had innovative power and found a link with IPM knowledge development (1 in Fig. 3) evident. Moreover, there were already serious research efforts on development of an IPM strategy for Dutch cut-chrysanthemum production, with involvement of several stakeholders. Therefore, a STN around system development (2 in Fig. 3) and not directly around IPM knowledge development was initiated (De Buck and Buurma 2004).

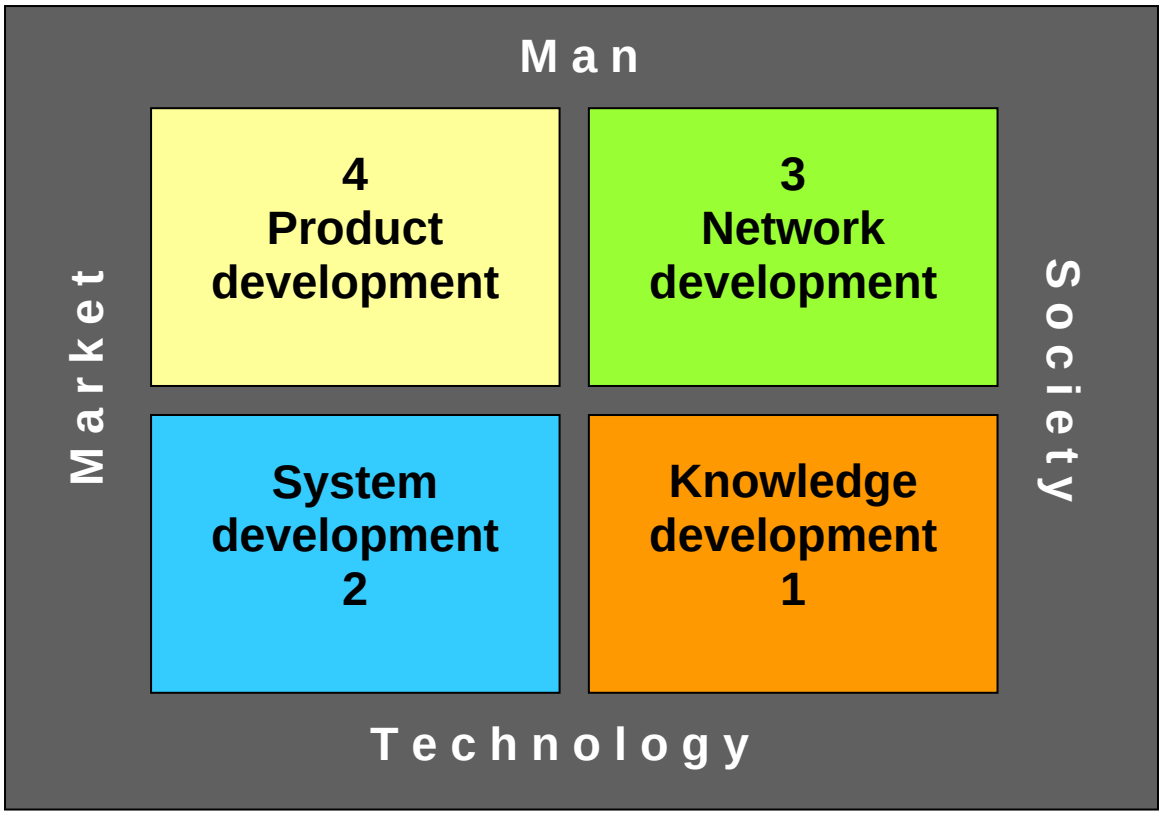

Figure 3. Mind landscape: the four developmental pathways for system innovation in chrysanthemum.

The chairman of the National Crop Committee (in Dutch: Landelijke Gewascommissie Chrysant, an NGO), a chrysanthemum grower himself, was appointed as the central person of STN. Through his position as chairman and grower, he was able to create support for the innovation throughout the sector. As a first activity of the STN a meeting was organized with all leaders of IPM initiatives in cut-chrysanthemum, including 'Farming with future' (chrysanthemum growers' network), 'Strategist' (communication project), a crop-protection producer and its supplier (carrying out a trend-setting IPM project), and a researcher involved in fundamental and applied aspects of IPM in chrysanthemum. This meeting has contributed to a close collaboration between all current projects on IPM in the chrysanthemum sector. In fact, this initiative can be considered as a first step in network development (3 in Fig. 3).

Composing a collaboration agreement. In the final step a collaboration agreement is composed, reflecting the intentions and commitment of the participants in this STN to implement a specific innovation development. An appropriate action for this is a workshop with all interviewed stakeholders in which future images are outlined and a plan is designed, necessary to reach one or more of these desired future images.

Concerning the STN in the chrysanthemum sector, a strategic document on sector development on behalf of the National Sector Organization for Horticulture was drafted (De Buck and Buurma 2004). This document elaborates sustainable development as a combination of the four developmental pathways. For the approval and funding of RandD proposals in a specific sector in horticulture the National Crop Committee (representing the sector; LTO) advises the National Sector Organization for Horticulture (in Dutch: Productschap Tuinbouw, an NGO). Both organizations require support from the sector for their decisions. The sector will support those decisions that lead to sustainable sector development in terms of Profit as well as People and Planet.

As a conclusive step, a workshop was held for the stakeholders who had been interviewed. In this workshop, the participants agreed upon the four developmental pathways required for sustainable horticulture (Fig. 3). There was full support for the fact that IPM should be incorporated in the development of the new production system as soon as possible. The participants were aware of the need for support from the whole sector for such extensive changes (system innovation) in cut-chrysanthemum production. Furthermore, the participants concluded that better expertise in pest control is necessary, but acknowledged that this was covered by recent initiatives, *i.e.* the projects 'Strategist' and 'Farming with future'. Finally, the transition to a new production system and IPM should be used to enhance product and market development of chrysanthemum (development 4 in Fig. 3).

CONCLUSIONS

The growers' network – for example those of the project 'Farming with future' - is an appropriate method for participative and stepwise learning, and enables the implementation of complicated knowledge about IPM and biocontrol. A Socio-technical network (STN) appears to be a useful tool and an appropriate method for stakeholders to decide on an innovation agenda for system innovation, such as the implementation of biocontrol and IPM. It is activated by the innovative capacity and common interests, strategies and visions of growers.

Socio-technical networks and growers' networks mobilize all decisive stakeholders for the implementation of sustainable horticulture. The interrelationship between the two types of networks on a specific crop is evident. In the case of the cut-chrysanthemum sector, the Growers' network on IPM stands for the dimension of knowledge development of the STN on sustainable sector development. The Growers' network enhances the STN as it is driven by stakeholders rather than by researchers. Hence, these networks contribute to a new knowledge system as a successor for the traditional triptych of Research, Extension and Education in the Dutch agricultural sector. Briefly, in a modern knowledge system based on these networks, the focus has shifted from critical success factors to critical success actors. The chal-

lenge for the coming years is to spread biological control and new IPM strategies that are developed and applied in the networks, towards the rest of the growers in the sector.

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