

## Original Paper

# IPM Program Combined with “Rice Fields, Flower Banks” or BIO-IPM Program in Soc Trang Province (Vietnam)

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### **Abstract**

*The paper aims to present the implementation of IPM program in Soc Trang Province in two years 2015 and 2016. To evaluate the program, a lot of primary data was obtained from the farmer household survey at each phase: Baseline survey as before-project (abbreviation S1), implementation of four experimental FFS models according to the Farmer-Field-School approach (S2), survey after FFS implementation (S3), and survey after up scaling or after-project (S4). Totally 1,200 households are in consideration. The comparative methods such as the one-way ANOVA are used to examine differences in mean and variance of agricultural inputs and outputs between different groups S1, S41 and S42. The key innovation of this study includes not only the conventional measures of the IPM program but also biological measures such as “rice fields, flower banks” and green fungus. The main results are a reduction in the use of nitrogen (14.8-17.1%), and pesticides (48-51%), cost savings and higher profits for farmers and a lower environmental impact from growing rice. “Rice fields, flower banks” have not only proven themselves in rice fields but have also spread to villages. The rural landscape is becoming more beautiful in the context of the National Target Program on New Rural Development.*

### **Keywords**

*IPM, BIO-IPM, fertilizer, pesticide, “Rice fields, flower banks”, sustainable agriculture*

### **1. Introduction**

Vietnam is a traditional agricultural country with famous products such as rice, pepper, tea, coffee, rubber, and tropical fruits that have been exported to the world and have an important market share. Facing the new challenges (technical obstacles) when exporting agricultural products to countries with high-quality requirements such as the EU, Japan, the United States, and other countries, Vietnam’s

traditional agricultural production and processing need to be changed fundamentally. That means production must go back from high levels of use of production inputs like chemical fertilizers and pesticides to safe production with acceptable production resources. This also helps to promote the consumption in the country as domestic consumers are now more aware of safe products and determined to turn their backs on unsafe agricultural products. To date Vietnam has made a number of efforts towards sustainable agriculture. For example, in rice production in Asia, since late 2000s, the Plant Protection Center and IRRI (International Rice Research Institute) have been encouraging farmers to grow flowers, okra, and beans on the banks of paddies, instead of stripping vegetation. The plants attract bees and a tiny wasp that parasitizes plant hopper eggs, while the vegetables diversify farm income (Normile, 2013, p. 13). This type of organic or bio-rice cultivation has been introduced to Vietnam in the previous decades and first in the Mekong Delta (MD). Up to now, the model “rice fields, flower banks” (Note 1) has been widely applied throughout the country.

Soc Trang province ranks the fifth for paddy rice area in MD after Kien Giang, An Giang, Long An and Dong Thap; has a rice area and production of 8-9% of MD according to data of General Statistics Office of Vietnam (Figure 1). Total rice area of Soc Trang in 2018 is 351.8 thousand hectares with two main paddy seasons: Winter-Spring (WS) and Summer-Autumn (SA). At the 11th Annual World’s Best Rice Contest in Manila (Philippines), the Soc Trang-based organic rice ST24 was honored as the World’s Best Rice 2019 (Note 2). This is the result of many years of research by Soc Trang scientists headed by agricultural engineer Ho Quang Cua (Note 3).

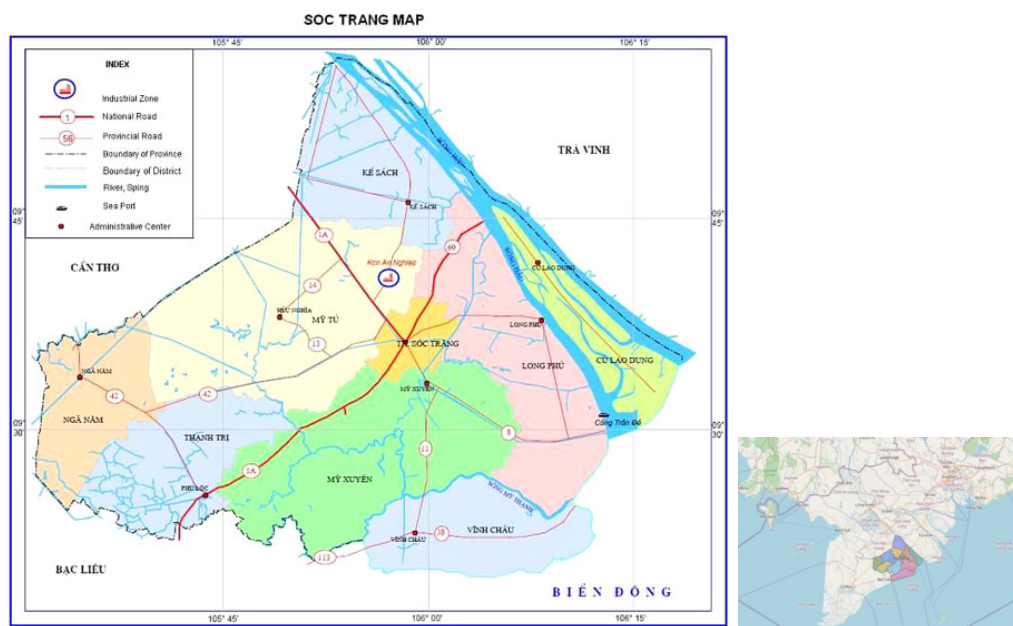
### *1.1 The First Attempts with IPM program in Soc Trang*

The Soc Trang Plant Protection Department (PPD) is one of those units in Vietnam with many achievements in research on management of pest and disease on crops. The activities or achievements can be listed below:

- a) Integrated Pest Management Mrogram (IPM) has been applied in Soc Trang Province since 1993 and has been very effective for many years (Note 4). IPM is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides. But in 2006-2007 nearly 100 thousand hectares of rice in the MD were infected with brown backed planthoppers (Note 5) and thousands of hectares with rice grassy stunt (Note 6). There were two basic causes for pest outbreaks on a large scale and difficult to control. Firstly, on the farmer side there were three reasons: (1) tend to sow with high density seeds (spreading seeds) and use too much fertilizers and pesticides for higher yields, (2) the habit of over-spraying pesticides to prevent disease, and (3) lack of knowledge about the harmful/adverse effects of overusing fertilizer and pesticide. Secondly, on the supply side, crop protection companies exaggerated in product advertising and launching in the mass media as well as in organization of seminars for farmers.
- b) Renewal of the IPM program with the application of biological measures in pest control from 2003 to 2009 with the first two bioproducts (Ometar and Bemetent), followed by bioproduct *Metarhizium anisopliae* (Note 7) which is produced by farmers. Over time, the pest of brown backed

planthoppers has been multiplied and persisted in the field, protecting and enriching the natural enemies, contributing greatly to the effective management of the planthopper pest (Note 8). The effectiveness of application of parasitic fungus in fields has been confirmed through the model “Application of green fungus production process at household to eradicate rice planthoppers in the Mekong Delta”, which was recognized by the Soc Trang PPD.

c) In 2009, PPD continued the IPM program and promoted the effectiveness of local biological measures. Therefore, the project “Building an integrated model of BIO-IPM application to improve crop quality” was implemented. The project aimed to expand and develop biological measures in the IPM system in order to enhance farmers’ awareness of the use of chemical pesticides into biological ones and to regenerate the field ecosystem in a sustainable and environmentally friendly way. According to Dang Thi Cuc and Huynh Thanh Binh (2010), PPD has transferred the process of producing green fungus at the household in the IPM model on rice and rice-shrimp. Specifically, experiments were conducted in 9 BIO-IPM models specializing in rice cultivation (50 ha/model), 6 models in the rice-shrimp area (20 ha/model) in 9 districts/communes with participation of 450 farmers. The results of the BIO-IPM model were evaluated very well so that the cost of pesticides was reduced by 42%, fertilizer 9%, seed 31%, and net benefit increasing to 18%.



**Figure 1. The Location of Soc Trang Province in the Mekong Delta (Vietnam)**

### 1.2 The Research Question

In the last decade, the IPM program is being updated with many new advances in science and technology. Therefore, farmers also need to update their knowledge accordingly. In contrast, practical applications gain new knowledge and enrich the knowledge base of the IPM program. Thus, the IPM program is developed in a closed circle between science and reality, reality and science.

So far there have been a number of studies in the world and in Vietnam on the application of IPM program, especially in MD. For example, Vo Thi Lang (2006) showed that with “Three reductions, Three gains” (Note 9) brought about positive results. It provided greater economic as well as environmental benefits to society in the form of input, especially pollution-related inputs (nitrogen, homestead) and of output gains (higher rice quality and net benefits).

The research question is how to achieve the main goals set out by the Ministry of Agriculture and Rural Development of Vietnam (MARD) in the project “Mekong Delta water resources management for rural development” of The World Bank (short: WB6): reducing 50% of pesticides and 10% chemical fertilizers. In which, it is necessary to use the measures of IPM program and scientific progress in rice production.

This paper—followed by two articles by Nguyen Trung Dung (2018a and 2018b) aims to show the main results of implementing and upgrading the IPM program in Soc Trang Province. The special and interesting point of this paper is the presentation of four FFS models. These are experimental models based on four options (e.g., the variation of different measures/factors such as with/without pest control using biological methods, use of chemical fertilizers and with/without water management in irrigation and drainage and so on). The other results are the expansion/upscaling models that farmers perform after participating in IPM training courses and visiting the four FFS models. These upscaling models are implemented with peasant’s innovation according to local conditions and experiences of farmers. Various comparison methods are used in the paper, for example “with and without”, “before and after” and “inside and outside”.

## 2. Data and Methods

Soc Trang PPD and M&E team of WB6 have proposed a research program, details of the program are:

### PROJECT BEGIN 2015

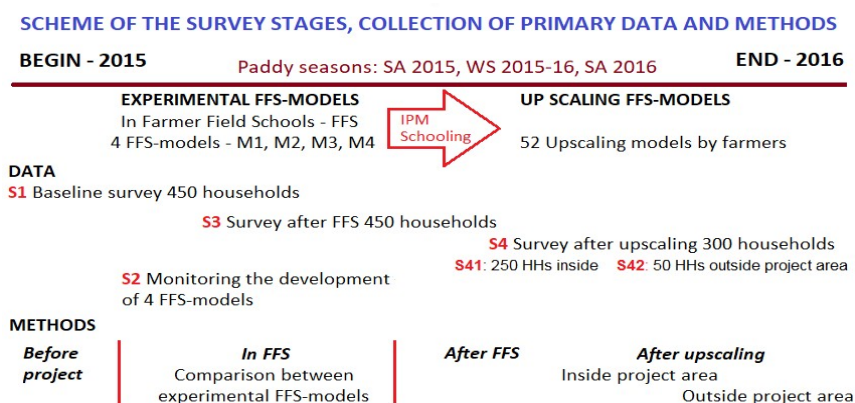
1. Baseline survey (450 households) for estimation of the current situation
2. Training course for farmers by using 4 FFS-models
  - The principles of IPM and pest management by IPM
  - Agrotechnical measures SRI, 1P-5G (1 must, 5 reduction)
  - Using biological and ecological measures: Rice fields & flower banks, green fungus, ...
  - Risk reduction in using pesticides
  - Impacts of climate change for agriculture
  - Using FFS (Farmer Field School) for demonstration
  - Survey after IPM-training and visiting FFS-models (450 households)
3. Up scaling FFS-models by using SRI and 1P-5G models with 50 farmers/model
4. Training for technical staffs of PPD Soc Trang
5. Training for fertilizer and pesticide dealers
6. Others (construction of waste tanks for pesticide packagings, supports for poor households, training for core groups of farmers, ...)
7. Survey inside and outside project area (250 households inside, 50 households outside)

### PROJECT END 2016

And the following primary data were available in four stages (Figure 2):

- Stage S1—Baseline survey as before-project: 450 households were examined in order to obtain the before-project data. A complex questionnaire was used.
- Stage S2—Implementation of four experimental FFS models each model has a small area of 2000-4000 m2 for demonstration.
- Stage S3—Survey after FFS: 450 farmers attending an IPM and FFS training course using a simple questionnaire about the practice and perceptions of farmers, and
- Stage S4—Survey after upscaling: 300 households using the same complex questionnaire of S1 and divided into S41 and S42.

The survey scheme with data collection and analysis methods is shown in Figure 2. The main statistical method used in the study is to compare means and variance between different groups or times/periods/stages with or without intervention. In which, the one-way analysis of variance (ANOVA) is applied to determine whether there are any statistically significant differences between the means of two or more independent (unrelated) groups.



**Figure 2. Four Survey Stages of Data Collection and Methods**

### 3. Results and Discussion

#### 3.1 General Information of Four Samples

Table 1 shows that most of the farmers surveyed are men (76-98%) because they are the main people responsible for their families’ agricultural production. The surveyed households represent the ethnic groups in Soc Trang (mostly Kinh, then Khmer and Vietnamese Chinese. Most households specialize in agriculture and have more than 10 years of farming experience.

**Table 1. The Characteristics of the Interviewees—Gender, Ethnic Groups and Education**

Sta- ge	HH num	Gender (%)		Ethnic groups (%)			Education (%)		
		Male	Female	Kinh	Khmer	Chine-	G.	M.	Gymnas

	ber				se	school	school	ium	
S1	450	83.8	16.2	84.9	14.9	0.2	32.0	48.9	19.1
S3	450	83.3	16.7	84.9	14.9	0.2	32.4	43.6	24.0
S41	250	76.0	24.0	96.4	3.2	0.4	36.4	50.8	32.8
S42	50	98.0	2.0	42.0	58.0	0	44.0	48.0	8.0

Concerning the land, most households have an available plot with an average area of 1.30-1.47 ha (Table 2). Nearly 99% of the land is owned by households according to the Vietnamese Land Law 2013 and the revised version. It is a shift from “land to the tiller” to the establishment of a “new landlord” to encourage farmers to permanently stabilize their agricultural production on a single piece of land and protect land resources. According to the statistical test method (Levene test and t-test) 4 samples S1, S3, S41, and S42 have the same variance and mean in terms of plot size.

**Table 2. The Land Situation and Farming Experience of Interviewees**

Sta- ge num ber	HH	Experience in farming (%)			Plot (ha)		Average	Min	Max
		≤10 y	11-20 y	> 20 y	Number of plot / Std.dev				
S1	450	21.1	33.1	45.8	1.12 / 0.342		1.47	0.1	1.0
S3	450	21.6	33.3	43.6	1.14 / 0.368		1.43	0.1	10.0
S41	250	21.6	28.4	50.0	1.28 / 0.864		1.30	0.14	13.0
S42	50	28.0	38.0	34.0	1.14 / 0.452		1.46	0.3	3.9

*3.2 Main Results of S2 or 4 FFS Models for Demonstration*

This can be considered as a further upgrade study as outlined in section 1.2. The purpose is to demonstrate the economic and environmental effectiveness of the BIO-IPM model. Therefore, Soc Trang PPD carried out research on four real FFS models, which are described in Table 3. So 3 experimental methods with agricultural measures SRI (System of Rice Intensification), 1M5R (1 Must 5 Reduction) (Note 10), and 1 traditional/conventional model were used. Each experimental model of M1, M2, M3 has an area of 2,000 m<sup>2</sup>, while M4 has twice the size. In addition, these models differ in seeding/planting density, application of chemical fertilizers (so-called Integrated Nutrition Management or INM), disease and pest management IPM (with or without pest spraying), application of ecological farming techniques, as well as irrigation & drainage management (so-called Alternate Wetting and Drying or AWD).

**Table 3. Characteristics of Four FFS Models in Stage S2 (2015-2016)**

Criteria	Treatment field			Control field
	M1	M2	M3	M4
Experimental method	SRI	1P-5G	1P-5G	conventional
Paddy season	SA 2015, WS 2015-16, SA 2016			
Number of models	1	1	1	1
Area (m <sup>2</sup> )	2.000	2.000	2.000	4.000
Seeding density (kg/ha)	60-80	80-100	80-100	200-250
Seeding/sowing method	In row	Spreading with limited amount	Spreading with limited amount	Spreading conventional as
Fertilizer	NPK balance, limiting excess nitrogen fertilizer (similar to INM)			conventional
Pest management	IPM program			No
Ecological farming				
- Rice fields, flower banks	Yes	Yes	Yes	No
- Use green fungus	Yes	Yes	No	No
Pesticide spraying	Yes	No within season	No within season	Yes
Irrigation and drainage management	Do not keep flooded rice fields. management (Note 11) (similar to AWD) according to 1M5R			Conventional, always flooding the rice fields

The main findings from this experimental study are explained below and presented in Table 4:

- a) Development of the sowing density: In 3 models M1, M2 and M3 such measures are used: Sowing in rows and spreading seeds, balancing the fertilizers, applying the biological methods such as “rice fields, flower banks”, use green fungus to add biological agents to the fields. Thereby helping the rice to grow well and significantly reduce the number of pesticide sprays from 31-51%, contributing to environmental protection and human health.
- b) Situation of rice growth (number of shoots and tillers) (Figure 3, left picture): Due to the application of the method for reducing the seed amount, the maximum number of shoots pro square meter at the seedling stage until tillering is lower than the control field. During rice maturation, however, the number of panicles between the treatment fields had a significantly lower or nearly the same to the control field. This shows that the proper sowing combined with the use of balanced fertilizer helps the rice to shoot early and shoot healthily. The rate of effective shoots is higher than in the control field.

- c) The pest situation in the treatment and control fields: In SA and WS seasons, pests were relatively lower, mainly brown plant shoppers and small leaf worms. They often occur in the late tillering until the stalk formation phase. However, in the treatment fields were applied IPM measures und “rice fields, flower banks” (Figure 3, right picture), limiting the drug and especially pesticide spraying. Therefore, in the treatment fields, the density of the natural enemy is higher, and the pest density lower than in the control field.
- d) Rice yield: The treatment fields M1 to M3 give a higher yield (2.8-5.7%) than control field. This shows that the use of 1M5R included in the IPM program brings higher rice productivity.
- e) Economic efficiency: Due to a reduction of seed, fertilizer and pesticide amount per unit area, and a higher average yield, the demonstration field has lower costs and higher benefits than the control field. So that the profits of model M1 to M3 increased from 30% to 48%.



**Figure 3. A rice Plant (Figure Left) and “Rice Fields, Flower Banks” Model Attracting Natural Enemies in Soc Trang Province (Picture Right, Huong Nhai, 2011)**

**Table 4. Summary of Experimental Results of Four FFS Models in 2015-2016 (in Brackets: - Reduce %, + Increase %)**

	M1	M2	M3	M4
	<i>Treatment field</i>			<i>Control field / 100%</i>
<i>Seed density (kg/ha)</i>				
SA 2015	70 (-65,7%)	100 (-51,0%)	100 (-51,0%)	204
WS 2015-16	79 (-58,4%)	100 (-47,4%)	100 (-47,4%)	190
SA 2016	78 (-57,4%)	98 (-46,5%)	98 (-46,5%)	183
<i>Urea (kg/ha)</i>				
SA 2015	82 (-25,5%)	82 (-25,5%)	82 (-25,5%)	110
WS 2015-16	85 (-24,1%)	85 (-24,1%)	85 (-24,1%)	112
SA 2016	83 (-27,8%)	83 (-27,8%)	83 (-27,8%)	115
<i>Pesticide (time/season)</i>				



SA 2015	6,4 (-31,9%)	4,6 (-51,1%)	6,4 (-31,9%)	9,4
WS 2015-16	6,8 (-36,4%)	5,2 (-48,1%)	6,8 (-35,2%)	10,7
SA 2016	7,0 (-35,2%)	5,6 (-48,1%)	7,0 (-35,2%)	10,8
<i>Paddy yield (ton/ha)</i>				
SA 2015	6,77 (+3,2%)	6,71 (+2,3%)	6,70 (+2,7%)	6,56
WS 2015-16	7,38 (+2,8%)	7,22 (+0,6%)	7,29 (+1,5%)	7,18
SA 2016	7,01 (+5,7%)	6,86 (+3,5%)	6,95 (+4,8%)	6,63
<i>Economic efficiency (tausend VND/ha)</i>				
SA 2015				
<i>Cost</i>	13.550 (-24,5%)	13.380 (-25,4%)	13.768 (-23,3%)	17.947
<i>Net benefit</i>	18.411 (+30,9%)	18.717 (+33,1%)	18.475 (+31,4%)	14.060
WS 2015-16				
<i>Cost</i>	13.905 (-26,8%)	13.786 (-27,5%)	14.220 (-25,2%)	19.006
<i>Net benefit</i>	24.258 (+33,2%)	23.637 (+29,8%)	23.614 (+29,7%)	18.206
SA 2016				
<i>Cost</i>	13.441 (-25,6%)	13.310 (-26,3%)	13.741 (-23,9%)	18.054
<i>Net benefit</i>	19.950 (+48,6%)	19.319 (+43,9%)	19.280 (+43,6%)	13.428

From the results of these practical models, it is possible to draw an important conclusion that the model of “rice fields, flower banks” and green fungus combined in the IPM program, also known as BIO-IPM, has brought efficiency in economy and environment, creating a premise for high yield and good and safe rice quality. Thanks to this study, it is possible to appropriately expand the model of rice-fish, rice-shrimp in the MD.

### 3.3 Some Results in S3

During the project implementation, many IPM trainings for farmers were organized in Soc Trang. Usually each training course lasted several days. After visiting 4 FFS models, the participants had to fulfill the questionnaire about their perceptions and practices of using homesteads in two cases: before-project and after-training in FFS models. The analysis results are shown in Table 5. This shows a shift in farmers’ perceptions of fertilizer, pest and water management as well as health protection.

**Table 5. Farmers' Perceptions in IPM**

Farmers' perceptions and awareness	S1	S3	S41	S42
1. Farmers' perceptions in IPM (N / %)				
<i>a) Farmers' perceptions of pest management</i>				
- Pesticide spraying	450 / 100	380 / 84	200 / 80	50 / 100
- Catch insects by hand	0	0	0	0
- Water management	201 / 44.7	450 / 100	250 / 100	7 / 14
- Traps insects by using lights	11 / 2.4	450 / 100	450 / 100	0 / 0
- Fertilizer management	219 / 48.7	350 / 77.7	180 / 72	19 / 38
- Sowing seeds to avoid pests	196 / 43.6	450 / 100	250 / 100	41 / 82
<i>b) Farmers' perceptions of labor protection when spraying</i>				
- Having labor protection	389 / 86.4	450 / 100	250 / 100	50 / 100
- Wear hat	227 / 58.4	440 / 97.8	222 / 88.8	26 / 52
- Wear glass	92 / 23.7	418 / 92.9	193 / 77.2	10 / 20
- Wear face mask	327 / 84.1	437 / 97.1	239 / 95.6	48 / 96
- Wear protective clothing	73 / 18.8	24 / 5.3	38 / 15.2	0 / 0
- Wear gloves	39 / 10	401 / 89.1	143 / 57.2	0 / 0
- Wear boots	11 / 2.8	8 / 1.8	0 / 0	0 / 0
2. Farmers' awareness of the environmental protection, no-use/surplus and packaging of crop protection products (N / %)				
- Pour into ponds	45 / 10.1	0 / 0	0 / 0	0 / 0
- Pour down ditches / water channels	195 / 43.7	186 / 42.1	54 / 22.3	5 / 10
- Pour on banks of fields and canals	167 / 37.4	161 / 36.4	80 / 33.1	45 / 90
- Pour into the field	190 / 42.6	215 / 48.6	133 / 55	1 / 2
- Put the packaging into tanks	40 / 9.2	193 / 43.7	219 / 87.6	0 / 0

### 3.4 Key Results in Comparison between S1, S41 and S42

In this section, a complex comparison between the stages S1, S41 and S42 is carried out to demonstrate the effectiveness of the IPM program with statistical evidence. The production inputs and outputs in paddy season SA (it means both season together SA 2014 and SA 2016) and paddy season WS (also WS 2014-15 and WS 2015-16) are compared. The comparison results can be seen in Table 6. Below are some explanations:

a) Pesticide use: the number of pesticide use in SA has decreased from 9.56 times/season in S1 (before-project) to 6.31 in S41 (after-project within the project area). Outside the project area in S42, thanks to the expansion of the IPM program, the number of applications has decreased slightly to 9.22. All data of S1, S41 and S42 are then tested by one-way ANOVA. Firstly, the homogeneity of variances is

tested by ANOVA. Then, in the ANOVA analysis the mean difference between S1, S41 and S42 is tested at level of significance of 0.05 or 5%. The results in Table 7 show the differences between the groups. There is no significant difference between mean values of before-project S1 and after-project S42 (outside the project area) because Sig. 0.054 > 0.05. However, there is a statistically significant difference between mean values of S1 and S41, also 9.56 and 6.31 respectively. In Table 8 there is a detailed comparison of the spray numbers against snails, weeds, pests and diseases in paddy seasons SA and WS. It can be seen that the important decrease of spraying from 29.9% in SA and 27.9% in WS.

**Table 6. Pesticide Use (Time / Season) in Season SA**

Stage	HH number	Mean	Std. deviation	Std. Error	Min	Max
S1	450	9.56	0.926	0.044	7	12
S41	250	6.31	1.153	0.073	4	9
S42	50	9.22	0.418	0.059	9	10

**Table 7. ANOVA Test between S1, S41 and S42 in Season SA for Pesticide Use**

Stage I	Stage J	Mean difference (I-J)	Std. Error	Sig.
S1	S41	3.252*	0.081	0.000
	S42	0.340	0.153	0.054
S41	S1	-3.252*	0.081	0.000
	S42	-2.912*	0.159	0.000
S42	S1	-0.340	0.153	0.054
	S41	2.912*	0.159	0.000

Note. \* The mean difference is significant at the 0.5 level.

**Table 8. Comparison of the Pesticide Use (Time/Season) (- Reduce and + Increase)**

Stage	Season SA					Season WS				
	Total	snails	weeds	pests	disease	Total	snails	weeds	pests	disease
S1	9.56	0.96	1.04	5.04	5.94	9.65	1.04	1.04	5.29	5.29
S41	6.70	0.90	0.93	2.47	4.93	6.96	0.96	0.93	2.75	4.14
	-29.9%					-27.9%				
S42	9.22	1.00	4.66	5.22	9.62	9.62	1.00	1.00	4.52	6.36
	-3.6%					-0.3%				

In subsequent comparisons on fertilizers, sowing density and yield were similarly calculated and the main results are summarized as follows:

b) Fertilizer use: especially in terms of nitrogen fertilizer, the amount of nitrogen fertilizer used by farmers before-project was higher than after participating in the project in crop season SA (reduced  $\approx 16$  kg (108.51-92.47) or 14%), the season WS (reduced 19 kg (111.39-92.38) or 17%).

**Table 9. Comparison of the Use of Chemical Fertilizers (- Reduce and + Increase in %)**

Stage	Season SA (kg / ha)			Season WS (kg / ha)		
	N	P	K	N	P	K
S1 as 100%	108.5	71.59	36.8	111.39	72.85	38.18
S41	92.47 (-14.8%)	66.78 (-6.7%)	34.91 (-5.1%)	92.38 (-17.1%)	64.83 (-11.0%)	34.7 (-9.1%)
S42	129.07 (+18.9%)	72.46 (+1.2%)	29.88 (-18.8%)	140.06 (+25.7%)	80.03 (+9.9%)	32.04 (-16.1%)

c) In term of the sowing density, the farmers who had received knowledge from IPM training reduced significantly compared to before-project. For example, inside project area S41 of crop season SA the seeding density decreased by 54.75 kg/ha (220.42-165.67) or 24.8%.

Regarding rice yield, the survey found that, thanks to the IPM program, sowing with sufficient density and balanced use of fertilizers and the use of many integrated pest control measures should support rice cultivation. Therefore, the rice yield in both S41 and S42 is higher than before-project (e.g., in SA with 6.58 and 6.74 higher than 5.81 ton/ha).

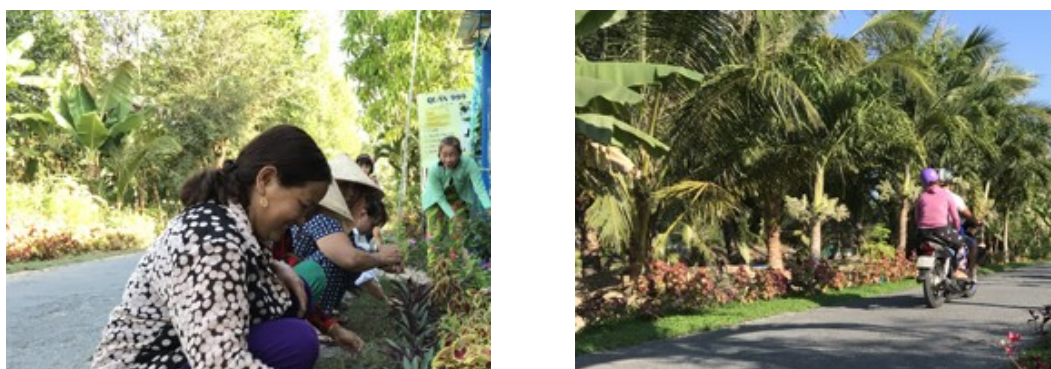
**Table 10. Comparison of Sowing Density and Rice Yield (- Reduce and + Increase) Unit**

Stage	Season SA		Season WS	
	Sowing density	Yield	Sowing density	Yield
	(kg/ha)	(ton/ha)	(kg/ha)	(ton/ha)
S1 as 100%	220.42	5.81	36.8	111.39
S41	165.67 (-24.8%)	6.58 (+13.3%)	34.91 (-5.1%)	92.38 (-17.1%)
S42	194.0 (-12.0%)	6.74 (+16.0%)	29.88 (-18.8%)	140.06 (+25.7%)

### 3.5 The Village Beautification as Result of the Eco-Farming

The movement “rice fields, flower banks” has gradually spread from rice fields to villages and the lives of farmers. According to Quoc Tuan (2020), My Tu district (Soc Trang province) has implemented many good and effective models in new rural development (in the frame of National Target Program on New Rural Development 2010-2020). The highlight is the “flower routes/roads” model undertaken by

the Commune Women's Union, which has brought a new face to the rural area, creating a green - clean - beautiful landscape, contributing to changing people's awareness on environmental sanitation and ensuring traffic safety corridor. Thien Hai (2020) writes in the article "When the countryside roads are ..." having new face as follows: "On some rural roads in Vinh Quoi Township (Nga Nam of Soc Trang Province), the situation of roadside garbage or overgrown trees has been eliminated and replaced with ornamental flowers of full color. The fences of the trees are carefully maintained, which improves the landscape here is getting fresher ... Commune People's Committee plans a week to spend 2-3 days directly in the hamlet, planting flowers and ornamental plants, fencing, campaigning to make flagpoles and hanging light bulbs in the alley." This movement has expanded simultaneously in other provinces in the MD and many localities throughout the country. For example, in Tien Giang province in 2009, it launched a movement to quickly multiply the model of "eco-technology" to many other districts and towns, then in 2010, An Giang province launched a propaganda to implement "rice fields and flower banks for three benefits" throughout the district. An Giang also brought this model to help Takeo province (Cambodia) twins in promoting intensive rice cultivation. Can Tho City is applying this model in suburban fields to combine with eco-tourism. The tourists often go by canoe on the river or cycle on the banks of the river/field. They are no longer afraid of the smell of pesticides and moreover enjoy the colors and aromas of inner grass. In addition to ecological rice fields, in many localities, home gardens are being built in the form of ecology. Instead of a dense garden with many species of low economic value and replaced with orchards specializing in eco-fruit trees. It is also the spirit of building criteria for household gardens in building new rural communes.



**Figure 4. Flower Routes and Roads - New Face for Villages (Quoc Tuan, 2020)**

#### **4. Conclusion**

The paper has provided a lot of statistical evidence and data proving the effectiveness of the IPM program implemented in Soc Trang Province in two years 2015 and 2016. In particular, Soc Trang has creatively incorporated biological measures such as "rice fields, flower banks" and green fungus which have been previously tested and now retested again in four demonstration models. Thanks to this good IPM or BIO-IPM program, farmers can save rice seeds, chemical fertilizers due to the application of

balanced fertilizer programs (INM), pesticide spraying due to the application of IPM with different biological measures (IPM), saving water for irrigation (AWD). By reducing production costs and increasing rice yield, farmers have a higher profits. The impressive numbers that mentioned above are: Reduction of chemical fertilizer use (N 14.8-17.1%, P 6.7-11%, K 5.1-9.1%); Reduction of pesticide use from 48-51% and increasing the paddy productivity from 13-14%. If compared with the research results in Zenaida (2008) and Vo Thi Lang (2006) when applying “Three Reduction Three Gains” or 3R3G in MD, these results are actually better.

Looking back at history. In the world, IPM has been the dominant crop protection paradigm promoted since the 1960s. However, its adoption by developing country farmers is surprisingly low. According to Parsa et al. (2014), there are six factors identified as important and difficult, that are weak adoption incentives, research weaknesses, outreach weaknesses, IPM weaknesses, pesticide industry interference, and farmer weaknesses. In Southeast Asia, there are two important factors that hinder the implementation of IPM: weak adoption incentives and pesticide industry interference.

In Soc Trang province, the IPM program has been applied quite early in Vietnam (Note 12) since 1993 with support of FAO, DANIDA and others, with certain results. However, after the epidemic of brown backed planthoppers in 2006-2007 due to many unfavorable factors, Soc Trang farmers did not return to application of IPM. The reasons are: “weak adoption incentives”, “IPM weakness”, “farmers’ weakness” and “pesticide industry interference”. Since the early 2000s, when the quality of exported rice was not a top priority, most of Vietnamese rice has been exported to non-standard markets such as China. That is why the farmers in MD are pursuing rice production in large quantities. As a result, the fertilizer and pesticide industry has been more active through strong advertising and promotion programs. On the other side, the IPM program is not strong enough to convince farmers. Lastly, farmers’ awareness is low. According to the WB (2016), Vietnam’s agriculture must transform: gaining more from less, enhancing sustainable agricultural development and exporting many high quality products on the international market. Therefore, rice production in MD has developed towards high quality and so that Soc Trang province has the best rice in the world ST24 and ST25. The efforts of the fertilizer and pesticide industry were pushed back and forced them to change their production range to produce more environmentally friendly products. This paper demonstrates with impressive figures the economic efficiency and environmental protection of the IPM program combined with ecological factors (so-called BIO-IPM program). In addition, these ecological factors also contribute to the development and renewal of the villages on MD’s rivers and canals.

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## Notes

Note 1. See different articles by Cong Tri (2011), Huong Nhai (2011), Nguyen Van Huynh (2009), Nguyen Van Thuoc (2011), Luu Son (2017).

Note 2. Article “Vietnam jasmine rice crowned best in world”. Retrieved from <https://en.nhandan.com.vn/business/item/8119002-vietnam%E2%80%99s-jasmine-rice-crowned-best-in-world.html>

Note 3. Article “Ho Quang Cua, father of the world’s best rice”. Retrieved from <https://vovworld.vn/en-US/new-year-festival-features/ho-quang-cua-father-of-the-worlds-best-rice-819686.vov>

Note 4. “As early as the 1980s, IRRI and the FAO convinced some Southeast Asian governments that, with integrated pest management (IPM), natural predators could control planthoppers.” (Normile, 2013).

Note 5. Vietnamese: rầy nâu.  
<http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/planthopper>

Note 6. Vietnamese: bệnh vàng lùn - lùn xoắn lá.  
<http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/diseases/item/rice-grassy-stunt>

Note 7. Short explanation for *Metarhizium anisopliae*: One of the most important species of parasitic fungus to kill brown plant hopper is the fungus *Metarhizium anisopliae*. This species parasites on many different insect orders/groups such as (1) Orthoptera such as locust, grasshopper, (2) Homoptera as aphids, (3) Coleoptera such as king ants, coconut worm, (4) Lepidoptera such as pests, (5) Hemiptera such as stink bugs.

Figure 5. Simple phylogenetic tree of insect orders (in Jay, D.E. and Gundersen-Rindal, 2003)

The fungus reproduces and spreads by spores. When the spores attach to an insect’s body, the spores germinate and grow into a filamentous fungus that crept inside the insect’s body to absorb nutrients that will make the sick insect die. When an insect die, its spores stick out to develop new mold spores, which are called “green fungus”. When some insects are infected with the fungus, the spores continue to multiply, causing a series of other insects in the population to be infected with the fungus and die in mass.

Note 8.  
<http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/planthopper>

Note 9. “Three Reductions, Three Gains” (Vietnamese: 3 giảm 3 tăng) initiative is a media campaign developed through a participatory planning process to motivate rice farmers in the MD region to reduce seed, fertilizer, and pesticide use and to increase productivity, economic efficiency and product quality. The campaign was piloted in the provinces of Can Tho, Tien Giang, and Vinh Long in 2003.

Note 10. That means to use certified varieties to produce commercial rice; seeds, fertilizers, pesticides, pumping costs, and post-harvest losses should be reduced.

Note 11. Similar to AWD (Alternate Wetting and Drying). It is a water-saving technology that lowland (paddy) rice farmers can apply to reduce their water use in irrigated fields. In AWD, irrigation water is applied to flood the field a certain number of days after the disappearance of ponded water.

Note 12. In the last half decade 1990s and the first half decade 2000s Vietnam had realized the FAO IPM programs with many successes in controlling rice insect pests. After supporting of FAO, Vietnam has continued to broaden with own National IPM program. IPM programs have a significant impact on minimizing the adverse effects of insecticides, and in increasing the profitability of rice production.