Chapter VII

Benefits of Adopting Blast Management Technology

7.1 Profitability of adopting technology

This section attempts to describe and analyze the benefits accrued from growing blast resistant variety compared to the traditional or local varieties, since the farmers are increasingly adopting improved disease resistant varieties. However, the benefits of adopting blast management technology on local varieties is also covered in brief as majority of the farmers continue to grow local varieties, which becomes highly susceptible to blast in the events of favorable biophysical conditions.

Rice farming in Bhutan is of subsistence nature with hardly any commercial rice farmers, who sell their produce in bulk in the local markets (Renewable Natural Resources Research Centre-Bajothang, 2000). Given the nature of small family-oriented subsistence farming system of the study site, farmers are primarily concerned with assuring an adequate food supply for the family first and then sale of surplus to generate some cash income. The quantity sold in Thimphu and Paro districts was 2.3 and 2.7 percent of the total production, respectively (Ministry of Agriculture, 2002b). The secondary objective of earning cash income is often met by other farm enterprises such as apple, milch/ diary animals, mushroom, potato, vegetables and off-farm activities. The International Maize and Wheat Improvement Center (CIMMYT) (1988) states that whether farmers market little or most of their produce, they are interested in economic returns and that farmers will consider the cost of changing from one practice to another and the economic benefits resulting from that change. On the other hand, Gibbs (1997) does not fully agree to the above statement. Though, he agrees that, while some farmers want to maximize returns from their business, still there are others, who consider their lifestyle is more important than income.

The profitability of adopting blast resistant variety was computed from the gross margin analysis of both the resistant and local varieties and then compared between the two. Given the complexity of small mixed farming systems, Turner and Taylor (1998) have noted that for most farm businesses, it is impractical to do full accounting, although full cost accounting has many advantages. Their suggestion to overcome this problem is by ignoring costs, which are difficult to allocate (overhead costs) and then concentrating solely on the performance of the enterprises relating to output and variable costs. However, profitability of varieties is affected by the level of output, which is depended on yield and price, the input levels of variable and overhead costs associated with that enterprise.

Gross margin analysis is also used for the adopters and non-adopters of blast management practices on the local varieties.

7.1.1 Yield

The level of output of variety (yield) is the main factor determining the gross margin of rice farming enterprise, though the yield level is depended on many socio-economics and biophysical components of the systems, both within and outside its boundary. Table 48 shows that on average, the yield of local varieties was higher in Thimphu (1,331.8 kg/acre) than in Paro (1,197.8 kg/acre), while the yield of resistant variety in Paro (1,552.3 kg/acre) was higher than Thimphu (1,529.7 kg/acre). In general, the yield of resistant variety (1,544.5 kg/acre) significantly out yielded the local varieties (1,243.4 kg/acre) by 19.5 percent. This indicates that even in the low input paddy production system of the study area, the productivity of resistant variety is better than the local varieties. Therefore, higher yield of resistant variety compared to the local rice blast susceptible variety will culminate to higher profitability for the farmers. Moreover, in case of local varieties, there are more chances of partial or complete loss of output (yield) in the events of disease outbreak.

Table 48. Summary of the yield of local and resistant varieties

	Paro		Thimphu		Both districts	
	Local	Resistant	Local	Resistant	Local	Resistant
	---------------------------------- kg/acre----------------------------------					
Mean	1,197.8	1,552.3	1,331.8	1,529.7	1,242.4	1,544.5
SD	234.6	445.7	236.7	337.9	242.5	410.3
CV	0.2	0.3	0.2	0.2	0.2	0.3
Minimum	720.0	960.0	960.0	752.0	720.0	752.0
Maximum	1,800.0	2,571.4	1,860.0	2,360.0	1,860.0	2,571.4

Source: Survey, 2002.

The yield of farmers adopting at least one of the management practices on local varieties (1150.3 kg/acre) had higher yield than the non-adopters of management practices on local varieties (1284.5 kg/acre) with a significant difference of 10.4 percent, indicating the positive impact of technology on rice blast (Appendix 2).

7.1.2 Input use

The subsistence type of farming systems of Bhutan depend less on external inputs. Farmers rely more on natural resources than on purchased external inputs such as seeds, fertilizers and chemicals. It is also reported by Renewable Natural Resources Extension Support Project, (2002) that the current use of inorganic fertilizers and pesticides are limited, though the system for release of new varieties is well established.

Seed

All the farmers in the study area have kept their own local variety seeds, while the source of resistant variety seeds in the two study sites, greatly varied. 70 percent of the farmers in Paro used their own resistant variety seeds against 8.3 percent of the farmers in

Thimphu. Both, the District Agriculture Office (43.8 percent) and the Renewable Natural Resources Research Center, Yusipang (29.2 percent), significantly contributed in supplying resistant variety seeds to the farmers of Thimphu, while in Paro their contribution was only 10 and 5.6 percent, respectively. There was not much variation in other sources of resistant seeds in both the districts. The formal institution, the Druk Seed Corporation and the informal seed suppliers (neighbors) contributed 7.2 and 8.7 percent, respectively.

Table 49. Source of blast resistant seeds

District	HH growing resistant variety	Own	District Office	Druk Seed Corporation	Neighbor	Research Center
	Number	-----------------------		-%-		-----------------------
Paro	90	70.0	10.0	6.7	7.8	5.6
Thimphu	48	8.3	43.8	8.3	10.4	29.2
Total HH	138	48.6	21.7	7.2	8.7	13.8

Source: Survey, 2002.

The seed rate used by farmers for raising nursery varied due to uncertainty involved during the cold and dry winter season. Therefore, in both varieties, the average seed rate used by the farmers was higher (27.4 and 28 kg/acre for local and resistant varieties, respectively) than the recommended seed rate of 20-25 kg per acre. The seed rate ranged from 20 kilogram per acre to as high as 36.4 kilogram per acre, but there was no significant difference between these two varieties. Therefore, irrespective of the variety, seed rate used by the farmers was higher than the recommended rate due to uncertainty. This trend is likely to continue, unless an alternative technology, ensuring high survival rate of nursery seedlings is developed. The cost of local and resistant variety seed was Ngultrum 15 (US$ 0.3) and Ngultrum 18 (US$ 0.4) per kilogram, respectively.

Table 50. Seed rate of local and resistant varieties of sample households

	Local variety	Resistant variety
	---------------kg/acre---------------	
Mean	27.4	28.0
SD	3.8	3.6
Minimum	20.0	20.0
Maximum	36.4	36.0

Source: Survey, 2002.

Labor

Hossain and Pingali (1998) comment that with land, water, and labor becoming scarce, the potential source of yield growth is to close the "technical efficiency gap", either by achieving higher yields with same level of inputs or sustaining the present yield with reduced input levels. Most of the input use in paddy production is expended on human labor. A study on the economics of rice production done by Renewable Natural Resources Research Center-Bajothang, concluded that the rice production in Bhutan is labor intensive (Renewable Natural Resources Research Center-Bajothang, 2000; Department of Research and Development Services, 2001a).

Recognizing this situation as the priority area of agricultural development in general and rice production in particular, the Royal Government of Bhutan in its move against easing labor shortage, has highly subsidized the sell of farm machineries, equipment and tools. It is reported that not much has picked up, save for few farmers using paddy transplanter and harvester in Paro, Thimphu and Punakha-Wangdi valley. The low rate of adoption was attributed to low ratio between machine use and its high cost (Department of Research and Development Services, 2001a).

In spite of government's initiative to reduce the drudgery of farm labor, the study shows that the number of labor per acre was 68.6 and 70.3 for local and blast resistant varieties, respectively. The difference in labor use, however, was significant at 5 percent.

The difference of labor use between the adopters and non-adopters of technology on local varieties was insignificant, since labor requirement for adopting the technology was either minimal or took a part of family labor before or after their normal working hours.

Table 51. Summary of labor used for local and resistant varieties of the sample households

	Paro		Thimphu		Both districts	
	Local	Resistant	Local	Resistant	Local	Resistant
	---manday/acre---					
Mean	68.7	69.6	68.5	71.7	68.6	70.3
SD	5.4	6.2	6.3	6.3	5.7	6.3
CV	0.1	0.1	0.1	0.1	0.1	0.1
Minimum	53.8	57.9	56.9	60.0	53.8	57.9
Maximum	79.2	87.7	79.3	87.3	79.3	87.7

Source: Survey, 2002.

The respondents reported that the availability of labor had become acute over the years. The labor cost was computed from the existing government wage rate of Ngultrum 100 (US$ 2.1) per day, irrespective of the gender and an additional sum of Ngultrum 50 (US$ 1.1) per head for meals and drinks.

Manures and fertilizer

Farmyard manure and compost are by far the most important sources of plant nutrients in the traditional rice-based farming systems in the country. Chemical fertilizer use in

Bhutan is one of the lowest in Asia (4.3 kg per hectare of cultivated land), of which, 20-30 percent are applied on rice (Department of Research and Development Services, 2001a). It is reported that the rate of nutrient depletion is faster than replenishment and crop yields are declining with the intensification of cropping patterns combined with the use of modern varieties (Renewable Natural Resources Research Center-Bajothang, 1996).

Almost all the sample households applied farmyard manure as the main source of nutrient to paddy crop. 99 percent of the households applied FYM to local rice varieties (Table 52) and 94.9 percent of the households to blast resistant varieties (Table 53). The application of chemical fertilizers by the sample households on local variety was 50.5 percent (Table 52) and 71.7 percent for blast resistant varieties (Table 53). Many farmers tend to use less chemical fertilizers to local varieties and more to the improved blast resistant varieties because by their physiological nature, improved varieties require higher inputs. It is in concurrence with the recommendation made by the research and extension to farmers to apply more synthetic fertilizers to the improved varieties to get higher yield.

Table 52. Sample households applying farmyard manure (FYM) and chemical fertilizers to local varieties

District	HH growing local variety	FYM		Fertilizer	
		Do not apply	Apply	Do not apply	Apply
	Number	------------% of households------------			
Paro	66	1.5	98.5	50.0	50.0
Thimphu	39	1.0	100.0	33.3	51.3
Total HH	105	1.0	99.0	43.8	50.5

Source: Survey, 2002.

Table 53. Sample households applying farmyard manure (FYM) and chemical fertilizers to resistant varieties

District	HH growing resistant variety	FYM		Fertilizer	
		Do not apply	Apply	Do not apply	Apply
	Number	% of households			
Paro	90	3.3	96.7	16.7	83.3
Thimphu	48	8.3	91.7	50.0	50.0
Total HH	138	5.1	94.9	28.3	71.7

Source: Survey, 2002.

The quantity of farmyard manure (FYM) used in both the varieties varied between two locations of the study site (Table 54). Farmers of Paro applied almost equal quantities of farmyard manure (FYM) to both the varieties (1,423.8 and 1,438 kg/acre for local and resistant varieties, respectively), while the farmers of Thimphu had applied more to local varieties (3,121.3 kg/acre) than the resistant varieties (2,525.6 kg/acre). Synthetic fertilizer applied to local varieties in Thimphu (12.9 kg/acre) was less than Paro (21.8 kg/acre). However, synthetic fertilizer applied to resistant varieties was higher in both the districts compared with local varieties, but the quantities applied was more in Paro (32.9 kg per acre) than Thimphu (24.5 kg/acre). This may be the reason of lower yield of blast resistant variety in Thimphu compared with Paro. Conversely, the yield of local variety was higher in Thimphu than in Paro, possibly due low blast incidence in Thimphu.

It may be worth noting that farmers in both the districts can increase the quantity of synthetic fertilizer application to the improved blast resistant varieties to realize higher yield. However, it would be more economical to test the soil samples to determine the optimum quantity of fertilizer required to get higher rice yield, or farmers should be encouraged to take advantage of the farmer-extension fertilizer use trials (FEFUT).

Table 54. Summary of nutrient management of the sample households

	Local variety				Resistant variety			
	Paro		Thimphu		Paro		Thimphu	
	FYM	Fertilizer	FYM	Fertilizer	FYM	Fertilizer	FYM	Fertilizer
	------kg/acre------							
Mean	1,423.8	21.8	3,121.3	12.9	1,438.0	32.9	2,525.6	24.5
SD	1,131.5	23.7	1,279.2	18.0	1,161.6	35.0	1,899.3	33.7
CV	0.8	1.1	0.4	1.4	0.8	1.1	0.8	1.4
Minimum	0.0	0.0	900.0	0.0	0.0	0.0	0.0	0.0
Maximum	4,000.0	80.0	5,714.3	80.0	6,400.0	150.0	7,000.0	145.5

Source: Survey, 2002.

Among the adopters and non-adopters of technologies on local varieties, adopters used more farmyard manure (2130.5 kg/acre) and less urea (12.9 kg/acre) than the non-adopter, who applied less farmyard manure (1680.9 kg/acre) and more urea (20.8 kg/acre). The difference of farmyard manure and urea application by the adopters and non-adopters were significant at 10 percent and 5 percent, respectively (Appendix 2).

Weed control

With the farm labor becoming increasingly acute, farmers are facing difficulty coping up with the peak labor requirement for transplanting, weeding and harvesting. Even though, the herbicide, Butachlor 5G (trade name: Punch) is being used to control grasses and sedges, intensive hand weeding is necessary to weed out the most noxious perennial weed *shochum* (*Potamogeton distinctus*), which is not controlled by the common weedicides. It poses a serious problem in the wetlands of 1,200-2,500 meters above the mean sea level (high altitude). It is reported that a minimum of 3-4 weeding is required for the one cropping season to weed out *sochum* (Renewable Natural Resources Newsletter, 2000. Vol. XV Issue No. 78). Thus, the desperation of farmers from weeds is apparent from the fact that almost all the sample farmers (89.9 percent) were applying the most popular weedicide, Buachlor 5G to contain weeds in their paddy fields.

Table 55. Herbicide use by sample farmers to control weeds

District	Sample households	Not applied	Applied
	Number	---% of households---	
Paro	91	7.7	92.3
Thimphu	67	13.4	86.6
Total sample households	158	10.1	89.9

Source: Survey, 2002.

7.2 Comparison of cost and profitability of local and blast resistant varieties

The gross margin analysis was used to compare the profitability of using local and resistant varieties. The imputed costs for labor, seed and chemicals (fertilizers, pesticides, herbicides) were based on the price fixed by the government and applicable at farm level, all throughout Bhutan. The cost of farmyard manure was fixed at Ngultrum 0.85 (US$ 0.02) per kilogram, based on the economic analysis of FYM production, which was conducted by the Renewable Natural Resources Research Center-Bajothang (2001). The Commission Agents sold seeds; chemical fertilizers and herbicides, while the extension agents except in Thimphu handled chemical pesticides. However, the extension agents of Thimphu also procured chemicals for farmers on their request. The cost of output was same for both the local and resistant varieties at Ngultrum 22 (US$ 0.5) per kilogram of rice.

Table 56 shows that growing improved varieties having resistance to blast disease was more profitable in terms of gross margin, irrespective of the quantity of inputs used to produce paddy rice from one acre wetland production system in the study site. The gross margin of local and improved blast resistant varieties at Ngultrum 11,307.4 (US$

240.6) per acre and Ngultrum 17,659.4 (US$ 375.7) per acre, respectively, with the difference of 36 percent was highly significant. The cost of producing a kilogram of local (Ngultrum 13.3 or US$ 0.3 per kilogram) and improved blast resistant rice (Ngultrum 11.2 or US$ 0.2 per kilogram) was also highly significant at 1 percent. This indicates that producing resistant varieties needed Ngultrum 2.2 (US$ 0.05) per kilogram less than the local varieties, due to higher yield.

The maximum cost of production was expended on labor that made up 64.2 percent in local and 64.6 percent in resistant varieties and the rest was spent on materials that included all the inputs other than the labor, however, the labor use was significant at 5 percent. It should be noted that none of the sample farmers had bought the farmyard manure and the quantity used on local varieties was more than the improved varieties, but non-significant, while the other input use, especially urea was higher in improved blast resistant varieties and highly significant at 1 percent. In general, it could be stated that the expenditure on inputs in terms of cash was lower in local varieties because all the farmers used their own local seeds and farmyard manure, while synthetic fertilizers and, in some cases, seeds had to be procured for resistant varieties. However, the difference of the total variable cost incurred for local and blast resistant varieties was not significant. Therefore, the overall cost for production of local and blast resistant varieties did not vary much.

The returns to materials cost for local varieties (3) and resistant varieties (4.1) were significant at 1 percent, while returns to labor cost for the former (2.1) and the later (2.7) were significant at 5 percent. The significant mean differences in returns to material cost and labor cost between the local and resistant varieties clearly indicate higher returns to their investment on resistant variety due to higher yield advantages with increased amount of inputs.

Table 56. Summary of gross margin analysis of local and improved varieties

Item	Unit	Local	Resistant	Mean difference	Calculated t
Yield	kg/acre	1,242.4	1,544.5	302.0	6.5210***
Gross return	Nu./acre	27,333.8	33,978.0	6,644.2	6.5210***
Total variable cost	Nu./acre	16,026.4	16,318.6	292.2	1.3401*
Gross margin	Nu./acre	11,307.4	17,659.4	6,352.0	6.5009***
Cost of producing 1kg	Nu./kg	13.3	11.2	-2.2	-6.2724***
Material cost	Nu./acre	5,732.1	5,776.3	44.2	0.2536 [ns]
Labor cost	Nu./acre	10,294.3	10,542.2	248.0	2.0906**
Return to materials cost	times	3.0	4.1	1.1	6.2487***
Return to labor cost	times	2.1	2.7	0.6	5.9105***

Source: Survey, 2001.

*, **, ***, and ns indicate the significance of Student t-test at 10%, 5%, 1%, and non significant, respectively.

Nu: Ngultrum (US$1 = 47 Ngultrum in 2001, approximately).

7.3 Comparison of cost and profitability of using blast management technologies on local varieties

The gross margin analysis was also used to compare the profitability of those sample households adopting and not adopting and the blast management technology on local varieties.

The comparison of cost and profitability of using recommended blast management technologies was computed by taking into consideration the adoption of one of the technological options by the respondents on local varieties.

The ultimate objective of adoption of technology is to prevent yield loss, and reap the harvest either at higher or at their average yearly yield level. The advantage of adopting the blast management technology was displayed by the mean yield difference of 10.4 percent between the adopters (1,284.5 kg/acre) and non-adopters (1,150.3 kg/acre) of blast management technology, which was highly significant.

The gross margin that was used to gauge the profitability of adopting the blast management technology was higher for the adopters (Ngultrum 12,201.5 or US$ 259.6 per acre) than the non-adopters (Ngultrum 9,346.1 or US$ 198.9 per acre) with a highly significant difference of 23.4 percent.

Though the material cost and labor cost was not significant, demonstrating that there was no difference in the total variable cost incurred between the adopters and non-adopters of blast management technologies, the returns to material and labor costs between non-adopters and adopters were significant at 5 and 1 percent, respectively. This means that, it is worth investing on materials and labor to get higher benefits or profits.

Overall, Table 57 proves that the adopters had better benefits and higher returns than the non-adopters in all respects. Consequently, it can be concluded that the sample farmers adopting even one of the blast management technologies on local varieties recommended by the research and extension, accrue higher yields and higher returns than those not opting to adopt any of the technologies on the local varieties, which are known to be highly susceptible to the rice blast.

Table 57. Summary of gross margin analysis of adopting management technologies in local varieties

Item	Unit	Non adopter	Adopter	Mean difference	Calculated t
Yield	kg/acre	1,150.3	1,284.5	134.2	2.6288***
Gross return	Nu./acre	25,305.7	28,258.3	2,952.6	2.6288***
Total variable cost	Nu./acre	15,959.6	16,056.8	97.2	0.3030 ns
Gross margin	Nu./acre	9,346.1	12,201.5	2,855.4	2.5594***
Cost of producing 1kg	Nu./acre	14.4	12.9	-1.5	-2.7282***
Material cost	Nu./acre	5,516.9	5,830.2	313.3	1.1795 ns
Labor cost	Nu./acre	10,442.7	10,226.6	-216.1	-1.1730 ns
Return to materials cost	times	2.7	3.2	0.5	2.1447**
Return to labor cost	times	1.9	2.2	0.3	2.5818***

Source: Survey, 2002.