CASE STUDY: KNOWLEDGE TRANSFER IN CABBAGE IPM THROUGH FARMER PARTICIPATORY TRAINING IN DPR KOREA

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ABSTRACT

Yield losses in DPR Korean cabbage production are serious due to the main brassica insect pests, diamondback moth (*Plutella xylostella* L.) and small white butterfly (*Pieris rapae* L.). Traditional chemical pesticides have a limited impact on these pests because the diamondback moth has developed pesticide resistance. A new Integrated Pest Management (IPM) approach was therefore implemented in 2003. A preliminary IPM trial on five Cooperative Farms (Co-Farms) proved to be very successful and the feedback from participating farm managers was so positive that project partners decided to expand the area of IPM implementation. However, preparing for a large-scale shift in agricultural practices requires effective capacity building at each level of organization in the DPR Korean agricultural structure as well as a sustainable system for knowledge transfer within and between these levels. In 2004, a knowledge transfer concept was developed for the organization of training activities based on the experience from previous years. The scheme is adapted to the DPR Korean agricultural system and meets the requirements of an increased IPM implementation area. The thorough training of the Cabbage IPM Focus Group, a core group of scientists at the Plant Protection Institute, was continued. The knowledge about developing, implementing and monitoring IPM systems is thereby anchored in a scientific DPR Korean Institution, encouraging further independent initiatives for sustainable agriculture. At the same time these scientists were trained to become Master Trainers for the IPM implementation through the national extension service. Training material for the dissemination of IPM ideas was jointly developed by the project partners. A set of farmer participatory exercises was adapted to the DPR Korean context and evaluated at several Co-Farms. From the experiences gained with the training at the Co-Farm level and with the input of the Focus Group members, "A Farmer's Manual for Cabbage IPM in DPR Korea" was developed. This comprehensive information compilation on cabbage IPM will support the knowledge transfer to the practitioner in the cabbage field.

With these measures the stage is set for a successful large-scale implementation of cabbage IPM leading towards strengthening food security in DPR Korea through sustainable production of healthy food.

INTRODUCTION

Cabbage crops are of high importance in the traditional diet and local economy of DPR Korea. The amount of cabbage distributed yearly within DPRK varies between counties and ranges from 60 to 400 kg per family. Cabbage is particularly important as a food source during winter, as it is made into kimchi, a long lasting pickle. The high nutritional value is not the result of a high caloric level but rather the content of vitamins and trace elements. Cabbage is a good source of vitamin C and B as well as iron. Processing cabbage into kimchi by lactic acid bacterial fermentation is very effective in preserving vitamin C and increasing levels of vitamin B. In DPRK, regular kimchi consumption is indispensable for a balanced diet, especially in winter. It is therefore not surprising that the demand for kimchi raw material, cruciferous vegetables, is consistently high. Particularly in urban centres of DPRK, this represents a real challenge for the vegetable farms. One of the consequences of this is that large areas in close proximity to cities are used for continuous brassica cultivation. As a result, problems arise such as decreasing soil fertility, the build-up of soil borne diseases, insect pest outbreaks, and a general negative impact on bio-diversity in the agro-ecosystem.

Surveys during the past years showed that in DPRK, extensive problems arise because of the damage from agricultural insect pests, particularly from the diamondback moth, *Plutella xylostella* Linnaeus (Lepidoptera: Yponomeutidae), and the small white butterfly, *Pieris rapae* L. (Lepidoptera: Pieridae). This is exacerbated by the occurrence of insecticide resistance in the former species. The acquisition of pesticide resistance by diamondback moth is a wellknown phenomenon and leads to pest control failures in cabbage crops throughout the world (Talekar and Shelton 1993; Waterhouse 1992). In some areas, economic production of cabbage has become impossible (Talekar 1992).

Integrated Pest Management (IPM) is one of the remaining strategies available to achieve sustainable and profitable cabbage production. Over several years, applied research, capacity building, and knowledge transfer for the development and implementation of cabbage IPM were conducted in close collaboration with Cooperative Farm (Co-Farm) managers, executives and workers. Different methods, tools and techniques were tested in the field and a strategy was developed (Fig. 1.) that met with general approval. The core components of the strategy are 1) transplanting clean seedlings to delay insect pest population build-up, 2) replacing chemical pesticides with bio-pesticides and thereby enhancing the impact of the natural enemy community, 3) releasing natural enemies, and 4) following the recommendations of a monitoring and damage threshold model for pesticide applications. The area of implementation of this strategy was gradually increased and the results achieved on the five Co-Farms involved have proven to be very promising compared to the traditional chemical pest management approach.

Capacity building through knowledge transfer plays a major role within this strategy for the implementation of cabbage IPM. During the first project years, training activities were aimed at forming a core group of scientists, called the "Cabbage IPM Focus Group", at the Plant Protection Institute (PPI) Pyongyang.

1. Seedlings are **covered** with a synthetic fleece to prevent early pest damage; a **selective insecticide** is applied
→ the transplanting of clean seedlings delays the population build-up of pest insects

2. Application of the Swiss **monitoring and damage threshold model** to decide whether the field needs spraying or not
→ unnecessary sprays are eliminated, the impact of native natural enemies is strengthened on both target pest species

3. A **selective bio-pesticide** will be used (*Bt* product) to replace chemicals
→ pest populations are suppressed without killing natural enemies of the diamondback moth and the small white butterfly

4. Release of the **parasitic wasp** *Diadegma semiclausum* (natural enemy augmentation)
→ to enhance the suppression of the diamondback moth

Testing of the Pest Management strategy at five Co-Farms in DPRK

***Bt* 32'000 IU Switzerland**	***Bt* IU unknown DPRK**	**Traditional Chemical Pesticides**	**Untreated + releases of natural enemies**

<table>
<tr><th></th><th>Bt Switzerland</th><th>Bt DPRK</th><th>Chemical</th><th>Untreated + NE</th></tr>
<tr><td>Seedbed</td><td colspan="4">● Seedbeds are covered with a layer of synthetic fleece to suppress flea beetle and aphid attack and additional two layers for protection against cold temperatures
● If there are still insect pest problems, seedlings must be treated with the product Audienz 0.03% prior to transplanting
● Treatment of seedlings must be similar to make sure that plant quality at the transplanting date is comparable; seedlings must be free of pests</td></tr>
<tr><td rowspan="3">Transplanting and Cultivation Period</td><td>● The pest density in the field is assessed weekly with the damage threshold model
● The Bt product Delfin is applied following the re-commendations of the model
● Formulation: 500g in 300 litres per ha (max. 4-5 treatments)</td><td>● The pest density in the field is assessed weekly with the damage threshold model
● The local Bt product is applied following the re-commendations of the model
● Formulation: According to the producer (PPI)</td><td>● The monitoring strategy applied is defined at the beginning of the growing season
● A chemical product (e.g. Deltamethrin) is applied following the recommend-dations of the Ministry of Agriculture</td><td>● The pest density in the field is assessed weekly with the damage threshold model
● No pest management action by the farmer
● Formulation: 500 to 1000 natural enemies per ha (min. 2 releases)</td></tr>
<tr><td colspan="4">● Standardized farming practises (weeding, irrigation, fertiliser applications) are carried out in all the field plots throughout the growing season</td></tr>
<tr><td colspan="4">● PPI Focus Group will carry out studies about pest density levels on a per plant basis and will determine the incidence of natural enemies</td></tr>
<tr><td>At Harvest</td><td colspan="4">● Yield per area will be estimated for each field plot individually (several replicates within each field plot). Care has to be taken to make sure that results from differently managed plots are not mixed up.</td></tr>
</table>

Figure 1. Integrated pest management strategy for cabbage in DPRK.

Knowledge transfer for the Focus Group included various aspects of developing and implementing IPM in the model crop cabbage. Scientific aspects were covered during this time like the development of monitoring and damage threshold models, experimental design and analysis of IPM related field studies as well as technical aspects like the rearing of a diamondback moth parasitoid. At the same time, pilot farmer training activities started at five Co-Farms. Since the field testing of the newly developed IPM strategy was conducted at these farms, the cooperating farmers had to be trained in order to implement IPM in the test fields. The first on-farm training sessions focused on rather technical aspects like using the monitoring and damage threshold model and the application of a Bt bio-pesticide.

The overall aim for the training remained the same during the entire project activities: to build up a sustainable system for the knowledge transfer in DPRK with competent trainers transferring knowledge at the Co-Farm level. In this paper we describe the four prerequisites identified by the project partners for a successful, scaled up implementation of IPM in DPRK: 1) the development of a *knowledge transfer concept* on an institutional level in order to meet the requirements of an increased implementation area; 2) the continuation of *capacity building for trainers*; 3) the development and evaluation of *training exercises* for the transfer of basic ideas behind IPM in *Farmer Participatory Training (FPT)* and 4) the preparation of *didactic materials for knowledge transfer,* like e.g. tailor-made information in an adapted language and illustrations such as high quality pictures, for the on-farm implementation.

MATERIALS AND METHODS

COLLABORATION AND IMPLEMENTATION AREA

A joint initiative from the Plant Protection Institute (PPI) of the Academy for Agricultural Sciences (AAS) Pyongyang together with CABI Bioscience Switzerland and the Swiss Agency for Development and Cooperation (SDC) addressed the above mentioned problems in DPRK, with the aim of achieving a sustainable improvement of brassica production through the biological control of key pests in an Integrated Pest Management approach. The work concentrated on three different regions of DPRK: Pyongyang City, the Miru Hills area, and the South Hamgyong Province in the northern highlands (see Fig. 2.)

KNOWLEDGE TRANSFER CONCEPT

For the development of a knowledge transfer concept, the organizational and socio-political structure of DPRK agriculture had to be considered. In DPRK, a cooperative farming system is established where 1000 to 2000 people are living and working together on a farm covering an area of approximately 500 hectares (in the case of vegetable production). Crops that have to be grown are defined by the governmental planned quota, and usually more than 90% of the yield is fed into the public distribution system. Co-Farms, led by a manager and a chief engineer, are partitioned into work teams and sub-work teams with their respective leaders and engineers. Each work team specializes in the cultivation of a certain crop (a vegetable in the case of vegetable farms). Access to Co-Farms is limited and subject to permissions issued by the Ministry of Agriculture (MoA) for each farm and visit, respectively. The main project partner, the Plant Protection Institute, is one of the research institutes of the Academy of

Figure 2. Collaborating Cooperative Farms for the farm-wide implementation of the cabbage IPM strategy.

Agricultural Sciences (AAS), the latter being active in various fields of agricultural sciences. The traditional pathway for knowledge transfer in this system is a top down approach via the extension service of the MoA. Extension officers (one per Co-Farm) act as intermediaries of MoA and the farm. PPI traditionally is the advisory body for the MoA. It was necessary to develop a knowledge transfer structure that was adapted to these conditions.

CAPACITY BUILDING FOR TRAINERS

The capacity building for the Cabbage IPM Focus Group had to be continued during the 2004 project phase. Members of the Focus Group must, on the one hand, become experts in IPM, understanding the complex interactions in the agro-ecosystem and being able to cover scientific requirements for IPM implementation. On the other hand, they have to acquire didactic concepts and the pedagogic background to transfer their knowledge in an appropriate way, based on principles of adult education. The training in 2004 for the cabbage IPM Focus Group reflected these two parts. During the more scientific part, further training was provided to the Cabbage IPM Focus Group for the rearing of natural enemies of the diamondback moth. The Focus Group attended a one week training course "Statistics and Threshold Models" covering important aspects of experimental design and data analysis in the context of IPM implementation. As in previous years, the experimental design of the field testing, the monitoring program during the field season and the data analysis were jointly planned and carried out. Training of Trainers (TOT) for the Focus Group included the transfer of previously consolidated knowledge about crop rotation and, as a main activity, the planning, preparation, implementation and analysis of the "Introductory Training for the Implementa-

tion of Cabbage IPM" at the Co-Farm level. The IPM Focus Group implemented this training course in collaboration with a facilitator from CABI Switzerland on the four Co-Farms close to Pyongyang and independently on the highland Co-Farm.

FARMER PARTICIPATORY TRAINING (FPT)

The first steps of Farmer Participatory Training (FPT) during the first project phase focused on the transfer of basic project ideas about IPM and technical skills for the implementation of the strategy such as the introduction of the "Monitoring and Damage Threshold Model". Since the area managed for IPM in 2004 was extended and more farmers were involved in its implementation, the basic training was repeated for new participants and further training sessions were created. The first new session, carried out in spring, concentrated on crop rotation. The focus of these participatory learning sessions was on the importance of soil-born diseases and their impact on cabbage production. In summer 2004, the FPT field exercises were planned and evaluated at the five project Co-Farms. FPT focused first on the recognition of cabbage insect pests and the natural enemy complex controlling them. In a next step, the impact of using a broad-spectrum chemical insecticide compared to a specific *Bt* biopesticide was investigated. This knowledge is required for a better understanding of the IPM concept that is to be implemented. Courses were based on the following principle of adult education (see also Pontius *et al.* 2002): adults learn best from direct experience. Learning by doing adds to farmers' knowledge and experience, and improves their capacity as farm managers in a way that passive experience, like listening to extension messages, can not. Therefore, the most important components in the training were the exercises, where a logical sequence of small experiments, carried out by the farmers, supported the knowledge acquirement.

DIDACTIC MATERIAL FOR KNOWLEDGE TRANSFER

With respect to a broader dissemination and implementation of the cabbage IPM strategy, a manual was developed to provide a concise information compilation on cabbage IPM for the DPRK context in order to support the knowledge transfer. Step by step, inputs from all sides, farmers and scientists, and material adapted from already existing sources (Praasterink 2000; Van Mele *et al.* 2002; Vos 1998) were put together with the aim of developing a booklet that meets the needs of the practitioner in the cabbage field. The intended final product was a portable, weather-resistant booklet with all information necessary for cabbage IPM implementation to make sure that the knowledge can be transferred to where it is needed

RESULTS

KNOWLEDGE TRANSFER CONCEPT

The plan developed for knowledge transfer in DPRK (Fig. 3.) includes a pilot phase, which focuses on the thorough training of a core group of scientists at the PPI. The main aim is to anchor the capacity of developing, implementing and monitoring IPM systems in a scientific DPRK institution, thereby making sure that further IPM activities in other crops could be developed and implemented independently in the future. Parallel to the scientific capacity

building, a TOT is run and subsequently PPI scientists gain their first experience in facilitating FPT at the Co-Farms. Over the course of the first phase and with the appropriate training, these scientists become IPM specialists and Master Trainers.

For large-scale dissemination of the IPM approach in cabbage, the farm extension officers are involved and will be responsible for the knowledge transfer on their farms. At the same time, county extension officers from the MoA join as trainers. Each county extension officer will later become a Master Trainer transferring knowledge to the farm extension officers in the respective county. In the beginning, the TOT is carried out by the core group of PPI scientists together with a CABI extension specialist with the aim that the latter makes her-/himself redundant.

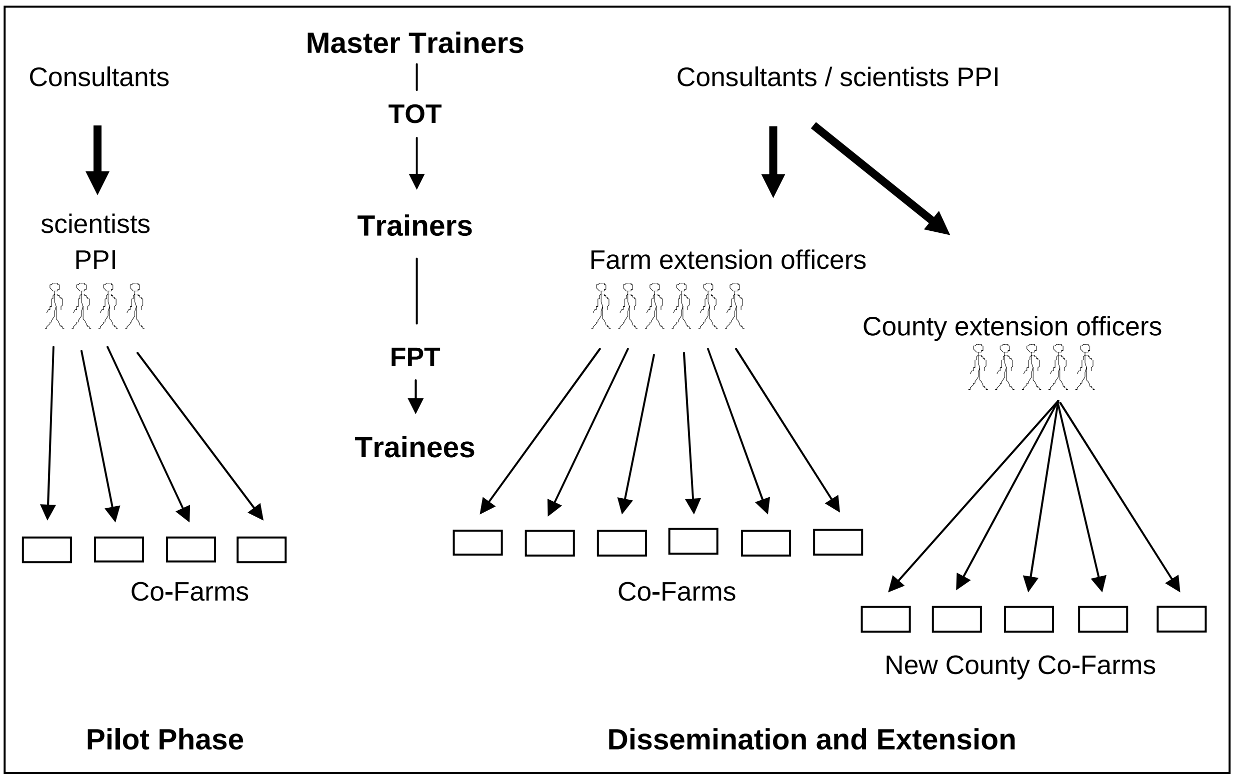

Figure 3. IPM knowledge transfer concept for DPR Korea.

CAPACITY BUILDING FOR TRAINERS

To assure that the Cabbage IPM Focus Group meets the requirements in this knowledge transfer concept, capacity building was continued on two levels: concerning scientific contents and FPT. The main training units, which were in the context of IPM implementation in 2004, are summarized in Table 1.

Extended CABI visits to DPRK in 2004 set the foundation for continuous knowledge transfer to the Cabbage IPM Focus Group and made it possible to discuss problems and IPM-specific questions. In addition to this continuous process, specified training activities were planned. The topic "Crop Rotation" was subject of discussion and dealt with in depth. Further training was provided for the important IPM component of rearing natural enemies.

Table 1. Topics and methods of the main training units in 2004 for the capacity building of the IPM Focus Group in chronological order. SCI = scientific topics; FPT = Farmer Participatory Training topics.

	Topic	Methods
SCI	Crop rotation: theoretical background.	Lectures and discussions as a preparation of FPT
FPT	Crop rotation: On-Farm Information sessions based on current Farm practices	Theoretical sessions with a participatory approach at all participating Co-Farms
SCI	"Statistics and Threshold Models"	One week training course in Pyongyang
SCI	Rearing of natural enemies	Practical work in greenhouse and rearing lab; working out guidelines and management practices during a one month consultancy
SCI	Design of the experimental set-up 2004 for the Co-Farm areas of IPM implementation	Discussion and deduction of the program, monitoring plan
FPT	Basic training for the cabbage IPM implementation at Co-Farms, training for the threshold model and technical training	Participatory training sessions at all Co-Farms carried out by the Focus Group
FPT	Implementation of the experimental set-up on at Co-Farm level	On-site support and backstopping, weekly at all Co-Farms
SCI	International Plant Protection Conference Beijing	Poster presentation at an International Congress, international contacts and exchange of experiences
FPT	Monitoring, the application of bio-pesticides and yield measurements	On-site support and backstopping, weekly at all Co-Farms
FPT	"Introductory Training for the Implementation of Cabbage IPM" on the 4 lowland Co-Farms	Training unit with participatory exercises; hands-on training, discovery learning
FPT	Introduction of the strategy, technical backstopping and FPT unit at the highland Co-Farm	Methods as above, carried out by the Focus Group
SCI	Data compilation, analysis and interpretation	Preparation of the data set 2004 for the presentation at the National Information Day

During a 10 day training course "Statistics and Threshold Models", the Focus Group together with 16 other participants were able to improve their statistics skills. Other topics covered were an introduction to hypothesis testing and experimental design, and the knowledge gained could be applied to the IPM program by the Focus Group. Finally, attending the International Plant Protection Congress in Beijing facilitated international contacts with researchers world-wide. Moreover, four future Master Trainers from DPRK had the opportunity to exchange experiences in the field of IPM.

The main FPT activities for the Focus Group were directed towards the "Introductory Training for the Implementation of Cabbage IPM" to be carried out at the Co-Farms. The

main steps of knowledge transfer were discussed and the didactics and pedagogical concepts behind the exercises were clarified. Together with the Focus Group, the training was prepared in terms of logistics and material. After the implementation in the Pyongyang area together with the consultant, the Focus Group had the opportunity to consolidate the acquired skills by implementing the training themselves at the highland Co-Farm.

FARMER PARTICIPATORY TRAINING (FPT)

The first new unit of FPT in 2004 concentrated on crop rotation at four Co-Farms (Hwasong, Changchon, Dangsan, and Mangyongdae). All the crops grown at the Co-Farms in one season were compiled with their respective areas and yields. Farmers identified soil-born diseases causing problems on their farms. Adverse effects like yield losses due to these diseases and due to the degradation of soil fertility associated with continuous cabbage cultivation were explained. The method of crop rotation was presented as a means to solve production problems. It became clear that, at the present time, the implementation of a three or four year crop rotation on a large scale is not feasible. Especially in autumn, the production of cabbage and turnip occupies almost the total surface area available for crop rotation in order to respond to the high cabbage demand for kimchi production. Nonetheless, Co-Farms are highly interested in the basic principles of crop rotation. As an important first step for further activities in Integrated Crop Management (ICM), all the Co-Farms will implement and test a small-scale, three-year rotation of vegetable crops.

The main FPT activity in 2004 was the "Introductory Training Unit for the Implementation of Cabbage IPM", compiled and implemented with the trainers from the IPM Focus Group at the five project Co-Farms. At each Co-Farm, 15-30 participants, both farmers and work-team leaders, attended the training sessions. Training focused first on the recognition of cabbage insect pests and the natural enemy complex controlling them (Table 2). This was done with activities around a so-called "insect zoo": insects collected in the field were identified and in a discovery learning approach (Fig. 4.) were dealt with to improve the farmers' understanding of the cabbage arthropod community. Important steps of this part of the training were:

- The identification of "good" and "bad" insects (farmers' friends and foes)
- The direct observation of predators killing pests
- The direct observation of parasitoids attacking their host

In a next step, the impact of using a broad-spectrum chemical insecticide compared to a specific bio-pesticide, *Bacillus thuringiensis kurstaki*, was shown. Important steps of this part of the training were:

- The effect of a chemical on the pest/natural enemy
- The effect of a Bt product on the pest/natural enemy
- Implications of the findings on the use of a damage threshold model

Table 2. Activities and objectives of the FPT, implemented at partner Co-Farms in 2004.

Introductory Training for the Implementation of Cabbage IPM	
Activities	**Objectives**
DAY 1	
Exercise 1: Insect zoo: collection and identification of insects	
Different insects are collected in the cabbage field. They are sorted and identified.	Curiosity about the arthropod community in the cabbage ecosystem is stimulated. Participants acquire basic skills in handling and identifying pests and beneficial insects.
Exercise 2: Insect zoo: studying predators	
Experiments are set up in order to find out about qualitative (who is eating whom?) and quantitative aspects (how much do they eat?) of predation.	Participants recognize predators and discover the importance of these beneficial insects in the cabbage field.
Exercise 3: Insect zoo: studying life cycles of pests	
Experiments are set up in order to observe the entire life cycles of lepidopteran pests. They are discussed after having reared different field collected instars.	Participants observe egg laying and subsequent development of pest instars in order to understand life cycles and phenology of these insects. This is an important prerequisite to anticipating pest problems.
Exercise 4: Insect zoo: studying life cycles of parasitoids	
Parasitoids are directly observed when laying eggs. The possible impact of this behavior is assessed in experimental caging.	Participants gradually become acquainted with different aspects of parasitism, starting with a general life cycle of a model parasitoid (Diadegma).
DAY 2	
Theory part 1: Discussion of the results from Ex2 / 3	
Results from the experiments are reported to the group. Examples of pest insect life cycles and pest - predator interactions are summarized. Additional theoretical background information is provided.	With short presentations by the participants and the subsequent discussion including theoretical inputs by the facilitator, new findings about pests and predators are structured and consolidated.
Exercise 5: Comparison of biological and chemical pesticides used in caterpillar control	
The action of chemical broad - spectrum pesticides on pest insects is compared with the action of a specific Bt product. In cage experiments, Plutella and Pieris larvae feed on leaves treated with a) Bt, b) a chemical insecticide, or c) nothing.	Based on the previously acquired knowledge about pest - natural enemy interactions, participants can imagine to what extent "natural" control is decreased, if broad-spectrum chemical insecticides are used. They are motivated to conserve natural enemies.
Exercise 6: Effects of pesticides on natural enemies	
The set-up from Ex 5 is used to assist the discovery of the survival of different natural enemies when Bt is used.	As above (Ex 5).
Exercise 7: Parasitoids on the small white butterfly and the diamondback moth	
Pest pupae (and mature Piers larvae) and parasitoid cocoons are collected and identified. Parasitoid life cycles are repeated. The parasitism level in the field is assessed for both pests, and its impact is analyzed.	Participants become more familiar with the most prevalent parasitoid species of Plutella and Pieris. They learn more about parasitism and its effect on the two main pest species in cabbage.
Theory part 2: Brief analysis of Ex 5 / 6	
First results are discussed and experiments are assigned to participants for further observations.	

Table 2. Activities and objectives of the FPT, implemented at partner Co-Farms in 2004 (continued).

Introductory Training for the Implementation of Cabbage IPM	
Activities	**Objectives**
DAY 3	
Theory part 3: Discussion of the results from Ex 5 / 6	
The outcome of the experiments is reported to the group and discussed.	The initiated dialogue amongst participants creates awareness about pesticide associated problems.
Exercise 4: Evaluation of the caging experiment	
Parasitized and unparasitized diamondback moth pupae are counted and the influence of parasitism on the Plutella population is discussed.	Participants discover the efficacy of a parasitoid and find out about possibilities to conserve adult parasitoids in the cabbage field
Theory 4: Implications on the use of the damage and threshold model	
Based on the new knowledge acquired during the previous training days, factors which influence the extent of damage done in the field by a certain number of pests are listed. Theoretical examples are given on how to consider these factors (parasitism, predation, crop stage, pest stage) and the weather situation into a model-based decision making process.	Participants consolidate their knowledge by its application in the new context of threshold model implementation. They are motivated to translate a refined threshold model approach into practice

Figure 4. Distinguishing between "good" and "bad" insects through discovery learning at the Co-Farm level.

The Cabbage IPM Focus Group facilitated the training unit helped to successfully implement this training component. It became obvious that the Focus Group does not only have a broad knowledge about IPM and its principles, but is also capable of transferring the acquired knowledge in IPM to other people. The participants showed high interest and commitment during the courses. From the remarks and questions made by the participants it became clear, that with this training, a vital support for IPM was induced.

DIDACTIC MATERIAL FOR KNOWLEDGE TRANSFER

During the cabbage IPM implementation, the project partners realized that, despite the wealth of information available for IPM and cabbage, there was a need for a manual that provides concise information on cabbage IPM, is written in the Korean language and adapted to the local context. Descriptions and illustrations of major cabbage insect pests and diseases had to be included, as did ideas on how knowledge in IPM needs to be transferred. The first step in the manual's development was a joint decision about its contents. Considering that IPM as a plant protection strategy is new for most cabbage producers in DPRK, an introduction into this approach and its tools was seen to be essential. Farmers should recognize major cabbage insect pests, natural enemies and diseases in the field. Therefore, a section of fact sheets was considered to be indispensable for the manual. It was also decided that a segment covering the discovery-learning exercises should be included in order to facilitate knowledge transfer. When the first draft of the English version of the manual was written, the Cabbage IPM Focus Group reviewed it and adapted it to the local context. Pictures of cabbage pests and diseases, as well as pictures from participatory training, were taken during the whole season. In order to illustrate the IPM component, an artist from the AAS made the drawings. After reviewing the English text version once more, it was translated into Korean while the layout for the English version of the manual was completed.

The English version of "A Farmer's Manual for Cabbage IPM in DPRK" is now available. It consists of 120 pages in a loose leaves system in a ring binder. It has a handy C6 format and the water-repellent paper and print allow farmers to take it to the field (some extracts are printed above).

Part one (Figs. 5a + b.) gives a rather general overview of the IPM approach and its methods and tools. Specific advice is included for the cultivation of cruciferous vegetable crops in DPRK. These different ideas can be implemented and tested in the cabbage field according to the prevailing situation.

The successful implementation of IPM requires fundamental skills and understanding of the relatively complex interactions of organisms in the agro-ecosystem. This in turn demands knowledge about the components of the interactions. Part two (Fig. 5c.) is therefore dedicated to the identification and understanding of pests, diseases and natural enemies in the cabbage field.

Part three (Fig. 5d.) takes into account that the knowledge transfer of a complex matter like IPM is challenging, but nevertheless essential for its implementation. The manual provides a training curriculum based on discovery learning exercises for the introduction of cabbage IPM at the Co-Farm level. The unit was carried out and evaluated on five Co-Farms in 2004 and proved to be very successful. As with the IPM approach itself, the knowledge transfer of its contents has to be flexible and adaptable to specific situations. Therefore some additional exercises were compiled for trainers and farmers covering topics such as the spread and effects of pathogens, plant compensation studies and cage exclusion of natural enemies.

Within the framework of the National Information Day for Cabbage IPM Implementation in DPRK, the English version of the manual was presented to the audience. Options are currently being explored to print the Korean version in Pyongyang and joint efforts will ensure that a high-quality manual in the Korean language will be available in the future for the dissemination of cabbage IPM on a large scale in DPRK.

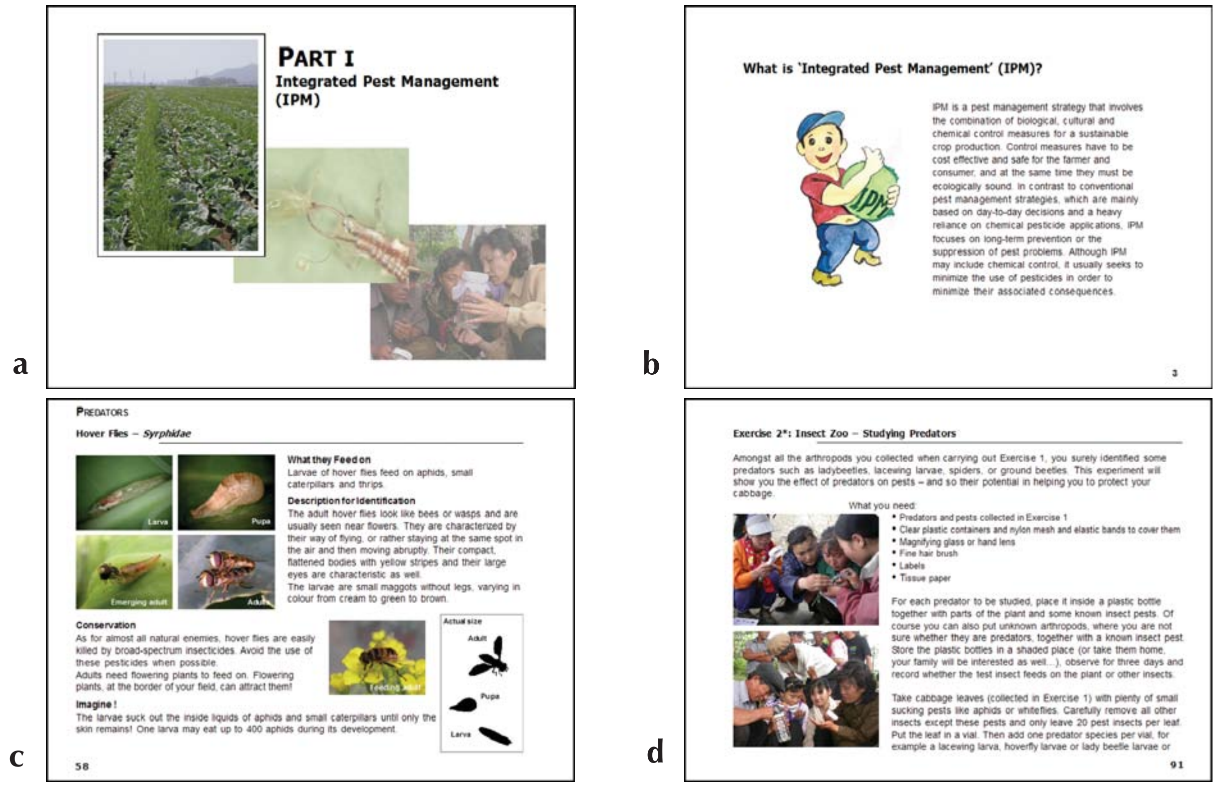

Figure 5. Extracts from "A Farmer's Manual for Cabbage IPM in DPRK".

CONCLUSIONS

The experimental implementation of the cabbage IPM strategy in DPRK showed promising results. White cabbage yield has been increased by up to 40% compared to the traditional chemical pest management approach. Unnecessary chemical treatments were avoided in Chinese cabbage since IPM was adopted. In 2004 the IPM strategy was extended to nearly 150 ha representing the majority of the white cabbage cultivation at the five Co-Farms. For the transition from an experimental to a field-testing scale and ultimately to common agricultural practice, capacity building through knowledge transfer is of highly important.

- A *knowledge transfer concept* was developed and adapted to the local agricultural system. A core group of PPI scientists will become Master Trainers through appropriate training and will then facilitate the central TOT involving farm and county extension officers as trainees. The option will also be available for county extension officers to become Master Trainers for county-based TOTs.

- To assure that the core group of PPI scientists meets the requirements in this knowledge transfer concept, *capacity building* was intensified. Through the planning and implementation of training units at Co-Farms, this group acquired the necessary background for FPT and subsequently acting as Master Trainers in the national extension service. Training continued at the same time for scientific aspects of developing, implementing and monitoring IPM systems, encouraging further independent initiatives for sustainable agriculture.
- Training material for the dissemination of IPM ideas through *FPT* was jointly developed by the project partners. A set of FPT exercises has been designed, adapted to the DPRK context and evaluated at several Co-Farms. The participants showed high interest and commitment during the courses. From the remarks made and questions asked by the participants it became clear that this training stimulated awareness and support for IPM.
- Based on training experience at the Co-Farm level and with additional input from the Focus Group and consultants, "A Farmer's Manual for Cabbage IPM in DPRK" was developed. This didactic material will be used to support knowledge transfer to field-level personnel.

These measures have created the framework for a successful large-scale implementation of cabbage IPM leading towards strengthening food security in DPRK through sustainable production of healthy food.

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REFERENCES

Pontius, J., Dilts, R. and Bartlett, A. (Eds.) 2002. "From Farmer Field School to Community IPM: Ten Years of IPM Training in Asia," 106 pp. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

Praasterink, F. M. 2000. "Cabbage Integrated Pest Management: An Ecological Guide," 205 pp. FAO Inter-Country Programme for the Development and Application of IPM in Vegetable Growing in South and South-East Asia.

Talekar, N. S. 1992. Integrated Management of Diamondback Moth: A Collaborative Approach in Southeast Asia. *In* "Integrated Pest Management in the Asia-Pacific Region" (P. A. C. Ooi, G. S. Lim, T. H. Ho, P. L. Manalo, and J. Waage, Eds.), pp. 37-49. Proceedings of the Conference on Integrated Pest Management in the Asia-Pacific Region, 23-27 September 1991, Kuala Lumpur, Malaysia.

Talekar, N. S. and Shelton, A. M. 1993. Biology, ecology and management of the diamondback moth. *Annual Review of Entomology* **38**, 275-301.

Van Mele, P., McGillivray, L., Brunt, J., Crowson, H., and Vos, J. 2002. "Discovery Learning Manual for Cabbage Pest Management," 290 pp. CABI Bioscience.

Vos, J. G. M. 1998. "Vegetable IPM Exercises: Protocols, Implementation and Background Information," CABI Bioscience/FAO.

Waterhouse, D. F. 1992. Biological Control of Diamondback Moth in the Pacific. *In* "Diamondback Moth and other Crucifer Pests: Proceedings of the Second International Workshop, 10-14 December 1990, Tainan, Taiwan" (N. S. Talekar, Ed.), pp. 213-224. Asian Vegetable and Development Center, Shanhua, Taiwan.