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MASS PRODUCTION AND UTILIZATION OF *TRICHOGRAMMA EVANESCENS* AS A BIOLOGICAL CONTROL AGENT AGAINST ASIAN CORN BORER *OSTRINIA FURNACALIS* IN THE PHILIPPINES.[1]

(Status as of 1992)

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INTRODUCTION

In the Philippines three crops namely rice, corn and coconut are dominating agriculture in respect of hectarage planted to it (≈ 85% of arable area) as well as in their importance as cash crop (Table 1). Among them, corn has seen a remarkable increase in its importance over the last decade with an increase in hectarage from 3.3 M ha in 1980 to more than 3.5 M ha at present. The reason for this development is the growing demand for feeds by the livestock industry. Aside from this the availability of high-yielding hybrid varieties with yields 7-fold compared to the local varieties made farmers to utilize more land

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1. This report has been made in the framework of the Philippine-German Biological Plant Protection Project (PGBPPP), a cooperation between Bureau of Plant Industry and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, funded by the German Government

for corn production. However these hybrid varieties showed to be highly susceptible to the indigenous Asian corn borer *Ostrinia furnacalis* and as such it necessitated the application of pesticides making corn production more costly, too costly in fact, farmers cannot afford insecticides but at the same time their crops are subjected to higher pest incidence and what ever remained to be harvested received lower market value.

Table 1. Importance of agricultural crops in the Philippines in 1980 and 1987

Crop	Hectarage 80 (ha)	% of farm area	Yield 80 (tons)	Hectarage 87	% of farm area	Yield 87
Rice	3,636,810	30%	7,835,795	3,402,910	28%	8,957,760
Corn	3,201,070	26%	3,122,843	3,564,480	29%	4,015,040
Coconut	3,125,920	26%	4,570,165	3,360,020	28%	3,262,503
Others	2,163,380	18%		1,820,520	15%	

Source: CENTER FOR RESEARCH AND COMMUNICATION (1990)

Because of this situation resorting to a cheap but effective biological pest control method was considered. The Department of Agriculture (DA) with the Bureau of Plant Industry (BPI) Manila coordinating as lead agency had been active since 1987 in the framework of this responsibility together with the Philippine-German Biological Plant Protection Project (PGBPPP) in order to rear and provide farmers with the egg parasitoid *Trichogramma evanescens* as a bioagent against the Asian corn borer.

Trichogramma technology aims to reduce the utilization of chemical insecticides in corn production by offering a more safer biological pest control method.In consequence, it is expected to increase the income of farmers by reducing their production costs and lessen the danger of poisoning which occurs quite frequently when using chemical pesticides.

THE TRICHOGRAMMA METHOD

T. evanescens is a tiny ($\approx$ 0.6 mm in length) wasp of the genus *Hymenoptera*. Since it is an egg parasitoid *T. evanescens* depends on eggs of other insects in order to produce offspring. The female wasp deposits one or several of her eggs inside the egg of another species - in this particular case - Asian corn borer. The parasitoid larva/larvae will feed on the contents of the host egg killing the embryo of the Asian corn borer in this process.

For pest management purpose huge numbers of Trichogramma wasps are needed for the release on the onset of corn borer invasion into the field. This amount of parasitoids cannot be reared on eggs of the target pest out of economic and technical reasons. Instead, eggs of cheaply reared storage pests are used for the multiplication process. In the Philippines, originally only the rice moth *Corcyra cephalonica* and now, also the Angoumois grain moth *Sitotroga cerealella* are in use. Accordingly, the shift to *S. cerealella* made possible the increase to production levels as in the rearing stations of the Regional Crop Protection Center (RCPC) Ilagan and the Agricultural Pilot Center (APC) in Iguig, Tuguegarao.

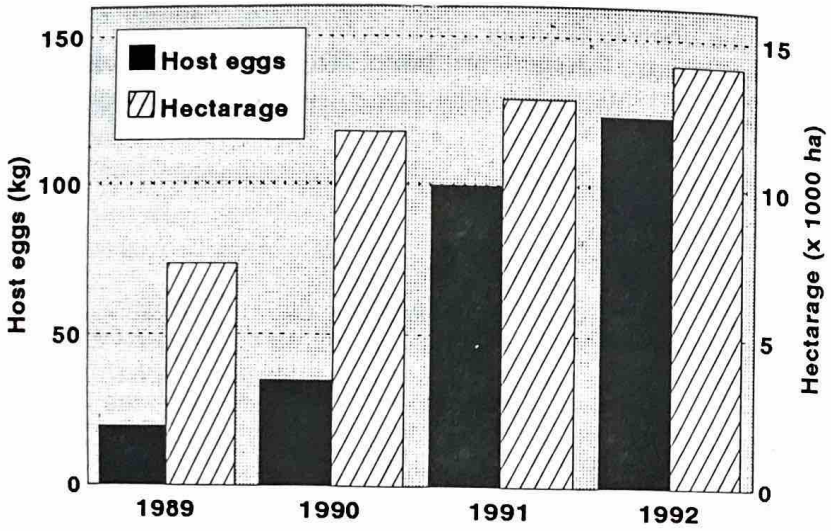
The parasitized host eggs are glued onto cardboard frames called trichocards. Farmers receive these cards (50 - 70 cards per release per hectare) either by the extensionists or directly from the rearing stations and distribute them evenly into the field. The trichocards, hanging on corn plants 12 - 14 meters apart, release the fully developed parasitoids within 1 - 2 days after distribution in the field. After mating the female wasps are searching for corn borer eggs and parasitize them. The offspring of these eggs will continue the cycle one week later and build up a parasitoid population strong enough to protect the field.

PRODUCTION AND UTILIZATION

The BPI/PGBPPP joint effort started with a few rearing stations with production on laboratory level. The project has today expanded to a countrywide network of rearing stations, two of them with production outputs of international standard (RCPC Ilagan, APC Iguig; Figure 2 and 3). At present an area of more than 10,000 ha corn fields are treated yearly with the beneficial and more than 100,000 ha benefited from the dispersal and establishment of *T. evanescens* (Figure 1). This was made possible by the introduction of an improved rearing technology and better management which allowed higher

output and reduced at the same time production costs (per trichocard) and the workload of the staff involved.

Figure 1. Trichogramma production in the Philippines 1989 - 1992



	1989	1990	1991	1992	
Host eggs:	19846	34759	99714	123723	(grams)
Trichocards (TC):[1]	315234	580691	956501	1236207	(no.)
Hectarage:	7333	11763[2]	12895[3]	14139[4]	(ha)

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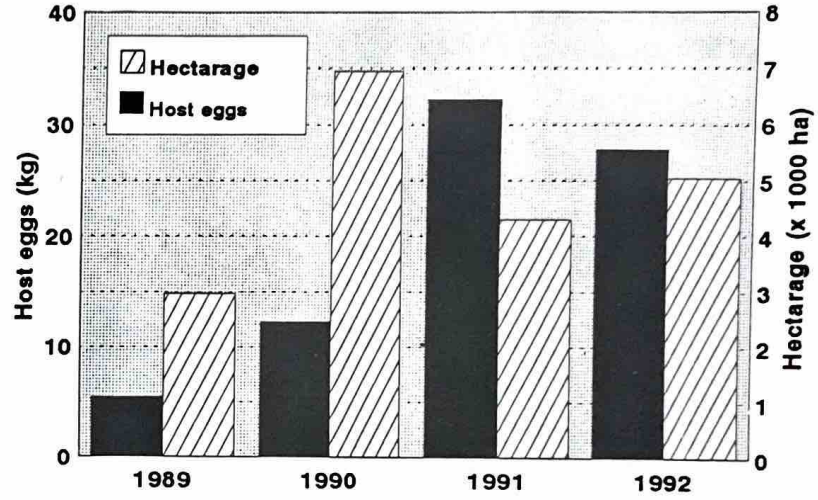
1. Since 1991 20 TC are produced out of one gram of parasitzed eggs
2. 10 - 50 TC per ha
3. 50 TC per ha
4. 50 - 70 TC per ha

Figure 2. Trichogramma production in RCPC Ilagan 1989 - 92



	1989	1990	1991	1992	
Host eggs:	5432	12230	32280	27767	(grams)
Trichocards (TC):[1]	1500	343120	289802	573061	(no.)
Hectarage:	2971[2]	6946[3]	4297[4]	5043[5]	(ha)
Farmer:	2376	6908	4096	4747	(no.)

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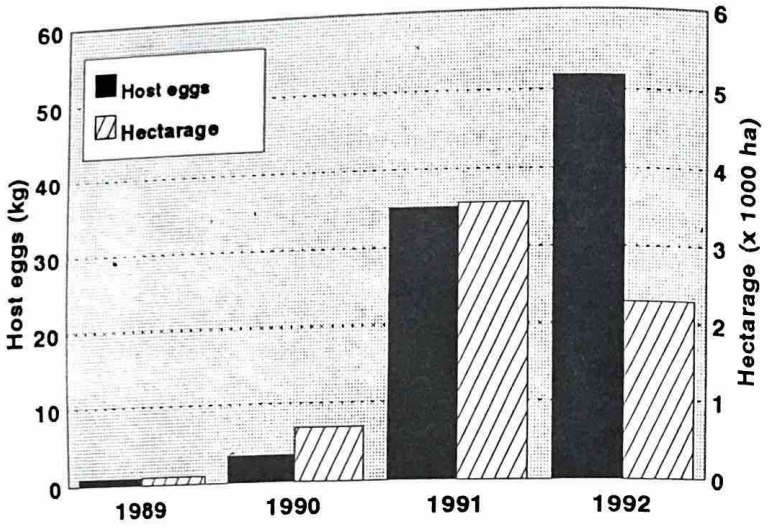
3. 10 - 50 TC per ha
4. 50 TC per ha
5. 50 - 70 TC per ha

Figure 3. Trichogramma production in APC Iguig 1989 - 92



	1989	1990	1991	1992	
Host eggs:	912	3425	35113	51850	(grams)
Trichocards (TC):[1]	5182	47825	400175	290415	(no.)
Hectarage:	103[2]	694[3]	3559[4]	2287[5]	(ha)

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4. 50 TC per ha
5. 50 - 70 TC per ha

Table 2. Trichogramma production 1989 - 92, according to station[1]

Host eggs (g):	**1989**	**1990**	**1991**	**1992**
Sta. Barbara	1148	1181	3202	3232
APC	912	3425	35113	51850
Ilagan	5432	12230	32280	27768
Maligaya	0	0	290	3325
Pili	145	1543	1582	2186
Iloilo	924	248	1319	1991
Mandaue	0	250	499	2568
Dipolog	0	1050	5795	6837
Molave	0	386	1522	1353
Malaybalay	5312	4490	4003	6831
Bago Oshiro	4048	3937	10149	11864
Tacurong	1925	6019	3960	3918
Total:	**19846**	**34759**	**99714**	**123723**
Trichocards (no.):				
Sta. Barbara	11266	8344	24024	22248
APC	5182	47825	400175	290415
Ilagan	171500	343120	289802	573061
Maligaya	0	0	0	5610
Pili	732	27278	20380	27231
Iloilo	9165	1441	9458	5268
Mandaue	0	4420	8840	31698
Dipolog	0	3441	41235	43275
Molave	7588	3415	14104	7155
Malaybalay	54635	55617	47273	109586
Bago Oshiro	22904	33030	61198	82320
Tacurong	32262	52760	40012	38340
Total:	**315234**	**580691**	**956501**	**1236207**
Hectarage (ha):				
Sta. Barbara	149	177	420	676
APC	103	694	3559	2287
Ilagan	2971	6946	4297	5043
Maligaya	0	0	0	63
Pili	8	492	416	168
Iloilo	177	7	80	38
Mandaue	0	88	176	1241
Dipolog	0	85	304	574
Molave	60	68	202	68
Malaybalay	441	445	461	781
Bago Oshiro	2121	661	1224	1674
Tacurong	1304	2100	1756	1526
Total:	**7334**	**11763**	**12895**	**14139**

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1. The amount of TC per gram parasitized host eggs as well as the number of TC per ha for Mandaue and Tacurong are only 50% of the national standard

Table 3. Trichogramma production in 1991, listed according to Region

REGION	HOST EGGS (grams)	TRICHOCARDS (no.)	HECTARAGE (ha)
1	3202	24024	420
2	67393	689977	7856
3	290	0	0
5	1582	20380	416
6	1319	9458	80
7	499	8840	176
9	7317	55339	506
10	4003	47273	461
11	10149	61198	1224
12	3960	40012	1756
TOTAL	99714	956501	12895

Table 4. Trichogramma production in 1992, listed according to Region

REGION	HOST EGGS (grams)	TRICHOCARDS (no.)	HECTARAGE (ha)
1	3232	22248	676
2	79618	863476	7330
3	3325	5610	63
5	2186	27231	168
6	1991	5268	38
7	2568	31698	1241
9	8190	50430	642
10	6831	109586	781
11	11864	82320	1674
12	3918	38340	1526
TOTAL	123723	1236207	14139

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of 20 TC per gram of parasitized host eggs and 50 TC per ha. In case of hectarage for Bago Oshiro (1990, 1991) and Tacurong (1990) no figures from the stations were available so the presented figures are computed by using their distribution pattern (# of TC per ha) of the year before.

SOCIO-ECONOMIC IMPACT

The socio-economic impact of this technology can be seen in different levels:

(a) Farmers switching from insecticides to Trichogramma

At present, the cost of insecticide and labor in the treatment of 1 ha of corn field is between ₱500 to ₱1000 depending on whether the farmer is doing the job by himself or hires a laborer. The application of insecticides for one hectare field takes 3 man-days per application. This involves the gathering and application of 500 liter insecticide solution.

In case of Trichogramma the time of application is reduced to once or twice for 30 minutes and the cost - even when farmers are asked to repay the production cost - does not exceed ₱150 per ha giving farmers a saving of ₱350 - ₱850. In future, should private producers join in and offer Trichogramma for the same biological method will still be cheaper than the chemical alternative.

(b) Farmers using Trichogramma without previous use of insecticides

Farmers who did not use pesticides before they started with Trichogramma cannot save money as inferred above. Since Trichogramma is as effective as chemicals they will save on their yield which would otherwise be reduced or totally damaged by the pest. Considering that above group in (a) is expecting to gain at least the amount in yield equivalent to the cost of pesticide application the amount of corn saved by Trichogramma should have a minimum value of ₱500 to ₱1000 or in case production costs must be paid ₱350 to ₱850.

(c) Farmers using neither insecticides nor Trichogramma

This group of farmers benefits on the fact that Trichogramma wasps do not remain only at the field of release. They disperse, especially when parasitization is high, and migrate to neighboring fields. Additionally, surveys prove that Trichogramma is well established even in areas without previous releases (FELKL et al. 1990). This population - even that it is not sufficient to provide an acceptable protection - reduces the overall population of the pest and

the danger of serious outbreaks for all farmers. There is no complete survey concerning the abundance of Trichogramma in the Philippines but it can be stated beyond doubt that Trichogramma is at least permanently present on 100,000 ha.

(d) Prospect for the Philippine economy

The Philippines imports all of its pesticides and has to pay for them in US$ currency. Every reduction in the use of pesticides will therefore lessen the burden for the Philippine treasury. Even that it is unrealistic that all of the insecticides against corn borer will have to be substituted by Trichogramma we strongly believe that for the approximately 200,000 ha presently treated with insecticides there is a big portion wherein Trichogramma can come in.

SOCIAL IMPACT

When comparing the usual way of applying pesticides (no proper air filter, body partly exposed, spraying in front of oneself and walking into the mist of the insecticides) with the regulation of application as stated on pesticide containers or in manuals it becomes understandable to learn that dizziness and vomiting amongst farmers is quite a normal experience. These are only outward manifestations. Nobody knows how many lives have ended prematurely because of acute poisoning or due to reduced resistance to ordinary diseases in connection with continuous exposure to pesticides.

In case of Trichogramma there is none of these risk factors since the small insects cannot harm anything but insect eggs in their natural course of existence.

The benefit to human health as well as other advantages (Table 5) are well known to farmers. In Region 2 where both rearing stations are producing in international level the production cannot cope with the demand by the farmers. It will still need additional rearing stations in order to satisfy the market.

Table 5. Reasons for the immediate adoption of Trichogramma technology

Reasons	No.	%
Recommended by extension worker	149	37
Easy to use	104	26
Cheap	51	13
Requires less labor	21	5
Recommended by fellow farmers	16	4
Readily available	15	4
Effective	14	3
Recommended by other persons	14	3
Recommended by relatives	5	1
Concerned about side effects of pesticides	3	1
Concerned about health effects of pesticides	2	1
Others	9	2
	403	100

Source: VALDEZ (1992)

SUPPORT SYSTEM REQUIREMENTS

We also have to ask "What is the role of the DA concerning this technology?". At present the Department of Agriculture is producing and distributing Trichogramma thru its regional stations (RCPCs and other satellite stations). But on the long run production and distribution should be handed over to interested private entrepreneurs since Trichogramma production can be quite profitable. If we take the production figures of APC Iguig as an example we can state, that APC is producing during each year trichocards saving yield in a value equivalent to more than 3.5 million Pesos. By taking the price for a trichocard (₱3.50 per card) asked by a private entrepreneur in Mindanao the output in 1991 was equivalent to 1.4 million Pesos with production costs of only 500,000 pesos.

In case, private entrepreneurs are responsible for production and distribution the DA must still be involved in the technology. The DA shall be responsible in respect of quality control of the delivered trichocards and in monitoring the effect in the field. It will be also necessary to maintain the present coordination system with BPI Manila as a central coordinating body in a network of independent rearing stations, DA related or private. Experience in Western Europe prove that such a network is absolutely necessary to avoid break-downs of single stations. The central laboratory in BPI Manila will also be

necessary in order to act as a trouble shooter in case of problems and as a provider of the initial stock for a complete restart of a rearing.

ENVIRONMENTAL IMPACT

The tropics are considered immensely rich in diversity of plants and animals. But when surveys are conducted in our fields it is surprising that beneficial insects (predators, parasitoids) are hardly found. The reason for this can be clearly pointed out to be the intensive use of pesticides. Whereas insects feeding on plants have undergone for millions of years a selection for resistance (plants produce poison, insects develop detoxination mechanisms), this has not been true for predators and parasitoids since there was no need for it.

Under present field condition this difference in adaptivity to pesticides has started a vicious circle. The pest insects can still survive in a surrounding where beneficials get killed. As a result the need to apply pesticides increases in order to compensate the loss of pest control derived from beneficials.

The use of Trichogramma can break - at least locally - this cycle. Since the Asian corn borer is the only important pest in corn and Trichogramma can handle this pest, corn fields can provide a pesticide-free environment for the build-up of populations of different beneficials like coccinellids, lacewings, syrphids etc.

It leaves us a question of a possible danger caused by Trichogramma to the environment. *T. evanescens* is utilized as biocontrol agent against corn borers worldwide (1988: 16 million ha) since about 25 years. Up to now there has been no report of a negative influence on the environment and we do not expect any in using this technology here in the Philippines.

REMARKS/ADDITIONAL INFORMATION

What are the basic requirements for the Trichogramma technology? The answer can be stated in a short sentence: "Trichogramma technology must be competitive to its chemical counterparts." This means, that Trichogramma technology must be (a) as effective as chemical insecticides under all conditions, (b) cheaper, or at least not more expensive than insecticides and (c) at any time available for a large number of users. The efficiency has been proven with the result, that worldwide 16 million hectares planted to

corn are treated annually with *T. evanescens*.

For point (b) it looks already different. In highly industrialized countries labor is very expensive and the rearing of Trichogramma wasps is very much dependent on manual labor thus making the technology in these countries more expensive than chemical alternatives. In the Philippines the situation is reverse. Labor is cheap and the Trichogramma technology can be offered - even on a commercial basis - for a price of less than 50% compared to the chemical treatment. When labor in the application is counted in, the difference is even higher.

Point (c) proved to be the most difficult point. The rearing of insects is always endangered by pests and climate factors. This holds especially true in the Philippines where frequent power break-downs make it impossible to maintain the proper climate and sanitation. Nevertheless, in Region 2 where these problems could not be eradicated but were properly managed the two rearing stations produce each a safe output of up to one kilogram of host eggs a day. The two stations show also clearly that the output of Trichogramma must stay above a certain level in order to benefit the farmers. Only with a daily output of 300 g of hosteggs or more it is possible to establish an effective distribution system and farmers can resort to Trichogramma without risking that delivery does not take place due to low production.

Trichogramma technology provides the Filipino farmer with an effective corn borer control method for less cost, with less labor and without the health risks connected with the utilization of chemical pesticides.

But there are also limitations of this technology. Since a proper maintenance of the climatic conditions in the rearing stations is not possible, storage of the beneficials is limited to only a few days. Planning on the side of the rearing stations is therefore absolutely necessary in order to avoid unwanted excess production thus excess costs. The limited storage ability also ma' .s it necessary that the farmer undergoes training to handle the bene..cial properly. At present, such trainings are conducted in Region 2 by the PGBPPP with close to 400 participants.

RECOMMENDATIONS FOR FUTURE ACTION ON TECHNOLOGY

At present, we know that mass production of Trichogramma is possible in the Philippines even under our difficult conditions. We also know that Trichogramma is a very effective alternative to the common pesticide treatment in corn.

The technology is ready to be transferred to the private sector except for the distribution system where the extensionists of the DA will still play a vital role during the next few years. At present trials to establish a distribution system more acceptable to the private sector are being undertaken in Region 2. Final results will be available in about one year.

We also feel that the government should still be active in the production and distribution of Trichogramma as long as the above mentioned network of private rearing stations has not yet been adequately established.

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