12.3 The Importance of Local Production to Foster the Uptake of Augmentative Biological Control in Developing Countries

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Augmentative biological control is the periodical release of large numbers of natural enemies mass-reared in biofactories to obtain an immediate control of pests (van Lenteren, 2012). It has been practiced for commercial mass production and sale of natural enemies for roughly 120 years (van Lenteren, 2012) and successfully applied against a range of open-field and greenhouse pests (van Lenteren and Bueno, 2003; Bale *et al.*, 2008). Nevertheless, augmentative biological control is applied on a relatively small acreage (van Lenteren, 2012), even though it has been considered an environmentally and economically sound successful alternative to chemical pest control (van Lenteren and Bueno, 2003). The limited use of augmentative biological control is not only attributed to social and economic factors such as attitudes of the pesticide industry, farmers, governmental institutions and biological control community as well as influence of guidelines and regulations (van Lenteren, 2012), but also due to problems associated with the production and distribution of parasitoids and predators, particularly, the limited shelf life of most natural enemy species (Bale *et al.*, 2008). Some of these limitations may be overcome with evolved government policy to tackle pesticides problems and promote integrated pest management practices, increased demands of food retailers and consumers for safe agro-products and further research. Here we report a grassroot approach towards the establishment of local biological control agent production facilities. Knowledge transfer from an international biocontrol manufacturer to the community level in a developing country was facilitated to overcome the barriers to uptake of augmentative biological control.

Maize, *Zea mays* L. (Poaceae), is one of the most important food crops in the world and, together with rice and wheat, provides at least 30% of the food calories to more than 4.5 billion people in 94 developing countries (Shiferaw *et al.*, 2011). In Myanmar, Laos and Yunnan - southwestern China, maize is the most important crop after rice, being used as

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both animal feed and for human consumption. It is grown by approximately 15.4 million smallholder farmers on about 1,871,000 ha, with farm size ranging from 0.2-3 ha (unpublished data). The Asian corn borer, *Ostrinia furnacalis* (Guenée) (Lepidoptera: Crambidae), is the most prevalent and destructive insect pest of maize throughout Asia (Nafus and Schreiner, 1991). In China, annual loss due to this pest ranges from 6 to 9 million tons per year (He *et al.*, 2003). So far, the majority of maize growers in Southeast Asia still use conventional pest control methods, relying heavily on broad-spectrum insecticides. Synthetic insecticides are readily available in China and Myanmar, where fear of crop losses results in overuse. In contrast, farmers in Lao PDR have virtually no access to commercial plant protection products and are thus at high risk of pest outbreaks.

Augmentative biological control with *Trichogramma* (Hymenoptera: Trichogrammatidae) has been used worldwide in a number of crop-pest systems, particularly maize - corn borers (Li, 1994), and has been especially successful to control the Asian corn borer on maize in northeastern China (Wang *et al.*, 2014) and DPR Korea (Zhang *et al.*, 2008, 2010). In recent years, the mass production technology and release technique of *Trichogramma* have been greatly improved, making *Trichogramma* production and field application more practical and cost efficient (Wang *et al.*, 2014). However, smallholder farmers in Myanmar, Laos and Yunnan - southwestern China are unable to fully adopt the approach because they either do not have the knowledge or lack resources and support to access *Trichogramma* products. Therefore, a joint collaboration, funded by DG DEVCO - EuropeAid (DCI-ASIE/2011/261-127), involving agricultural research, development and extension institutions, as well as a commercial biological control manufacturer, was initiated in the three target countries to strengthen intra-regional linkages and transfer of *Trichogramma* production and release technology through south-south partnerships.

Results: Since the beginning of the collaboration, a grassroots approach was employed to facilitate the active participation of all relevant stakeholders and strengthen the links between them, particularly smallholder farmers being brought into the mainstream of technology transfer and playing a key role in the decision-making process. Involving multi-institutional representatives from the target regions, an intra-regional knowledge and exchange platform was established to strengthen south-south partnership and to facilitate the transfer and knowledge and the *Trichogramma* production and release technology. A Chinese production technology for *Trichogramma* was adapted to the hotter climates and the specific needs of management by small-holder maize farmers, and as release strategies.

In total, eight smallholder communities (3 in Myanmar, 4 in Yunnan - China, 1 in Laos) covering approx. 8000 smallholder maize farmers were mobilized and established local grassroot organisations responsible for i) training of facility personnel to produce *Trichogramma* and farmers to apply the *Trichogramma*, ii) management of the *Trichogramma* production facility, according to a business plan, and iii) marketing of the *Trichogramma* and improved access to market opportunities. Such an innovative community-based approach is instrumental for long-term sustainability of the established *Trichogramma* production facilities, ensuring that profits stay within the community and inheriting the promotion of product and the ecologically-friendly farming practices at the community level.

About 37 rearing technicians were trained on *Trichogramma* production and over 5000 farmers were trained on *Trichogramma* application through participatory-based training of trainer approach. Through stepwise approach, eight *Trichogramma* production facilities have been established and produced *Trichogramma* egg cards in standard quality but still

have a way to go in order to reach a higher production capacity and thus the economic break-even point. The facilities were providing not only *Trichogramma* products but also other essential agricultural inputs and marketing services as well as associated capacity building to catalyse the uptake of the integrated pest management practices by smallholder maize farmers. Moreover, national or regional stakeholder conferences and local awareness/promotion days were organised in three target countries to improve awareness and create conducive environment for large-scale dissemination of the available biological control technology for the first time in the region. Over 9000 participants were attracted to these awareness creation events, including local farmers, extension staff and officials from local and regional governments.

Discussion: Many farmers in the developing countries face several barriers to adopting new and potentially profitable agronomic practices and technology, during which access to information, input and output markets and services play a critical role (Shiferaw *et al.*, 2011). Deployment of biological control agent production facilities at the community level would facilitate farmers' access to a tangible biological control product and promote adoption of augmentative biological control technology in developing countries. In our case, farmers are not passively receiving a technology but rather proactively involved in technology adaptation and adoption. Farmers also learnt how to operate and manage the facilities in a business way. However, future success is largely dependent on a great level of investment by public and private sector and sustained political commitment from developing country governments to upscale these innovations through enhanced support for extension and marketing services and increased inputs and value chain development.

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