Three Reductions, Three Gains (3R3G) Technology in South Vietnam: Searching for Evidence of Economic Impact

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Three Reductions, Three Gains (3R3G) Technology in South Vietnam: Searching for Evidence of Economic Impact[1]

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Abstract: The aim of the "Three Reductions, Three Gains" (3R3G) project is to reduce production costs, improve farmers' health, and protect the environment in irrigated rice production in Vietnam through the reduced use of seeds, nitrogen fertilizer, and pesticides. It was developed by the International Rice Research Institute and introduced to farmers in South Vietnam by the Ministry of Agriculture and Rural Development in early 2000 through traditional extension work and mass media. Farm survey data provide evidence of adoption of 3R3G primarily in terms of lowering seed rates. The resultant changes in the farm production/cost structure and farmer profits are measured.

Key words: information-intensive technology, technology transfer, farm-level impacts

1. Introduction

In the context of Asian agriculture, 'rice is life'. Approximately 90% of world rice production of 620 metric tons in 2005 was grown and consumed in Asia. Only 7% of production is traded. In Bangladesh, Cambodia, Indonesia, Lao PDR, Myanmar, Thailand, and Vietnam, per capita rice consumption ranges from 90 to 200 kg per year and accounts for about 50-80% of the caloric intake. Two-thirds of the world's poor also live in Asia.

A turning point in Vietnam's rice history occurred in the mid-1990s when the county was transformed from an importer to an exporter of rice. By 2005, Vietnam's rice area of more than 7 million ha covered 75% of the country's cultivated land and produced 36 million tons of rice, which exceeded domestic demand. As a result, Vietnam has become one of the world's leading rice exporters. For example, Vietnam exported four million tons of milled rice in 2004. Meanwhile, there was also increased use of agrochemical inputs, specifically inorganic fertilizers and pesticide products. Concerns about the environmental and health consequences of the injudicious use of agrochemicals are extensively discussed in the literature.[3]

Yield-increasing and cost-saving technologies are at the centerfold of programs aimed at increasing food supply and farm household incomes to achieve global food security and reduce poverty. Although research into varietal improvement is still paramount, there has been increased attention toward developing technologies (largely crop management strategies) that will result in a reduction in the injudicious use of agrochemicals without sacrificing yield. Broadly speaking, these crop management strategies can be categorized as (a) those aimed at increasing yield while largely maintaining input use, and (b) those aimed at reducing input requirements without sacrificing yield. The technology of interest here which is commonly referred to as 'Three Reductions, Three Gains' (3R3G) falls into the second broad category. In essence, it is a knowledge-based technology aimed at lowering the cost of growing rice in irrigated systems (through reduced seeds, nitrogen fertilizer, and pesticides) while maintaining

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[3]See for example, Nguyen and Tran (2003) in http://203.116.43.77/publications/research1/ACF124.html.

yield, and improving farmer's health and better protecting the environment (through the reduced reliance on agrochemicals).

The 3R3G project evolved from an integrated pest management (IPM) project in which the concept of not spraying for pests in rice fields the first 40 days after sowing was developed. This concept was based on research findings that showed that early spraying was unnecessary as any damage from the leaf-feeding insects (the prime cause of early spraying) did not affect yield (Heong et al 1994). Given the strength of the research finings, a 'No Early Spraying' (NES) media campaign was funded and reached around 92% of the 2.3 million farmer households in the Mekong Delta in Vietnam. As a result, the number of insecticide sprays per season dropped by 70% from 3.4 to 1.0, (Huan et al 1999). This was a remarkable change as farmers responded positively to the challenge posed by the media campaign

The success of the NES experiments, combined with the knowledge that farmers in the Mekong Delta were applying high seeding rates (200-300 kg/ha) and nitrogen applications of around 150-300 kg/ha, resulted in the Irrigated Rice Research Consortium (IRRC), with funding support from the Swiss Agency for Development and Cooperation (SDC), to conduct on-farm research in the province of Can Tho in 2001 to determine the amount by which seed and fertilizer use could be reduced. In the following year, the Plant Protection Division (PPD) under Vietnam's Ministry of Agriculture and Rural Development (MARD) validated the results of the experiments in 11 provinces with matching funds from the Danish International Development Agency (DANIDA). This study, involving 951 farmers, showed that seeds, fertilizers, and insecticides can be reduced by 40%, 13%, and 50%, respectively, resulting in marginal yield increases and increased profits of US$44-58/ha (corrected figures from Huan et al 2005). As a result, the pesticide management practice of NES was packaged with lower seed rates[4] and lower nitrogen use and became known locally as *Ba Giám Ba Tăng* or Three Reductions, Three Gains. (See Table 1 for information on 2002 data on farmers' practice and the scientist-based recommended target rates.) By February 2005, a national committee was established by MARD to develop plans to scale up implementation of 3R3G. In 2006, MARD allocated about US$230,000 to 64 provinces, specifically for *Ba Giám Ba Tăng* implementation.

The national program used standard extension activities combined with a quite elaborate and creative mass media campaign. Through a multi-stakeholder participatory planning process, a campaign package was developed to reach and motivate large numbers of rice farmers in the Mekong Delta (Huan et al 2005). It consists of communication media (TV, radio, print, and demonstrations) and materials (soap operas, leaflets, pamphlets, and farmer field days) geared toward increasing the farmers' ability and motivation to modify their resource management practices by adopting the relatively knowledge-intensive technology. The strategy was to change a farmers' attitude toward input use from one of 'more is better' to one of 'less is more sensible' through a number of information-delivery systems. In particular, these included billboards along main roads, soap operas aired in national radio and television stations,[5] and public amplifiers in the villages which were used to replay the radio broadcasts before daybreak, just before the farmers go to the rice fields. It became nearly impossible for a farmer not to hear about 3R3G.

[4]It will be shown later in the discussion that although 3R3G was inspired by NES, seed reduction is its most important component. Further, unforeseen recurrence of brown plant hopper "outbreak" and the diseases it carried in 2005 compromised the benefits of 3R3G.

[5]Funding support for various radio and television soap operas came from The Rockefeller Foundation and The World Bank (US$131,800) with IRRI as project proponent. One specific radio program is the "Chuyen Que Minh" or "My Homeland," which is well described by Escalada and Heong (2007).

The principal scientists behind the 3R3G received recognitions and awards from the Vietnamese government and the SDC, suggesting that the technology succeeded in making a difference in terms of farmer (and environmental) well-being. The aim of this paper is to provide some preliminary estimates of the economic impact at the farm level. In particular, it addresses the questions:

(a) How effective was the media campaign in promoting 3R3G awareness and adoption?

(b) Did adoption result in significant reductions in input use and thereby lower costs and increase profits?

2. The data and analytical framework

2.1 South Vietnam (Mekong Delta)

Vietnam's Mekong Delta is at the end of the world's 12th longest river. Arising from the Himalayas, the Mekong River supplies the tropical wetlands of Vietnam with rich alluvial deposits making the soil sufficiently fertile that the area is home to 15 million people. The intense green of cultivated rice paddies can be seen across the Mekong Delta, threaded through by an intricate web of irrigation and drainage canals.[6] The Mekong Delta has 13 provinces that altogether accounted for about 52% of total national rice output of 36 million tons in 2005. Generally, two rice crops are grown per year. The national yield average in 2005 was 5 tons/ha.

2.2 The data

Household surveys were conducted in the provinces of An Giang and Can Tho in July-August 2006. For each province, three districts and three villages per district were selected. Sample sizes at each geographical level were proportioned to rice area. Farmers interviewed were chosen at random in each village. Thus, a stratified/random sampling procedure was used to select 200 farmers in each province (Table 2). The questionnaire used was well-structured and designed to collect input-output data and information on the knowledge and perceptions of farmers with regard to 3R3G in particular and to rice farming in general. The data were collected for two seasons –the dry season (winter-spring 2005-06) and the wet season (summer-autumn 2006)—by the staff of the Faculty of Economics at An Giang University, An Giang Province, Vietnam. The farm survey was complemented by farmers' focus group discussions (FGD); key informant interviews (KII) of provincial/district government officials, extension workers, and seed growers; and collection of price data from agricultural chemical retail shops in all the provinces.

2.3 Pathway to higher farm profits

The 3R3G technology is not a physical good (such as in the case of a new high-yielding rice variety) but rather a package of input management recommendations that farmers can use in their profit-maximizing or input use-decision making process. The 3R3G technology capitalizes on the synergistic effects of reducing three inputs together without sacrificing yield – that is, if seed rates are lowered, less fertilizer is required which, individually and jointly, makes the crop less attractive to pest, reducing the need for insecticides for the whole cropping season. Further, the adoption of NES also discourages pest population buildup because not only is early spraying unnecessary in terms of yield benefits (as stated above) but, by destroying pest predators, it can lead to pest resurgence problems. In other words, the more a farmer sprays, the more a farmer may need to spray. As such, the benefits of the 3R3G technology package should manifest in reduced input use intensities without yield loss and, therefore, reduced costs and hence higher profits.

The 3R3G package was taken up by the Vietnamese MARD - first at the provincial level and then at the national level. Perhaps, part of the reason for MARD's interest in 3R3G was that it complemented other (much larger) R&D programs aimed at increasing the use of seeders and certified (good) seeds. As

[6] Source: http://earth.esa.int/cgi-bin/satimgsql.pl?pf=473

discussed below, data from the 2005-06 survey showed that seed reduction was the component that contributed most to overall gains from 3R3G.

In addition to the development and promotion of other technologies, the adoption of one or more of the components of 3R3G was influenced by a range of biotic and abiotic stresses. For example, the marked resurgence of an insect called brown plant hopper in the Mekong Delta in 2005 could have had a significant negative impact on the farmers' willingness to reduce insecticide use. In addition, farmers will react to changes in the price of inputs or output in terms of increased or reduced input use.

2.4 Definition of adopters and non-adopters

A requisite to measuring impact is being able to establish the 'with and without' technology scenarios. In this case, it is done by establishing and comparing two groups of farmers who have similar characteristics, except with respect to their uptake of 3R3G. In other words, the two groups are the 'adopters' and 'non-adopters'. Since 3R3G is basically a suite of crop management technologies comprising three components, it is possible for some farmers to fully adopt all three components and others to partially adopt one or a paired-combination of the components. Indeed, in this instance, there were very few farmers who reported to be 'full' adopters of the technology. As such, adopters are defined as farmers who have stated that they heard about and believed in the principles of 3R3G and have, to some degree at least, taken up one or more of the 3R3G recommendations and lowered their seed, nitrogen, and/or pesticide use. Conversely, the non-adopters group are farmers who stated that they (a) have never heard about 3R3G, (b) have heard about 3R3G but do not believe in the principal recommendations, or (c) have heard about and believed in the principles of 3R3G but are not willing to take the risk of changing their farming practices along the lines of those recommended under the 3R3G package.

2.5 Comparison of input rates, yield, costs, and income

The first step to finding evidence of economic impact is to look at farm-level data and examine changes in practices (input use) and performance (yield, costs, and income). Simple mean comparisons between adopters and non-adopters were done to measure such changes.

Moving forward, multivariate analyses involving production function frontier estimations to establish efficiency scores for adopters versus non-adopters will be done after data cleaning of the relevant variables is completed. Farm-level results shall be used in the second (and final) step which shall measure the economic benefits to society in terms of internal rate of return (IRR) using the DREAM[7] model.

3. Results

All farms considered in the analyses were direct seeded; the few transplanted farms were dropped from the analysis. Also excluded from the analysis in the wet season were farms with incomplete output information because interviews were done prior to harvesting. The following discussion refers to Tables 3-6.

3.1 Awareness and adoption

Strategic media campaign and traditional extension work promoting 3R3G succeeded in creating more than 80% awareness regarding the teachings and benefits of reducing the three key inputs–seed, fertilizer, and pesticides. Even those who have not participated in farmers' trainings and demonstration trials were able to enumerate the reduction teachings. The media was an effective tool in changing

[7] DREAM, or ***D***ynamic ***R***esearch ***E***valu***A***tion for ***M***anagement, is a menu-driven software package for evaluating the economic impacts of agricultural research and development (R&D). Users can simulate a range of market, technology adoption, research spillover, and trade policy scenarios based on a flexible, multi-market, partial equilibrium model. For more information, please go to http://www.ifpri.org/dream.htm.

farmers' attitude (and maybe beliefs also) regarding the optimal rates of seeds and fertilizer and timing of insecticide application. However, it takes more than awareness to affect practices. Farmers need to have the minimum knowledge and skills to apply them and be convinced that such a change will work to their advantage – this is where 'hard core' extension through the work of agricultural technicians plays an important role. The media campaign, however, made it easier for the technicians to motivate farmers in taking small risks by reducing inputs gradually from one season to the next. This eventually led to adoption. Equally important considerations to adoption are farmers' assessment of risks imposed by the vagaries of weather, incidence of migratory pests, and fluctuations in input/output prices. Natural disasters causing floods, migration of pests into the area, and unfavorable prices, singularly or in combination, will discourage farmers to reduce seed, fertilizer, and pesticides.

Partial adoption was most common, with reductions in the seed rate being the single component with the highest adoption rate. This is a positive outcome because if the farmer is able to reduce seed rates, then adoption of the other two components may follow as there is less pest pressure and reduced fertilizer requirements (Heong 2006). However, as was apparent from the field visits and discussions with key informants, the 3R3G was being promoted hand-in-hand with two other programs by MARD, namely, the provision of a reliable supply of affordable, good seeds and promotion of mechanical seeders. Seed reduction adoption rate is 11 percentage points lower in Can Tho (34%) than in An Giang (45%). This could be because of lower access to certified, registered or local seed, which are of better quality than previously harvested seeds. Indeed, the farmers indicated that they would further reduce seed rates in the future as quality seeds and mechanical seeders become increasingly available. In other words, indications are that the reduced seed rate is not solely attributable to 3R3G.

3.2 Changes in input use

Seeds. The lowest seed rate (153 kg/ha) was reported by adopters in An Giang Province during the dry season of 2005-06, whereas the highest seed rate (200 kg/ha) was reported by farmers in Can Tho in the wet season (Tables 5 and 6). These rates were both well above the science-based recommendation of 100 kg/ha (Table 1). Most of these adopters indicated that they will continue reducing seed rate in increments of about 10-20 kg/ha in the succeeding seasons if weather conditions are favorable and there is no significant yield sacrifice. This is consistent with the overall MARD strategy of allowing farmers to slowly achieve seed rate target year-by-year. As such, this continued fall over time need to be considered in an analysis of a temporal flow of benefits from the adoption of 3R3G recommendations.

Fertilizer. The mean values for elemental nitrogen and elemental phosphorus application for both adopters and non-adopters of 3R3G in An Giang and Can Tho were close to the science-based recommendations of 110 kg/ha and 40 kg/ha, respectively (Table 1). For example, in An Giang, farmers were using 108 kg/ha of elemental nitrogen and 30 kg/ha of elemental potassium (Table 5). Given that the adopters and non-adopters were both applying these fertilizers at levels close to the recommended rates, it is not surprising that there is limited evidence of a significant difference between adopters and non-adopters (Tables 5 and 6). The only exception was in the case of adopters in An Giang who applied around 8 kg/ha less elemental nitrogen in the dry season than did the non-adopters (Table 5).

In contrast, the use of elemental phosphorus was 35-80% higher than the recommended rate of 30 kg/ha (Table 1), with the highest level of use (54 kg/ha) being reported for adopters of 3G3R in An Giang. Nevertheless, there was no significant difference between adopters and non-adopters in either province (Tables 5 and 6).

Pesticides. The data suggest that adopters of 3R3G reduced the use of insecticides, fungicides, and even molluscicides (for snail control). Adopters in the two provinces spent US$8-12/ha/season less on pesticides than did the non-adopters (Tables 5 and 6). As mentioned earlier, 3R3G had its roots in NES. However, rather than promoting NES *per se*, the message delivered in the media campaign was one of a general reduction in the use all pesticides as it is a relatively less complicated NES message to abstain from applying insecticides in the first 45 days after planting.

Further discussions with farmers and district technicians revealed an active integrated pest management (IPM) program in the region prior to 3R3G. IPM taught farmers to practice judgment in assessing pest situations and use pesticides judiciously and to adopt NES. Since 3R3G can be regarded to have only reinforced the IPM teaching, then the benefit of a reduction in pesticide use cannot be fully attributed to 3R3G.

3.3 Yield

The national yield average for Vietnam in 2005 was 4.9 tons/ha. Yields are naturally much higher in irrigated (favorable) than in rainfed (less favorable) areas. South Vietnam is a prime rice-growing area because of high alluvial deposits that feed the paddy soils along the trail and tail end of the Mekong River. The provinces along the river are expected to have higher yields. Also, yields are much higher in the dry season because of greater solar radiation that results in more and heavier grains. This is supported by the survey data which show that, in the dry season, average yields for An Giang and Can Tho were 7.7 tons/ha and 7.8 tons/ha, respectively. Yields were much lower in the wet season, averaging 5.8 tons/ha and 5.2 tons/ha for An Giang and Can Tho, respectively. Nevertheless, the wet season yields for these two provinces were still higher than the national average.

As stated above, the aim of the 3R3G technology is to reduce the use of seed, nitrogen fertilizer, and insecticides without sacrificing yield. Hence, it can be hypothesized that the adopter's yield should be equivalent to the yield obtained by non-adopters. This proved to be true for An Giang in both seasons (Table 5). In Can Tho, however, yield appeared to have been compromised, with non-adopters yield being around 350 kg/ha (440 kg/ha) higher than that of the adopters in the dry (wet) season (Table 6). This significant difference in yield could be the result of the lower seed rate, poorer seed quality, and the reduced use of pesticides. However, given the importance of the yield difference in assessing the economic benefits of 3R3G, further investigation will be undertaken to more fully understand the cause of the difference.

3.4 Production cost

Costs were aggregated into two components–labor and materials (Tables 5 and 6). Labor cost consists of paid-out labor costs (including meals) plus imputed family labor costs. Material costs include seed, fertilizer, pesticides, fuel, and oil. Roughly, labor was 36-42% of total costs and materials, 58-64%.

The hypothesis is that adopters should have lower per-unit cost or average cost, which theoretically mirrors a lower marginal cost. Average cost is total cost divided by total production. In absolute terms, farms in An Giang operated at a higher per-unit cost (US$64-108) than farms in Can Tho (US$57-95). The difference between provinces can be explained mostly by higher labor cost in An Giang due to the more intense land preparation activity and higher wage rates. There are also seasonal differences in the cost of production. The average cost of production is lower in the dry season than in the wet season crop. This is because of lower labor inputs associated with harvesting. Lodging at harvest time in the wet season was quite prevalent which resulted in greater use of labor and higher wage rates induced by increased demand. In An Giang, for example, the average costs in the wet season were higher than those in the dry season by US$26-38.

Finally, the ratios of average cost to paddy price farms suggest 29-62% profit margin. However, as shown in the discussion below, in terms of net income per unit area, the returns were still low.

3.5 Net income and poverty

Net income was computed as the difference between value of production and cost of production per unit of land (ha). It indicates the importance of the rice crop in the financial well-being of the rice farming household. Net income figures are more meaningful when compared with the poverty line and whether additional income from adoption of 3R3G can contribute to alleviation.

Given the World Bank poverty measure of US$1 a day and a family household size of 5 (survey average for household size ranged from 4.6 to 4.9), then household annual income poverty line would be US$1,825.

In An Giang, annual net incomes/ha were US$1,092 for adopters and US$883 for non-adopters. Given the average farm size of two ha and a household size of five the resulting per capita income per day were US$1.20 for adopters and US$0.97 for non-adopters. These are within close range of World Bank's poverty line of US$1 per capita per day. Noteworthy is the observation that adopters exceeded the rice incomes of non-adopters by $418 per year. This increase in income is sufficient to push the farmer over (even if just marginally) the poverty line. The additional incomes could be reinvested in the farm or they may be used to improve the health and education status of the household or social/cultural activities. Hence, the additional income from adoption of 3R3G may have high 'social value' – although assessing the social impact of the 3R3G-induced change in income is beyond the scope of this study. Of significance is the fact that the net income benefits received by the adopters in An Giang were bigger in the wet season (US$236/farm) than in the dry season, $184/farm, despite the lower yields.

In Can Tho, the net income per farm (per capita per day) is estimated to be US$2,047 (US$1.12) for adopters and US$2176 (US$1.19) for non-adopters. Hence, both adopters and non-adopters are above the poverty line, albeit marginally. However, these results are counter-intuitive in that they suggest non-adopters are better off than the adopters. As stated above, the reasons for the counter-intuitive results need further investigation.

3.6 Future analysis: technical efficiency and IRR

To further the search for economic impacts, a frontier production function will be specified in order to estimate and compare efficiency scores between adopters and non-adopters. While the yield-increasing technologies shift the production frontier, NRM technologies "push" a farm or firm toward the frontier through more efficient use of inputs. They basically reduce the gap between actual and potential/frontier yields. In an empirical study, both frontier shifts and efficiency gains should lead to an outward shift in the marginal cost or supply curve. This shift is the "change" component in economic impact analysis and the estimation of IRR within a consumer surplus framework and DREAM. Estimates of cost reductions and adoption rates were to be used as well in the estimation of IRR.

4. Conclusion

Evidence of economic impact of 3R3G at the farm level shows a US$92/ha to US$118/ha increase in net incomes in An Giang. This is equivalent to a US$5-17 per ton fall in the average cost of rice paddy. However, while these results would suggest that the 3R3G program has been successful, the results for Can Tho do not support this finding. Hence, while the total economic benefit for An Giang can be estimated, the An Giang farm-level data cannot be used as a proxy for the rest of the Mekong Delta as it could lead to a gross overestimation of the benefits. As such, the next steps are to explore what lies behind the counter-intuitive results for Can Tho and to complete the data cleaning and analysis for a third province, Soc Trang. Once this has been done, it may be possible to combine the farm-level data for the three provinces and obtain a measure of the returns to research. Issues of attribution will also need to be addressed.

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Table 1. Three Reductions-Three Gains (3R3G) Technology target seed, fertilizer, and pesticide use rates.[a]

	Farmers' practice in 2002[b]	Target for dry season (winter-spring)	Target for wet season (summer-autumn)
Seed (kg/ha)	200-350	70-100	100-120
Fertilizer			
Nitrogen (kg/ha)	150-300	120	100
Potassium (kg/ha)	No data available	30	50
Phosphorus (kg/ha)	No data available	30	30
Insecticide	Spray 10-15 days after planting	NES first 40 days after planting	
Fungicide	"Calendar" spraying	Use fungicide when blast symptoms are visible at booting stage (at 60 days after planting)	

[a]These are scientist-based recommended rates. The Ministry of Agriculture and Rural Development was aware that achieving these rates will take a few years so that annual targets were adjusted accordingly.
[b]Elicited from Plant Protection Division provincial, district, and village directors during key informant interviews in June 2006 and March 2007.

Table 2. Sample-distribution,[a] by survey site and cropping season,[b] South Vietnam, crop year 2005-06.

	An Giang	Can Tho
Dry season 2005-06	195	194
Wet season 2006	184	191

[a] Two hundred were interviewed in each province. Transplanted farms and those with incomplete information were dropped from the analysis.
[b] Very few planted a third (second wet season) crop.

Table 3. Awareness and adoption rates (%) of 3R3G as reported by farmers, South Vietnam, crop year 2005-06.

	An Giang	Can Tho
Awareness	86	83
Practice change		
• Reduced seeds	45	34
• Reduced nitrogen/fertilizer	35	25
• Reduced insecticide/pesticide	39	24
Adopters (one or more of above reduction)	47	36
Non-adopters	53	64
Number of farmers reporting	195	194

Table 4. Primary[a] and secondary[a] sources of information on 3R3G, South Vietnam, crop year 2005-06.

	Adopter	Non-adopter	ALL	Adopter	Non-adopter	ALL
		Primary			Secondary	
AN GIANG						
Agric. technician	**25**	**10**	**35**	**18**	**11**	**29**
Radio & TV	**24**	**32**	**56**	**35**	**19**	**54**
Others[b]	**5**	**4**	**10**	**32**	**20**	**53**
All sources	**91**	**76**	**167**	**85**	**50**	**136**
CAN THO						
Agric. technician	**19**	**13**	**32**	**7**	**10**	**17**
Radio & TV	**22**	**42**	**65**	**29**	**28**	**58**
Others[b]	**2**	**2**	**4**	**5**	**20**	**25**
All sources	**69**	**92**	**161**	**41**	**58**	**100**

[a] Primary sources refer to individuals or media from whom/which farmers heard and learned about 3R3G for the first time. Secondary sources are those from whom/which farmers heard about 3R3G in other times. Some farmers reported more than one secondary source.
[b] Co-farmers, relatives, and input suppliers.

Table 5. Input use, cost, and income comparisons, adopters vs non-adopters of 3R3G, An Giang, South Vietnam, crop year 2005-06.[a]

	Adopter (A)	Non-adopter (B)	Input/cost reductions (A-B)	Level of statistical significance	Adopter (A)	Non-adopter (B)	Input/Cost reductions (A-B)	Level of statistical significance
		Dry season, 2005-06				*Wet season, 2006*		
Number of cases	91	104			87	97		
Seed rate (kg/ha)	153.307	187.137	-33.830	0.000	154.438	194.257	-39.819	0.000
Elemental nitrogen (kg/ha)	107.804	115.984	-8.180	0.079	108.917	122.987	-14.070	0.029
Elemental potassium (kg/ha)	30.172	30.148	0.024	0.989	30.334	31.873	-1.539	0.506
Elemental phosphorous (kg/ha)	53.907	48.418	5.489	0.151	54.995	48.964	6.031	0.105
Herbicide cost (US$/ha)	14.921	14.931	-0.010	0.994	15.078	16.576	-1.498	0.380
Insecticide cost (US$/ha)	20.262	29.851	-9.589	0.009	21.544	27.407	-5.863	0.163
Fungicide cost (US$/ha)	44.037	49.862	-5.825	0.339	41.836	53.732	-11.896	0.044
Molluscicide cost (US$/ha)	10.974	12.137	-1.163	0.533	8.186	9.827	-1.641	0.302
Yield (t/ha)	7.719	7.634	0.085	0.593	5.87	5.708	0.162	0.359
Average cost (US$/t)	64.404	70.283	-5.879	0.061	90.144	108.027	-17.883	0.001
Paddy price (US$/t)	151.571	146.079	5.492	0.000	156.149	151.63	4.519	0.016
Income: gross (US$/ha)	1,170.26	1,115.63	54.623	0.034	912.9	863.69	49.210	0.071
Cost: labor (US$/ha)	185.345	189.99	-4.645	0.643	211.23	232.52	-21.298	0.034
Cost: materials (US$/ha)	300.371	333.291	-32.920	0.003	293.357	340.437	-47.080	0.000
Cost: total (US$/ha)	485.716	523.282	-37.566	0.029	504.583	572.961	-68.378	0.000
Income: net (US$/ha)	684.54	592.351	92.189	0.004	408.318	290.729	117.589	0.001

[a] All monetary values are in 2006 prices.

Table 6. Input use, cost, and income comparisons, adopters vs non-adopters of 3R3G, Can Tho, South Vietnam, crop year 2005-06.[a]

	Adopter (A)	Non-adopter (B)	Input/cost reductions (A-B)	Level of statistical significance	Adopter (A)	Non-adopter (B)	Input/cost reductions (A-B)	Level of statistical significance
	Dry season, 2005-06				*Wet season, 2006*			
Number of cases	69	125			68	123		
Seed rate (kg/ha)	195.273	211.324	-16.051	0.002	200.041	219.036	-18.995	0.001
Elemental nitrogen (kg/ha)	101.213	98.425	2.788	0.604	108.123	101.747	6.376	0.260
Elemental potassium (kg/ha)	26.667	27.561	-0.894	0.662	29.158	29.82	-0.662	0.769
Elemental phosphorous (kg/ha)	39.394	38.537	0.857	0.810	44.014	44.724	-0.710	0.852
Herbicide cost (US$/ha)	16.459	13.884	2.575	0.392	16.458	14.782	1.676	0.581
Insecticide cost (US$/ha)	18.598	29.422	-10.824	0.059	18.892	28.103	-9.211	0.004
Fungicide cost (US$/ha)	34.603	42.52	-7.917	0.103	30.703	40.225	-9.522	0.007
Molluscicide cost (US$/ha)	9.684	11.432	-1.748	0.258	7.835	15.802	-7.967	0.012
Yield (MT/ha)	7.615	7.968	-0.353	0.066	4.93	5.37	-0.440	0.022
Average cost (US$/MT)	57.14	59.943	-2.803	0.252	93.543	94.849	-1.306	0.748
Paddy price (US$/MT)	152.22	155.126	-2.906	0.079	148.231	150.005	-1.774	0.123
Income: gross (US$/ha)	1,160.22	1,236.73	-76.511	0.020	733.388	804.606	-71.218	0.015
Cost: labor (US$/ha)	161.532	175.596	-14.064	0.035	168.41	188.08	-19.670	0.002
Cost: materials (US$/ha)	265.588	291.772	-26.184	0.053	274.583	297.685	-23.102	0.063
Cost: total (US$/ha)	427.12	467.368	-40.248	0.013	442.991	485.762	-42.771	0.005
Income: net (US$/ha)	733.095	769.358	-36.263	0.262	290.398	318.844	-28.446	0.350

All monetary values are in 2006 prices.

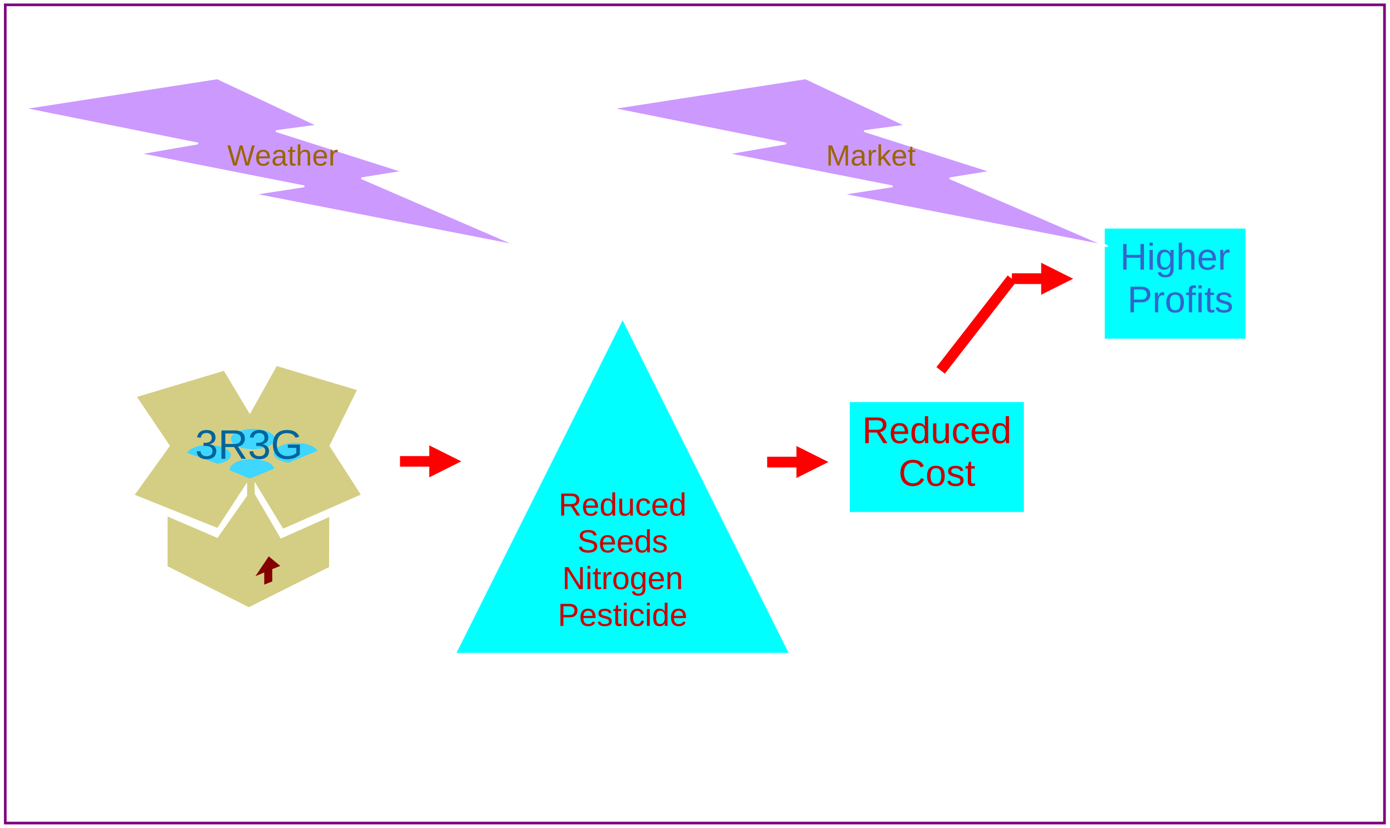

Fig. 1. Pathway to higher farm profits for "Three Reductions, Three Gains" technology.