

Farmers' participatory evaluation of reducing pesticides, fertilizers and seed rates in rice farming in the Mekong Delta, Vietnam

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Abstract

The farmers' participatory approach was used to evaluate the reduction of pesticide sprays, seed rates in crop establishment and nitrogen fertilizer in rice production. Nine hundred and fifty one (951) volunteer participants found that the reduced inputs had little effect on yields and gave them higher incomes—about US\$58 per hectare in the winter–spring and US\$35 in the summer–autumn seasons, respectively. The highest contribution to the increased gross margins was from pesticide reduction, constituting 80% of the increase. Pesticide spray reduction also meant reducing workdays used for spraying thus providing more incentives for the reduction of seeds and fertilizers. These results provided the basis for launching a national mass media campaign, locally called “*Ba Giam Ba Tang*” or “Three Reductions” to scale up the adoption of these practices in several provinces in the Mekong Delta, Vietnam. The analysis of variable differentials was a useful method in analyzing data obtained in farmer participatory experiments.

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1. Introduction

Rice farmers in the Mekong Delta have been using high seed rates for direct seeding, high fertilizer rates and applying more pesticides than necessary. These practices might have stemmed from the perceptions that high inputs, particularly seed and fertilizer rates would result in higher yields. On the other hand, the use of high seed rates and fertilizer can lead to higher pest and disease infestations, thus prompting higher use of pesticides. Research has shown that crops with enriched nitrogen can make insect pests produce more eggs, survive better, live longer and become ecologically more fit (Lu et al., 2004). Similarly, dense crops sown from high seed rates enriched with fertilizers are more disease prone (Webster and Gunnell, 1992). These beliefs formed by researchers as well as farmers have also

contributed to the higher use of pesticides whenever crops are highly fertilized. There is recent evidence to show that even in highly fertilized crops insecticide use can be reduced without incurring loss in production. A project that was started in Long An province in 1994, motivated farmers to reduce early season insecticide use (Escalada et al., 1999) had spread to about a million farmers in the Mekong Delta resulting in 53% reduction. The farmers' yields had remained unchanged but their seed rates in crop establishment and fertilizer use had remained high. Some farmers are still spraying insecticides in the early season, perhaps due to discontinuance or because the campaign had not reached them. The campaign success prompted us to explore if farmers could be motivated to reduce seed and fertilizer rates so as to further reduce pesticide use and have higher gross margins.

Agronomic research has shown that farmers' seed rates and the amount of nitrogen used are higher than required (Luat et al., 1998). In addition some farmers

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are spraying insecticides early in the season for leaf folder control. Research has shown that these insecticide sprays are generally unnecessary (Heong et al., 1998) and could be reduced with no consequence to yields. In this paper, we report results of applying Festinger's (1957) Theory of Cognitive Dissonance by presenting farmers with conflict information to motivate them to experiment with reduced insecticide sprays, seed and nitrogen rates. Information that contradicts existing attitudes, choices or behaviors can lead to a state of psychological dissonance and this state does not immediately disperse (Eiser, 1986). To resolve his or her dissonance, a person could resort to re-evaluation of the alternatives (Brehm and Cohen, 1962) and is motivated to re-evaluate if presented with a simple method to do so (De Bono, 1970). This approach successfully motivated farmers to reduce insecticides. (Heong and Escalada, 1997). When farmers were presented with conflict information that insecticides were not needed in the first 40 days after sowing and they can save money and work, they were motivated to try. Similarly, farmers may be motivated to reduce seeds, fertilizers and pesticides.

2. Methods

2.1. The Mekong Delta

The Mekong Delta, covering ~2 million ha of fertile rice land is cultivated by ~2.3 million farmers producing ~17 million tons of rice annually or ~51% of Vietnam's annual production (Cuc, 2003). With the introduction of policy reforms in the late 1980s, rice production in Vietnam increased dramatically from 10.3 million tons in 1975 to 32.5 million tons in 2000 (Hoanh et al., 2002) and is now a net exporter. Farm sizes are generally less than 1 ha and the average income is less than \$US 23 per person per month (Cuc, 2003).

2.2. Establishing farmer participatory experiments

In each village, a farmer meeting was organized to discuss about current use of pesticides, seeds and fertilizers. The experiments were conducted in 35 villages in 11 provinces (see Table 2 for names). The winter–spring (W–S) experiments were carried out between November 2001 and March 2002 while the summer–autumn (S–A) experiments were carried out between April and August, 2002. We presented field results to show that at reduced seeds, fertilizers and insecticides, there were no differences in yields and asked farmers if they would be prepared to experiment with these findings. Farmers were invited to participate in the experiment and set up in their own fields. Volunteer farmers allocated a portion of their fields (~1000 sq M) as the experimental area with the remainder of their fields as “control”. For the experimental area, farmers were given guidelines in adjusting their seed rates, fertilizer rates and to avoid using insecticides in the first 40 days after sowing for leaf folder control (Table 1). Otherwise farmers were to apply pesticides as required. For the control area, farmers were to practice their normal routines. A simple system to record their inputs in the two plots was provided to facilitate data recording. Participating farmers were motivated to take part in the experiment through farmer workshops and meetings to discuss ways to reduce inputs conducted by extension staff. Only volunteer farmers conducted the experiments and no compensation of any form was provided as incentives.

2.3. Data acquisition and analytical procedures

Rice yields and inputs data were obtained from participating farmers' reports of their control and experimental plots. A total of 951 farmers in the Mekong Delta participated in two rice seasons, W–S of 2001–2002 and S–A of 2002. The data were

Table 1
Guidelines of the three reduction practices provided to participating farmers

| | Seasons | |
|--------------------------------------|--|-----------------------------|
| | Winter–Spring | Summer–Autumn |
| Seed rates | 70–100 kg ha ⁻¹ | 100–120 kg ha ⁻¹ |
| Fertilizer rates (for alluvium soil) | | |
| Nitrogen | 120 | 100 |
| Potassium | 30 | 50 |
| Phosphorus | 30 | 30 |
| | Farmers were provided with a leaf colour chart for them to determine if the crop needed more nitrogen based on how green the leaves were | |
| Insect control | No insecticide use in the first 40 days for leaf feeding insects For other insect problems use insecticides as required | |
| Disease control | When blast symptoms and sheath blight were visible during the booting stage fungicides might be used as required | |

standardized to per hectare and converted to income. Labor costs were not included as all farmers used family labor in the farm operations. For each province the means of the control plots, experimental plots and the mean differences were computed for participants from each province in each season. The total variable costs of seeds, fertilizers, insecticides and fungicides, incomes from rice yields were computed using prevailing price rates. Herbicide costs of all farmers and all other costs were constant in both plots. The gross margins were thus computed by deducting the variable input costs from the incomes in all cases.

All statistical analyses were performed using SPSS version 11.5 (SPSS, 2002). Means between the control and experimental plots were compared using the paired *t*-test. The differentials between control and experimental plots were used to explore relationships. Pearson's correlation and the linear multiple regression analyses were used for hypotheses testing with the gross margins differential as the dependent variable. The stepwise regression method was adopted to explore model relationships between gross margins and six independent variables.

3. Results

3.1. Inputs

The mean seed rates used by farmers in the experimental plots were significantly lower in both seasons in all provinces (Table 2). Farmers in provinces Kien Giang, Can Tho and Soc Trang reduced the most from about 250–125 kg nitrogen. Seed rates reduction varied from 260 to 40 kg ha⁻¹ and on average farmers use reduced ~80 kg which would reduce input cost by ~

\$9.45 ha⁻¹. Nitrogen reductions varied from 2.0 to ~25.8 kg ha⁻¹ (Table 3A). On average farmers used ~13 kg N ha⁻¹ less in their experimental plots. Similarly phosphorus reductions were also significant (Table 3B). In 3 provinces, An Giang, Kien Giang and Tien Giang, farmers increased their phosphorus use in the S–A season. On average, farmers reduced the use of phosphorus by 9 kg ha⁻¹ in W–S season and 6 kg ha⁻¹ in S–A season. The use of potassium was increased in the experimental plots by 4 and 3 kg in the two seasons respectively (Table 3C). Most farmers used higher potassium rates and would have raised their input costs by ~ \$ 0.30 ha⁻¹.

Farmers' insecticide sprays were markedly reduced in all cases (Table 4). On average farmers reduced from 1.7 to 0.4 sprays ha⁻¹ in the W–S season and 1.3 to 0.3 sprays ha⁻¹ in the S–A season. This represented savings of ~\$21 and ~\$16 ha⁻¹, respectively. In most cases, fungicide sprays were also reduced in the experimental plots averaging from 1.3–0.3 sprays ha⁻¹ in the W–S season and 2.3–1.7 sprays ha⁻¹ in the S–A season. These reductions represented savings of ~\$13 and ~\$8 ha⁻¹, respectively.

3.2. Yields

In all the provinces, farmers generally had higher yields in their experimental plots. (Table 5). The average difference for the W–S season was ~ 0.15 t ha⁻¹ while in the S–A season yield differences were lower at 0.08 t ha⁻¹.

3.3. Input costs, incomes and gross margins

The input costs for seeds, fertilizers, insecticides and fungicides, incomes from yields and profit are shown in

Table 2
Mean seed rates (kg ha⁻¹) used by participating farmers in control and experimental plots in the Mekong Delta

| Seasons | Winter–Spring 2001–2002 | | | | Summer–Autumn 2002 | | | |
|-----------------|-------------------------|---------|--------------|-------|--------------------|---------|--------------|-------|
| | <i>n</i> | Control | Experimental | Δ | <i>n</i> | Control | Experimental | Δ |
| Vinh Long | 80 | 191.4 | 116.0 | 75.4 | 30 | 200.0 | 120.0 | 80.0 |
| An Giang | 129 | 211.2 | 120.9 | 90.2 | 60 | 219.8 | 124.2 | 95.7 |
| Dong Thap | 100 | 183.9 | 122.8 | 61.1 | 60 | 211.2 | 128.7 | 82.4 |
| Tiengiang | 30 | 184.1 | 120.0 | 64.1 | 60 | 169.3 | 142.3 | 27.0 |
| Tra Vinh | 50 | 211.8 | 100.0 | 111.8 | 60 | 200.8 | 100.0 | 100.8 |
| Long An | 51 | 163.3 | 115.3 | 48.0 | 9 | 179.4 | 133.3 | 46.1 |
| Bac Lieu | 30 | 225.3 | 120.0 | 105.3 | — | — | — | — |
| Ben Tre | — | — | — | — | 30 | 170.7 | 130.0 | 40.7 |
| Kien Giang | 50 | 211.6 | 120.0 | 91.6 | 60 | 254.6 | 120.0 | 134.6 |
| Can Tho | — | — | — | — | 30 | 246.3 | 120.0 | 126.3 |
| Soc Trang | — | — | — | — | 32 | 247.2 | 137.2 | 110.0 |
| Seasonal totals | 520 | 197.5 | 117.8 | 79.8 | 431 | 212.0 | 124.4 | 87.6 |

All mean differences between farmers' normal and experimental plots were significantly different (*p* < 0.01). Δ is the differential between control and experimental.

Table 3
Mean fertilizer rates (kg ha⁻¹) used by participating farmers in control and experimental plots in the Mekong Delta

| Seasons | Winter–Spring 2001–2002 | | | | Summer–Autumn 2002 | | | | |
|-----------------------|-------------------------|----------|---------|--------------|--------------------|----------|---------|--------------|----------|
| | Provinces | <i>n</i> | Control | Experimental | Δ | <i>n</i> | Control | Experimental | Δ |
| (A) Nitrogen | | | | | | | | | |
| Vinh Long | 80 | 95.4 | 77.9 | 17.6 | 30 | 107.5 | 91.3 | 16.2 | |
| An Giang | 129 | 98.0 | 86.3 | 11.7 | 60 | 111.4 | 96.0 | 15.4 | |
| Dong Thap | 100 | 100.3 | 88.2 | 12.1 | 60 | 139.8 | 117.4 | 22.4 | |
| Tiengiang | 30 | 91.0 | 77.7 | 13.4 | 60 | 92.8 | 90.3 | 2.7* | |
| Tra Vinh | 50 | 72.6 | 70.6 | 2.0* | 60 | 103.1 | 92.6 | 10.5 | |
| Long An | 51 | 105.6 | 94.4 | 11.2 | 9 | 99.6 | 80.1 | 19.4 | |
| Bac Lieu | 30 | 95.3 | 89.0 | 6.3 | — | — | — | — | |
| Ben Tre | — | — | — | — | 30 | 95.3 | 80.8 | 14.5 | |
| Kien Giang | 50 | 93.8 | 77.1 | 16.7 | 60 | 88.4 | 79.1 | 9.3 | |
| Can Tho | — | — | — | — | 30 | 106.0 | 86.0 | 20.0 | |
| Soc Trang | — | — | — | — | 32 | 98.6 | 72.8 | 25.8 | |
| Seasonal totals | 520 | 95.4 | 83.4 | 12.0 | 431 | 105.4 | 91.2 | 14.3 | |
| (B) Phosphorus | | | | | | | | | |
| Vinh Long | 80 | 55.0 | 47.7 | 7.3 | 30 | 46.9 | 39.8 | 7.1 | |
| An Giang | 129 | 51.7 | 41.5 | 10.2 | 60 | 49.6 | 55.3 | -5.7 | |
| Dong Thap | 100 | 49.5 | 41.6 | 7.8 | 60 | 57.6 | 48.8 | 8.8 | |
| Tiengiang | 30 | 55.9 | 50.8* | 5.2 | 60 | 53.5 | 54.5 | -1.0* | |
| Tra Vinh | 50 | 52.0 | 39.0 | 2.0 | 60 | 48.8 | 44.3 | 4.5 | |
| Long An | 51 | 81.9 | 71.3 | 10.6 | 9 | 61.4 | 43.2 | 18.2 | |
| Bac Lieu | 30 | 49.3 | 43.0 | 6.3 | — | — | — | — | |
| Ben Tre | — | — | — | — | 30 | 51.0 | 42.1 | 8.9 | |
| Kien Giang | 50 | 55.2 | 48.2 | 7.0 | 60 | 40.2 | 45.6 | -5.4 | |
| Can Tho | — | — | — | — | 30 | 93.3 | 68.3 | 25.0 | |
| Soc Trang | — | — | — | — | 32 | 77.4 | 49.5 | 27.8 | |
| Seasonal totals | 520 | 55.2 | 46.2 | 8.8 | 431 | 55.1 | 49.6 | 5.5 | |
| (C) Potassium | | | | | | | | | |
| Vinh Long | 80 | 24.8 | 34.2 | -9.5 | 30 | 24.7 | 31.0 | -6.3 | |
| An Giang | 129 | 38.8 | 40.4 | -1.5* | 60 | 39.5 | 33.0 | 6.5 | |
| Dong Thap | 100 | 40.6 | 45.7 | -5.2 | 60 | 40.4 | 41.1 | -0.7* | |
| Tiengiang | 30 | 39.9 | 49.0 | -9.1 | 60 | 26.4 | 32.4 | -6.0 | |
| Tra Vinh | 50 | 35.7 | 39.0 | -3.3 | 60 | 27.2 | 30.4 | -3.2* | |
| Long An | 51 | 51.1 | 56.0 | -4.8 | 9 | 49.9 | 53.9 | -4.0* | |
| Bac Lieu | 30 | 19.4 | 15.0 | 4.4 | — | — | — | — | |
| Ben Tre | — | — | — | — | 30 | 32.9 | 35.4 | -2.5* | |
| Kien Giang | 50 | 30.1 | 31.4 | -1.4* | 60 | 15.6 | 20.7 | -5.1 | |
| Can Tho | — | — | — | — | 30 | 16.0 | 33.0 | -17.0 | |
| Soc Trang | — | — | — | — | 32 | 57.3 | 54.1 | 3.2 | |
| Seasonal totals | 520 | 36.0 | 40.0 | -4.0 | 431 | 31.2 | 34.0 | -2.8 | |

All mean differences between farmers' control and experimental plots were significantly different ($p < 0.01$) except those marked *. Δ is the differential between control and experimental.

Table 6. In both seasons farmers significantly increased their gross margins by an average of $\sim \$58 \text{ ha}^{-1}$ and $\sim \$35 \text{ ha}^{-1}$ in W–S and S–A seasons, respectively. The highest gross margins were from farmers in Tra Vinh (\$85), Dong Thap (\$77), Bac Lieu (\$68) in the W–S season, while in the S–A season highest gross margins were from Ben Tre (\$51), Kien Giang (\$49) and Tra Vinh (\$42).

3.4. Analyses of variable differentials

As the variables from the farmer experiments were paired, the differences (Δ) between the control and

experimental plots can be a useful measure for further analyses. In each case the differentials were computed by the difference and the resulting measure may be labeled differential seed rate, differential nitrogen rate and so on. Zero order correlations between differential gross margins and differential input measures are shown in Table 7. The correlations among the independent variables were very weak with R -values < 0.19 . Gross margins were strongly related to insecticide and fungicide input costs. This is particularly true for the autumn–spring (A–S) season where the Pearson correlation coefficients were 0.72 and 0.70, respectively.

Table 4
Mean pesticide sprays used by participating farmers in control and experimental plots in the Mekong Delta

| Seasons | Winter–Spring 2001–2002 | | | | | | Summer–Autumn 2002 | | | | | | | |
|-----------------|-------------------------|---------|--------------|------------|---------|--------------|--------------------|----------|---------|--------------|----------|---------|--------------|----------|
| | Insecticides | | | Fungicides | | | Insecticides | | | Fungicides | | | | |
| Provinces | <i>n</i> | Control | Experimental | Δ | Control | Experimental | Δ | <i>n</i> | Control | Experimental | Δ | Control | Experimental | Δ |
| Vinh Long | 80 | 1.04 | 0.08 | 0.96 | 2.90 | 2.36 | 0.54 | 30 | 0.37 | 0.10 | 0.27* | 2.67 | 2.40 | 0.27 |
| An Giang | 129 | 1.40 | 0.12 | 1.29 | 2.58 | 2.20 | 0.38 | 60 | 1.25 | 0.53 | 0.72 | 3.02 | 2.73 | 0.28 |
| Dong Thap | 100 | 2.39 | 0.72 | 1.67 | 2.55 | 1.88 | 0.67 | 60 | 2.12 | 0.88 | 1.23 | 2.08 | 1.70 | 0.38 |
| Tiengiang | 30 | 2.71 | 0.67 | 2.10 | 3.43 | 2.60 | 0.83 | 60 | 1.67 | 0.35 | 1.32 | 2.63 | 2.20 | 0.43 |
| Tra Vinh | 50 | 1.56 | 0.22 | 1.34 | 3.42 | 2.06 | 1.36 | 60 | 1.07 | 0.00 | 1.07 | 1.72 | 0.83 | 0.88 |
| Long An | 51 | 1.94 | 0.88 | 1.06 | 1.57 | 0.78 | 0.78 | 9 | 1.89 | 0.89 | 1.00 | 2.56 | 1.89 | 0.67* |
| Bac Lieu | 30 | 2.00 | 0.27 | 1.73 | 3.00 | 2.00 | 1.00 | — | — | — | — | — | — | — |
| Ben Tre | — | — | — | — | — | — | — | 30 | 2.00 | 0.20 | 1.80 | 2.57 | 1.40 | 1.17 |
| Kien Giang | 50 | 0.71 | 0.18 | 0.54 | 2.96 | 1.68 | 1.28 | 60 | 1.34 | 0.08 | 1.25 | 1.77 | 0.83 | 0.93 |
| Can Tho | — | — | — | — | — | — | — | 30 | 0.93 | 0.00 | 0.93 | 1.03 | 0.27 | 0.77 |
| Soc Trang | — | — | — | — | — | — | — | 32 | 0.09 | 0.00 | 0.09* | 3.59 | 3.59 | 0.00* |
| Seasonal totals | 520 | 1.65 | 0.36 | 1.29 | 1.31 | 0.30 | 1.01 | 431 | 1.31 | 0.30 | 1.01 | 2.32 | 1.74 | 0.57 |

All mean differences between farmers' control and experimental plots were significantly different ($p < 0.01$) except those marked *. Δ is the differential between control and experimental.

Table 5
Mean yields (kg ha^{-1}) participating farmers obtained from control and experimental plots in the Mekong Delta

| Seasons | Winter–Spring 2001–2002 | | | | Summer–Autumn 2002 | | | |
|-----------------|-------------------------|---------|--------------|----------|--------------------|---------|--------------|----------|
| | <i>n</i> | Control | Experimental | Δ | <i>n</i> | Control | Experimental | Δ |
| Vinh Long | 80 | 6.33 | 6.39 | 0.06 | 30 | 4.03 | 4.03 | 0.0* |
| An Giang | 129 | 6.90 | 6.98 | 0.08 | 60 | 5.00 | 5.00 | 0.0* |
| Dong Thap | 100 | 6.59 | 6.88 | 0.29 | 60 | 4.89 | 4.89 | 0.0* |
| Tiengiang | 30 | 6.45 | 6.48 | 0.03* | 60 | 4.88 | 4.88 | 0.0* |
| Tra Vinh | 50 | 5.63 | 5.92 | 0.29 | 60 | 4.24 | 4.53 | 0.06 |
| Long An | 51 | 5.22 | 5.34 | 0.12 | 9 | 4.89 | 4.89 | 0.0* |
| Bac Lieu | 30 | 5.17 | 5.29 | 0.12 | — | — | — | — |
| Ben Tre | — | — | — | — | 30 | 4.46 | 4.54 | 0.03* |
| Kien Giang | 50 | 6.54 | 6.71 | 0.17 | 60 | 4.76 | 4.89 | 0.13 |
| Can Tho | — | — | — | — | 30 | 4.94 | 5.05 | 0.09 |
| Soc Trang | — | — | — | — | 32 | 4.66 | 4.73 | 0.06* |
| Seasonal totals | 520 | 6.30 | 6.46 | 0.15 | 431 | 4.69 | 4.77 | 0.08 |

All mean differences between farmers' control and experimental plots were significantly different ($p < 0.01$) except those marked with *. Δ is the differential between control and experimental.

To explore which input variables were greater predictors of gross margins, the 6 variable differentials were subjected to a stepwise multiple regression analysis with gross margins as the dependent variable and only 4 were included in the final model. The stepwise method allows the entry of the independent variables in blocks at each step. The independent variables that have little effects in the changes in the dependent variable are excluded in a stepwise manner. Thus the differential costs of nitrogen and potassium were removed because their inclusion did not make any change to the R^2 value. The R^2 of the final model was 0.40 accounting for 40% of the variation in differential gross margins and $F =$

158, $p < 0.001$ (Table 8). The final model was

$$\begin{aligned} \Delta \text{ gross margins} = & 14.04 + 0.87 \Delta \text{ insecticide} \\ & + 0.99 \Delta \text{ fungicide} \\ & + 0.68 \Delta \text{ seed} + 13.33 \Delta \text{ P.} \end{aligned}$$

The inclusion of the phosphorus and seed rate variables increased the R^2 slightly by 0.7% and 1.4%, respectively. The gross margins differential was mainly dependent on insecticide and fungicide variables accounting for 38% of the variations as in model 2. In examining the beta coefficients in Table 8, the insecticide and fungicide differentials were 0.43 and 0.37,

Table 6

Mean variable costs (seeds, fertilizer and pesticides), incomes from rice yields (in US\$ ha⁻¹) and net profit margins in control and experimental plots of participating farmers in the Mekong Delta

| Provinces | n | Variable costs | | | Income | | | Net profit margin | | |
|---------------------------------------|-----|----------------|--------------|-------|---------|--------------|-------|-------------------|--------------|-------|
| | | Control | Experimental | Δ | Control | Experimental | Δ | Control | Experimental | Δ |
| <i>Winter–Spring 2001–2002 season</i> | | | | | | | | | | |
| Vinh Long | 80 | 87.07 | 54.82 | 32.24 | 707.67 | 715.08 | 7.41 | 620.61 | 660.27 | 39.65 |
| An Giang | 129 | 92.57 | 54.98 | 37.59 | 771.18 | 780.80 | 9.62 | 678.62 | 660.27 | 47.21 |
| Dong Thap | 100 | 105.45 | 61.50 | 43.95 | 736.58 | 769.49 | 32.88 | 631.14 | 707.98 | 76.83 |
| Tiengiang | 30 | 122.70 | 69.46 | 53.24 | 720.99 | 725.10 | 4.10* | 598.30 | 655.63 | 57.34 |
| Tra Vinh | 50 | 104.30 | 51.16 | 53.14 | 629.88 | 661.87 | 31.99 | 525.60 | 610.72 | 85.13 |
| Long An | 51 | 84.42 | 50.56 | 33.87 | 583.76 | 596.92 | 13.16 | 499.35 | 546.37 | 47.03 |
| Bac Lieu | 30 | 107.68 | 52.69 | 54.99 | 578.59 | 591.26 | 12.68 | 470.92 | 538.58 | 67.66 |
| Kien Giang | 50 | 85.38 | 47.75 | 37.62 | 731.21 | 750.22 | 19.01 | 645.83 | 702.47 | 56.64 |
| Seasonal total | 520 | 96.45 | 55.42 | 41.03 | 704.94 | 721.95 | 17.01 | 608.50 | 666.54 | 58.04 |
| <i>Summer–Autumn 2002 season</i> | | | | | | | | | | |
| Vinh Long | 30 | 74.68 | 56.72 | 17.97 | 451.09 | 451.09 | 0.0 | 376.41 | 394.38 | 17.96 |
| An Giang | 60 | 97.74 | 69.41 | 28.33 | 559.39 | 559.39 | 0.0 | 461.65 | 489.99 | 28.33 |
| Dong Thap | 60 | 100.77 | 64.16 | 36.62 | 547.27 | 547.27 | 0.0 | 446.50 | 483.11 | 36.62 |
| Tiengiang | 60 | 91.25 | 61.06 | 30.19 | 545.97 | 545.97 | 0.0 | 454.72 | 484.91 | 30.19 |
| Tra Vinh | 60 | 73.74 | 32.19 | 41.55 | 473.83 | 506.45 | 32.62 | 400.09 | 474.26 | 41.55 |
| Long An | 9 | 97.68 | 65.82 | 31.85 | 546.77 | 546.77 | 0.0 | 449.10 | 480.95 | 31.85 |
| Ben Tre | 30 | 96.71 | 46.09 | 50.62 | 498.81 | 507.38 | 8.57 | 402.10 | 461.29 | 50.62 |
| Kien Giang | 60 | 63.21 | 34.19 | 49.01 | 532.36 | 547.27 | 14.91 | 448.51 | 513.08 | 49.01 |
| Can Tho | 30 | 67.72 | 27.19 | 40.53 | 552.86 | 564.79 | 11.93 | 485.15 | 537.60 | 40.53 |
| Soc Trang | 32 | 90.59 | 73.70 | 16.89 | 521.80 | 529.49 | 7.69 | 431.22 | 455.79 | 16.85 |
| Seasonal totals | 431 | 87.60 | 52.23 | 35.33 | 524.90 | 533.51 | –8.62 | 437.18 | 481.28 | 35.33 |

All mean differences between farmers' normal and experimental plots were significantly different ($p < 0.01$) except those marked*. Δ is the differential between control and experimental.

Table 7

Zero order correlations between differential gross margins and differential variable input measures

| Variables | Winter–Spring season | Summer–Autumn | Both seasons |
|--------------------|----------------------|---------------|--------------|
| Seed rates | 0.20* | 0.19* | 0.14* |
| Nitrogen rates | 0.05 | 0.05 | 0.04 |
| Phosphorus rates | 0.13* | 0.07 | 0.09* |
| Potassium rates | 0.03 | 0.08 | 0.01 |
| Insecticide sprays | 0.42* | 0.72* | 0.50* |
| Fungicide sprays | 0.37* | 0.70* | 0.45* |

*indicates that correlations are statistically significant ($p < 0.01$).

respectively indicating that these two independent variables accounted for ~ 80% of the gross margins.

4. Discussion

The farmers' participatory experiments have demonstrated that seed, fertilizers, insecticides and fungicides

can indeed be reduced resulting in higher gross margins. After participating in this evaluation most farmers modified their initial beliefs that reductions in seed and fertilizer rates would result in lower yields and gross margins. Increase in gross margins ranged from \$US 17 to US\$ 85 ha⁻¹ per season and the highest contributions were from reduction in insecticide use, followed by reduction in fungicides and seed rates. Reduction in fertilizers had only small contributions to the increase in gross margins. This was because fertilizer inputs were relatively lower in costs. In addition insecticide, and fungicide spray reductions also meant reduction in labor and reduced exposure to pesticide poisoning. The male members of the family usually carry out pesticide spraying. Although it only takes about 2 or 3 man-hours to spray, not having to perform this task, which is hard work, is often sufficient incentive for the reduction of pesticide sprays. Usually the labor saved may not be utilized although there are potential opportunities such as fishing (Nguyen, 2000) and non-farm activities. For seed and fertilizers however, farmers only saved materials costs as they still had to go out to apply them, although at reduced rates.

We found that the analysis of variable differentials can be useful for analyzing data obtained through

Table 8
Regression of profit differentials on predictor variable differentials

| Step | Predictor differentials | Regression coefficients | Standardized coefficients | R^2 | R^2 change | F | df |
|------|-------------------------|-------------------------|---------------------------|-------|--------------|-----|------|
| 1 | (constant) | 28.15 | | 0.249 | | 316 | 1948 |
| | Insecticide | 1.02 | 0.500 | | | | |
| 2 | (constant) | 21.95 | | 0.380 | 0.131 | 291 | 2947 |
| | Insecticide | 0.88 | 0.429 | | | | |
| | Fungicide | 1.02 | 0.369 | | | | |
| 3 | (constant) | 14.77 | | 0.393 | 0.014 | 205 | 3946 |
| | Insecticide | 0.89 | 0.434 | | | | |
| | Fungicide | 0.99 | 0.357 | | | | |
| | Seed rate | 0.74 | 0.117 | | | | |
| 4 | (constant) | 14.04 | | 0.399 | 0.007 | 158 | 4945 |
| | Insecticide | 0.89 | 0.434 | | | | |
| | Fungicide | 0.99 | 0.359 | | | | |
| | Seed rate | 0.68 | 0.108 | | | | |
| | Phosphorus | 13.33 | 0.083 | | | | |

farmer participatory experiments. By using differences between the control and experiment plots as variables, the differences due to agronomic practices, rice varieties used by each farmer and geographic locations may be minimized. The multiple step regression procedure also helped in determining the main factors that contributed to the dependent variable, profit.

Information that less seeds, fertilizers and pesticides are required to achieve good gross margins in rice cultivation is in conflict with existing beliefs. Thus, when farmers were presented with such information and a simple experiment to evaluate the new information, they were motivated to participate. Their previous experience with participatory research in the “no early insecticide spray” campaign (Heong et al., 1998) also enhanced their enthusiasm to experiment. Since in all cases ($n = 951$) participating farmers had obtained higher gross margins in their experimental plots, the three reduction practices were readily adopted. The experiment had helped participating farmers to resolve their cognitive dissonance and modified their attitudes that more seed and fertilizer inputs would give higher yields.

The results from this farmer experiment are being used to build a large communication strategy to motivate farmers to reduce seed rates, fertilizer and pesticides in the Mekong Delta, now popularly called “Three Reductions” or *Ba Giam Ba Tang* (Vietnamese for three reductions, three gains). This program developed a leaflet, a poster, a radio drama, a TV drama and a TV advertisement. The “*Ba Giam Ba Tang*” program¹ was launched on March 8, 2003 in Can Tho province. The monitoring survey conducted in June 2004 showed

that >80% of the farmers in the pilot area have learnt about the Three Reductions. In July 2004 officials of the Ministry of Agriculture and Rural Development in Hanoi announced their support of the “Three Reductions” program² to the news media. The potentials for reductions in seed and fertilizer use and further pesticide spraying that will contribute to improving the environment over a large scale in Vietnam are very promising.

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¹The “*Ba Giam Ba Tang*” program was awarded the 2003 Golden Rice Award for the best agricultural innovation by the Ministry of Agriculture and Rural Development of Vietnam in December 2003.

²<http://vietnamnews.vnagency.com.vn/2004-07/12/Stories/02.htm>.

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