

## DOES PRODUCTIVITY MATTER IN THE ADOPTION OF HYBRID RICE? A COMPARATIVE STUDY

RASHED SAEED<sup>1</sup>, ARSHED BASHIR<sup>1</sup>, MUHAMMAD QASIM<sup>1</sup>, IRFAN MEHMOOD<sup>1</sup>, KHUDA BAKHSH<sup>2</sup>

<sup>1</sup> Social Sciences Research Institute, PARC, Faisalabad, Pakistan

<sup>2</sup> University of Agriculture, Faisalabad, Pakistan

### ABSTRACT

The present study was designed to analyze comparative economics of hybrid rice and basmati in the core rice growing area of Punjab. Cross-data was collected through well-structured questionnaires from 80 farmers during May and June 2011. Study results reveal that higher yield and less time required for maturity in production were the main reasons for planting of hybrid rice. Hybrid rice occupied 3.6 acres whereas area under basmati was 5.9 acres of the total farm area. Farmers obtained above 60 percent increase in yield of hybrid rice. Results show that cost of production of basmati rice was estimated as Rs.37364 per acre and total revenue was Rs.44768 per acre. The benefit cost ratio of basmati rice was 1.20 and that of hybrid rice was 1.80, implying that hybrid rice has brought comparatively more economic benefits to the farmers as compared to basmati in the study area. Shortage of buyers, much costly poor quality hybrid seed, late payment and higher transportation costs are among major constraints in rice production and marketing.

### JEL CLASSIFICATION & KEYWORDS

■ O4 ■ Q00 ■ PRODUCTIVITY ■ PROFITABILITY ■ ADOPTION  
■ RICE ■ BASMATI ■ HYBRID

### INTRODUCTION

Boosting rice productivity and providing rice to the consumers at affordable prices is always at the top of political agenda of the governments for sustaining economic growth and political stability on the continent. Frequent food inflations have further altered Asian economies to keep rice development strategy and policy as a prime target in order to feed ever increasing population and sustain food security. Most rice-growing countries in the Asian region are doing remarkably well in meeting their rice needs over the past three decades using Green Revolution technologies.

It is not alone the yield potential of hybrid rice which induces farmers to grow its varieties but these are the profitability gains from production of hybrid rice that would encourage farmers particularly the commercial farmers to replace HYV with the new hybrids of rice. It is beyond doubt that hybrid rice has the potential to increase yields by 15 percent as compared to conventionally grown rice varieties in China (Lin, 1990). Similarly, hybrid rice yields by 30 percent have been noticed in India (Janaiah and Xie, 2010). Yield potential of hybrid rice varies within, over time and across the countries. For example in China, the hybrid rice yield raised from 3.4 to 6.7 tons per hectare during 1978 to 2008 (Li, Xin, and Yuan, 2009). In another year, 27 percent higher hybrid rice yield has been observed in China (Virmani et al, 2002). In Bangladesh, yields of hybrids were 14% higher than that of high yield varieties (Husain, 2001). Currently, about 20,000 ha are covered with hybrid rice in India, 10,000 ha in USA and 50,000 ha in Bangladesh. These have given on

<sup>1</sup> rashedkasuri@gmail.com

an average about 20-25 percent higher yields than the inbred, thereby contributing towards higher on-farm productivity (Food and Fertilizer Technology Centre, Taiwan, 2002). In Vietnam, hybrid rice has yielded higher output, hence better food security during the year 2006-07 (Vien and Nga, 2007). No doubt, breakthroughs in hybrid rice technology are considered a viable option to increase rice yields globally because hybrid rice has proved most important applications of genetics in agriculture which has not only contributed to food security but also benefited the environment (Duvick, 1999).

There are several constraints identified in the wider adoption of hybrid rice in spite of higher yield over the existing inbred rice varieties in south Asia. (Janaiah, 2003) found that stickiness of cooked rice and its relatively inferior quality in terms of taste were the constraints in hybrid rice adoption. Farmers in Andhra Pradesh, Tamil Nadu, and Karnataka province of India complained of inconsistent yield performance, low grain quality, high susceptibility to pests, and other factors that led to significant levels of rejection and dis-adoption.

According to Rice Exporters Association of Pakistan (REAP), at present, hybrid rice is cultivated on an area of approximately 202347 ha in Pakistan where average yield per hectare (2.387 mt/ha) are still lowest in the world (International the News, 2012). Rice ranks second among staple food grains of the country and it has remained source of foreign exchange earnings for the country but achieving self-sufficiency in rice is still the target. Pakistan is 4<sup>th</sup> largest producer of rice in world after China, India and Indonesia. It supplies 30 percent of the worlds' paddy rice output together with the rest of South Asia.

Several private companies in Pakistan are currently operating in the production and sale of hybrid rice seeds with tall claims that it would boost the production manifold. A total of 3,000 to 4,000 metric tonnes of hybrid rice seeds are imported every year since the outset of the technology's introduction (International the News, 2012). Farmers have to buy the costly seed every year and that may increase the input cost as compared to conventional rice. The seed availability and dependency on private seed companies could also put farmers on losing side. This situation could lead to dis-adoption and re-adoption of hybrid keeping in view the seed prices and availability of seed. Moreover, due to inferior quality of hybrid rice, the marketing problems may also arise as a result of wider cultivation of hybrid rice in the country. Keeping in view the present situation, the study was designed to see the comparative economics of hybrid and basmati rice in the core rice growing area of the Punjab with specific objectives as:

### Objectives:

- To assess the extent of adoption of hybrid rice;
- to investigate the role of seed and pesticide companies in the adoption of hybrid rice;

- to estimate and compare the profitability of hybrid rice and basmati rice; and
- to suggest policy recommendations.

## Methodology

### Sampling Procedure With Reference To Farm Categories

Typically basmati rice production areas of the Punjab consist of Sheikhupura, Sialkot, Gujranwala, and Hafizabad districts. Keeping in view the budget constraints, only two districts i.e. Sheikhupura and Sialkot were selected from the irrigated Punjab. A list of hybrid rice growers was obtained from the seed dealers out of which total numbers of 80 respondents (40 respondents from each district) were selected through purposive sampling technique during the year 2011. Pretested and well-designed questionnaire was developed in order to collect primary data. Economic comparison between basmati and hybrid rice was one of the major objectives of study, therefore, social and economic characteristics of the farm and farmers as well as cost of different used inputs involved in production of the crop were also computed in order to estimate cost benefit analysis separately for hybrid and basmati rice for useful cross comparisons between hybrid rice and basmati.

### Operational Components in Estimation of Rice Production Costs

The cost of production of rice has been apportioned into various operational components. These include land preparation, nursery costs, seed and sowing cost, doses of different fertilizers, farm yard manure, irrigations, plant protection/ weedicide, water rates, harvesting costs and mark up rate on relevant costs was also taken into account. Similarly, output price on market rates/ mill rates was also computed in order to perform further economic / data analysis.

### Data Analysis

For the analysis of data, following statistical technique was employed.

### Gross Margin

Gross margin was chalked out for the purpose of making comparisons. The formula used to calculate the gross margins is as under:

$$GM = TR - VC \quad (1)$$

where

GM = Gross Margin

TR = Total Revenue

VC = Variable Cost

### Net Income

Net Income was computed as:

$$NI = TR - TC \quad (2)$$

where

NI = Net Income

TR = Total Revenue

TC = Total Cost

### Benefit-Cost Ratio (BCR)

In order to study the feasibility of basmati and hybrid rice crops, Benefit-Cost Ratio is calculated which should be normally greater than one for feasible projects. The formula of BCR is as under:

$$BCR = TR/TC \quad (3)$$

where

BCR = Benefit Cost Ratio

TR = Total Revenue

TC = Total Cost

## Results and Discussion

The detail of analysis performed on collected data and results has been described in this part.

### Socio-Economic Characteristics of Rice Farmers

Socio-economic characteristics of the farmers may be described under two types i.e. personal and farm level characteristics. Both these types help a researcher in understanding the level of adoption of technological package, production as well as crop management habits of the farmers.

### Personal Profile of the Farmers

The average age of the respondents was 48.39 years. Education level of farmers was generally low near to middle level education (average years of regular schooling were 7.79). Most of the studies in this area have similar findings on level of education (Sheikh et al, 2003). The average family size was 10.16 members which is much higher as compared to average family size of 6.9 members in Punjab (Census Report of Pakistan, 1998). The farmers of area were quite experienced having more than 30 years average farming as well as experience in rice growing.

### Farm Level Characteristics

When asked about the status of land ownership, they reported average own-land ownership of 10.62 acres and average operational holding of 12 acres. Average annual land rent was nearly Rs.25000 per acre. Regarding traction (power) source, approximately 74 percent farmers owned tractor and remaining 26 percent were using hired tractor. Tube-well water was major source of irrigation in the study area as canal water comes off and on. In case of source for hybrid rice, almost all the farmers purchased seed from the market. In case of basmati rice, among three reported sources i.e. market, home-kept and rice mill, nearly 80 percent growers purchased seed from the market and 18 percent used home-kept seed whereas least number of farmers purchased seed from rice mill.

### Queries Regarding Impact of Hybrid Rice on the Rice Economy

#### Information Source about Hybrid Rice

It came to notice that seed and pesticide selling companies had little share in dissemination of information about hybrid rice. Main source of information about introduction of hybrid rice technology was the fellow farmer as nearly 60 percent respondents reported it. Ward and Pede (2013) found similar results that neighborhood effects are among significant determinants of hybrid rice technology in Bangladesh. Study results reflected that small farmers usually acquired information from fellow farmers. Sheikh et al (2003) also reported somewhat similar findings wherein fellow farmers played major role in dissemination of information about new varieties. Second source of information was seed dealers and again this was a major source of information for small farmers as more than 28 percent small farmers reported it.

#### First Time Adoption of Hybrid (Year)

Although farmers heard about hybrid in the year 2007 but started growing hybrid for the first time during the year 2009 when medium farmers took major initiative as compared to

other farmer categories. Socio-economic profile of the farmers as given in table 1 above, shows that education of medium level farmers was comparatively higher which may be the possible reason here that medium farmers were first adopter of hybrid rice. A household head's level of education has positive and significant effects on the household's probability and intensity of adopting hybrid seed (Lin, 1990). All the farmers were growing hybrid up to the year 2011. During the year 2011, small farmers were in majority (44.90 percent) who were practicing hybrid rice on their farms as compared to fellow medium and large farmers. Overall results imply that farmers were late adopters of hybrid rice (Table 1).

#### Impact on Production

Almost all the farmers (97.5 percent) reported that growing of hybrid rice left positive impacts on production whereas there was negligible number of small farmers (2.5 percent) who opposed this statement because yield and price of hybrid was not encouraging for them (Table 1)

#### Reasons for Planting of Hybrid Rice

It is believed that farmers will invest only on those practices in which they have visible benefits. Table 1 given below scientifically proves the above statement. It is evident from the analysis that majority of the farmers (70.0 percent) adopted hybrid rice because of less time of production and higher yield attached with hybrid rice. It is further clear from the 3 number of recorded reasons that higher weightage was attached to the higher yield potential of hybrid rice. It is surprising to note that 100 percent large farmers endorsed this finding/ reason behind planting of hybrid rice. Hybrid rice was found yielding the same trend towards output in the Karnataka, India (Chengappa et al, 2013).

#### Increase in Yield of Hybrid Rice

The study results shown in Table 1 indicate that there is much increase in the yield / acre for hybrid rice as compared to basmati rice and that increase in yield was seen from 35 % to 75 %. Majority (69.4 %) of small farmers achieved 51 to 60 % percentage increase in the yield of hybrid rice as compared to that of basmati. However, majority (60 percent) of large farmers reported higher percentage increase of beyond 60 % for hybrid rice (Table 1). Rice Exporters Association of Pakistan (REAP) has also observed higher yield in hybrid rice (around 80 maunds per acre) under the genetically modified technology in Pakistan. In some areas, Pakistani growers have achieved yield of hybrid rice as high as 110 to 120 maunds per acre (REAP-International the News, 2012).

#### The Replacement of Rice Varieties by Hybrid Rice

According to results in Table 1, on an average 78.8 percent farmers reported that hybrid rice is replacing coarse variety whereas 21.3 percent average farmers reported the replacement of basmati variety due to arrival of hybrid rice in study area. Majority of small farmers (83.70 percent) recorded that hybrid is replacing coarse rice. On the other hand, majority of large farmers (40 percent) said that hybrid is replacing basmati rice.

#### Difficulties in Sale of Hybrid Rice Yield

There was almost equal response regarding difficulty in sale of hybrid rice in the market. Majority of farmers (55 percent) including 100 percent large farmers reported no difficulty in sale of hybrid rice perhaps they had good rice output, transportation facility or strong market links. However, significant percentage (45 percent) including both the small and medium farmers reported problem in sale of hybrid produce (Table 1). Hybrid grain quality is a serious issue

in Pakistan but (Janaiah and Xie, 2010) found no such issue in India as latest generation of hybrid rice is coming at farms.

Table 1: Impact of Hybrid Rice on Rice Economy by Farm Size (Percent Farmers)					
Queries/ Responses	Small	Medium	Large	Overall	Sig.
<b>Information Source about Hybrid Rice</b>					
Friend	63.30	57.70	20.00	58.80	.000
Seed Shop	28.60	15.40	20.00	23.80	
Pesticide Shop	8.20	26.90	20.00	15.00	
Friends and Dealers	0.00	0.00	40.00	2.50	
<b>First Time Adoption of Hybrid</b>					
2009	22.40	26.90	20.00	23.80	.830
2010	32.70	42.30	40.00	36.30	
2011	44.90	30.80	40.00	40.00	
<b>Impact on Production</b>					
Positive	95.90	100.00	100.00	97.50	.523
Negative	4.10	0.00	0.00	2.50	
Total	100.00	100.00	100.00	100.00	
<b>Reasons For Hybrid Planting</b>					
High Yield	20.40	19.20	0.00	18.80	.124
Less Time Of Production & Higher Yield	73.50	57.70	100.00	70.00	
Less Attack Of Pests And Higher Is Yield	6.10	23.10	0.00	11.30	
<b>Percentage Increase in the Yield of Hybrid Rice</b>					
Increase up to 50 %	6.1	0.0	20.0	4.1	
Increase between 51- 60 %	69.4	65.4	20.0	65.8	
Increase > 60 %	24.5	34.6	60.0	30.1	
<b>Replacement of Rice Variety Due To Hybrid Rice</b>					
Coarse	83.70	73.10	60.00	78.80	.323
Basmati	16.30	26.90	40.00	21.30	
<b>Difficulties in Sale of Hybrid Rice Production</b>					
Yes	51.0	42.3	0.0	45.0	.087
No difficulty	49.0	57.7	100.0	55.0	
<b>Nature of Problems Faced in Selling of Hybrid Rice</b>					
No problem at all	49.0	57.7	100.0	55.0	.486
Few commission agent	49.0	42.3	0	43.9	
Less market price	20.4	15.4	0	17.6	
Poor quality of hybrid rice	8.1	0	0	5.1	
Distant markets	0	3.8	0	1.3	
Source: Authors					

#### Nature of Problems Faced in Selling of Hybrid Rice

Table 1 reflects the nature of problems faced in sale of hybrid as well as the response of farmers given in percentage. Despite the fact that majority of farmers used to go to commission agent for sale of hybrid rice yield yet they were facing shortage of buying agent i.e. commission agent as 43.9 percent farmers reported it a major problem. Overall 17.6 percent farmers reported less price of hybrid rice output. It is apparent that among a mix of problems, shortage of commission agent is a common response from small and medium farmers which further reflects that farmers have to bear higher cost on account of transport due to distant hybrid rice markets and resultantly they are receiving lesser prices for their hybrid rice. One important finding is that no large farmer reported any problem in the sale of hybrid rice perhaps they have good

market links, produce good quality hybrid rice or have their own carriage facility.

#### Cost of Production of Basmati Rice

In case of basmati rice, large farmers were cultivating higher acreage, obtaining higher yield and resultantly higher price per maund per acre as compared to other basmati growing fellow farmers. It appears that there is almost direct relationship between respective acreage, yield and price of basmati with the increase in acreage (right from small to large farmers), there is accordingly increase in respective yield and price. Medium farmers were using higher seed rate in basmati rice for raising nursery.

The salient inter-farm size statistics in Table 2 shows that large farmers are reaping comparatively more benefits in basmati growing as compared to other farm categories. However, values of BCR show that basmati rice was still a profitable crop in the area despite huge production costs.

Costs	Small	Medium	Large	Overall
Area (Acres)	4.3	7.5	13.3	5.9
Seed Rate (Kg/Acre)	3	3.4	3.1	3.30
Costs involved on nursery raising (Rs)	2466.68	2734	3021.22	2610.06
Costs from land preparation to harvesting	22446.79	22494.65	21687.57	22375.44
Variable costs (Rs/Acre)	24913.47	25229.34	24708.79	24985.5
Total cost (Rs/Acre)	37117.55	38085.11	36308.79	37363.63
Yield (Maunds/Acre)	36.2	36.3	38.8	36.4
Output Price / Maund	1217.39	1248.08	1250	1229.9
Gross Income (Rs/Acre)	44069.52	45306.03	48500	44768.36
Gross Margin (Rs/Acre)	19156.04	20076.69	23791.21	19782.86
BCR (with land rent)	1.19	1.19	1.34	1.2
BCR (without land rent)	1.77	1.8	1.96	1.79

Source: Authors

#### Cost of Production of Hybrid Rice

It appears that there is almost direct relationship between respective acreage, yield and price of hybrid rice because with the increase in acreage (right from small to large farmers), there is accordingly increase in respective yield and price. Medium farmers were using higher seed rate in hybrid rice for raising nursery. In general, hybrid rice required higher seed rate per acre (5.06 Kg) as compared to basmati rice (3.3 Kg). Contrary to it, (Ward and Pedde, 2013) found that hybrid rice varieties require less seed rate than basmati varieties. One prominent reason behind this reverse situation was lack of knowledge about hybrid rice production as there was no support at Government level in Pakistan and resultantly farmers had to rely totally on local seed companies and fellow farmers for pieces of information. Actually, farmers had no previous knowledge regarding hybrid rice production technology/ practices.

The salient inter-farm size statistics in hybrid rice are summarized below in Table 3 which shows that the large

farmers were reaping higher benefits in hybrid rice as compared to other farm categories:

Costs	Small	Medium	Large	Overall
Area (Acres)	2.5	3.3	5	3.6
Seed Rate (Kg/Acre)	5.8	5.8	5.00	5.6
Costs involved on nursery raising (Rs)	6464.58	6824.63	5996.44	6540.41
Costs from land preparation to harvesting	2472 5.22	2537 2.22	23528.1	24834
Variable cost (Rs/Acre)	31189.8	3219 6.85	2952 4.54	3137 4.42
Total cost (Rs/Acre)	4339 3.88	4505 2.62	4112 4.54	4375 2.55
Yield (Maunds/Acre)	96.9	101.11	103.6	98.66
Output Price / Maund	789.3	808.7	800	796.25
Gross Income (Rs/Acre)	7645 0.63	8177 0.69	82880	7855 8.03
Gross Margin (Rs/Acre)	4526 0.83	4957 3.84	5335 5.46	4718 3.61
BCR (with land rent)	1.76	1.82	2.2	1.8
BCR (without land rent)	2.45	2.54	2.81	2.5

Source: Authors

#### Comparisons between Basmati and Hybrid Rice

It is evident from the Table 4 given below that comparatively all the cost items in hybrid rice cultivation are on higher side which means that hybrid rice production was relatively costly as compared to production of basmati rice. The shifting from conventional to hybrid rice indicates higher yield but higher production costs is another feature of hybrid rice in major rice producing provinces of Philippines (Bordey et al, 2004). Although production of poor quality hybrid rice which is comparatively inferior in aroma/ taste than basmati appeared one of the reasons behind lower price of hybrid output in the market but on the other hand, very higher per acre yield of hybrid rice was compensating lower sale price of hybrid rice resulting into higher values of gross income, gross margin and benefit cost ratio for hybrid rice. China, the innovator of hybrid rice also witnessed increase in yield of hybrid rice but got lower output prices in the market due to inferior grain quality of hybrid rice (Chengappa et al). Overall results reveal that hybrid rice cultivation has brought more economic benefits to the growers as compared to basmati cultivation.

#### Conclusion

The economic analysis revealed that producing an acre of hybrid rice crop is comparatively more profitable than basmati rice. Overall cost of production of one acre of basmati rice is less than hybrid rice because of low costs incurred on raising nursery, purchasing seed, pesticides, fertilizer etc. as compared to these relevant costs on hybrid crop. The main reason for profitability in hybrid rice is almost three times higher yield of hybrid crop than basmati crop. Resultantly, Benefit Cost Ratio (BCR) of hybrid rice is also more than BCR of basmati rice. However, the dis-adoption of hybrid rice is increasing in the area due to serious problem of marketing and lower price. Moreover, dis-liking of hybrid rice due to poor quality of grain and

Costs	Basmati Rice				Hybrid Rice			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Variable cost (Rs/Acre)	24913.5	25229.3	24708.8	24985.5	31189.8	32196.9	29524.5	31374.4
Total cost (Rs/Acre)	37117.6	38085.1	36308.8	37363.6	43393.9	45052.6	41124.5	43752.6
Gross Income (Rs/Acre)	44069.5	45306.0	48500.0	44768.4	76450.6	81770.7	82880.0	78558.0
Gross Margin (Rs/Acre)	19156.0	20076.7	23791.2	19782.9	45260.8	49573.8	53355.5	47183.6
BCR (with land rent)	1.2	1.2	1.3	1.2	1.8	1.8	2.0	1.8
BCR(without land rent)	1.8	1.8	2.0	1.8	2.5	2.5	2.8	2.5

Source: Authors

inferior taste in contrast to basmati is also hindering its wider spread in Pakistan.

#### Recommendations

In the light of study findings, following recommendations are proposed for successful cultivation of both basmati and hybrid rice in the rice zones. In view of increasing input prices particularly of seed, pesticides and fertilizers, incidence of risk in farming is increasing day by day. Dissemination of information about newer cultivars, adoption of improved technology well in time and better management practices can help in minimizing such risks with parallel increase in yield per acre.

- As a matter of policy, good quality seed at the right time and at affordable prices to increase spread of hybrid rice on larger scale is essential because poor quality seed of rice is seriously affecting rice economy which otherwise may decrease area under coarse and basmati rice.
- There is shortage of hybrid rice buyers in the study area and farmers have to incur heavy expenditures on account of transportation. Hybrid rice marketing problems may also be taken up at government level for ensuring the good price to hybrid rice growers by promoting hybrid rice exports as hybrid rice has huge potential for earning additional income.

#### References

- Bordey, F.H., J.M. Cabling, C.B. Casiwan, R.G. Manalili, A.B. Mataia and G.O. Redondo. (2004). Socioeconomic Evaluation of Hybrid Rice Production in the Philippines. Proceedings of the 4th International Crop Science Congress. Brisbane, Australia.
- Casiwan, C. B., A. Janaiah, S.R. Francisco, M. Hossain, J. Narciso, C. Ellaine and F.C. Hidalgo. (2003). Hybrid Rice Cultivation in the Philippines: Early Farm-Level Experiences. Economic and Political Weekly, 38: 2502-2508.
- Chengappa, P.G., A. Janaiah, and M.V.S. Gowda (2013). Profitability of Hybrid Rice Cultivation: Evidence from Karnataka. Economic and Political Weekly, 2531-2534.
- Duvick, D.N. 1999. Heterosis: Feeding People and Protecting Natural Resources. In: Genetics and Exploitation of Heterosis in Crops. American Society of Agronomy, Inc., Crop Science Society of America, Inc., Soil Science Society of America, Inc. Madison, Wisconsin, USA.
- Government of Pakistan (1998). Census Report, Population Census Organization, Statistics Division, Government of Pakistan, Islamabad.
- Janaiah, A., and Xie. F.(2010). Hybrid Rice Adoption in India: Farm Level Impacts and Challenges. IRRI Technical Bulletin No.14. Los Banos (Philippines): International Rice Research Institute. 20 p.
- Lin, J.Y. (1990). Education and Innovation Adoption in Agriculture: Evidence from Hybrid Rice in China. Working Paper # 603, Department of Economics, University of California, Los Angeles.
- Rice Exporters Association of Pakistan. 2012. News correspondent from Lahore published statement of REAP in International the News regarding cultivation/yield of hybrid and basmati rice on Wednesday, December 19, 2012.

Sheikh, A.D., M.A. Mahmood. and A. Bashir (2003). Socio-Economic Research Studies, Pakistan Agricultural Research Council, 2002-03.

Virmani, S.S., C.X. Mao, R.S. Toledo, M. Hossain and A. Janaiah. (2002). Hybrid Rice Seed Production Technology and its Impacts on Seed Industries & Rural Employment Opportunities in Asia, paper published in Food & Fertilizer Technology Centre, 5.F14 Wenchow St., Taipei 10616 Taiwan.

Vien, T.D. and N.T.D. Nga (2007). Economic Impact of Hybrid Rice in Vietnam: An Initial Assessment, Hanoi University of Agriculture, Vietnam.

Ward, P.S. and V. Pede (2013). Spatial Patterns of Technology Diffusion: The Case of Hybrid Rice in Bangladesh. Paper prepared for presentation at the Agricultural and Applied Economics Association. AAEA & CAES Joint Annual Meeting, Washington D.C.