ECONOMICS OF BALANCED FERTILIZATION IN IRRIGATED RICE FARMS

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ABSTRACT

More than 100 half-hectare on-farm demonstration sites in the Philippines were planted in irrigated rice during the first and second cropping seasons of crop year 1997-98. A cost-and-return analysis was done for rice farms adopting balanced fertilization, and farms following conventional practices. A comparative analysis was done to determine the economic impact of balanced fertilization technology.

The analysis revealed that balanced fertilization was economically viable in each of the five identified fertilizer groups. This technology makes a positive contribution from the viewpoint of the farmers, the community and the economy as a whole.

INTRODUCTION

In 1997, the government of the Philippines began the balanced fertilization strategy (BFS). This is a three-year project which aims at providing location-specific fertilizer recommendations, in order to reduce the effects of variations in soil and climatic conditions in various rice producing regions of the Philippines.

Balanced fertilization refers to the optimum use of organic and inorganic fertilizers, at the proper grade and in the proper amounts to supply the correct ratio of plant nutrients, and to ensure that the soil will sustain high crop yields over long cropping periods. Balanced fertilization strategy is primarily designed to supplement limiting nutrients (Govit and Kaore 1997 in Concepcion *et al.* 1998). Deficiency of any nutrient will impair the crop uptake and utilization of any other nutrient (Balasubramanian 1996 in Concepcion *et al*. 1998). Balasubramanian futher stated that timely correction of deficiencies of all nutrients is vital to sustain high crop yields and that this can be solved by adopting balanced fertilization through integrated nutrient management, through the judicious and combined use of all nutrient sources. Oluf *et al.* 1996 in Concepcion *et al.* 1998, further advised that fertilizer use and management are not limited to having a balanced fertilizer nutrient ratio but likewise, the needs and removals of plant nutrients must be given due consideration. It must not be taken as application of only major soil nutrients but likewise micro-nutrients such as zinc and sulfur and other limiting essential nutrients, depending on soil nutrient status and crop requirements.

The various soils devoted to irrigated rice were classified into five soil fertilizer groups. Each of these fertilizer groups had an initial balanced fertilizer recommendation for rice, as prepared for the rice-growing areas of the Philippines (Concepcion 1997). The results from various demonstration sites during the initial two cropping seasons led to changes in these fertilizer recommendations. To date, there are now seven soil fertilizer group (Concepcion *et al.* 1998).

The BFS fertilizer recommendations promote the combined usage of both organic and inorganic fertilizers. Organic fertilizers include both commercial products, and locally available farm manure, compost etc. The BFS demonstration sites tend to utilize commercial organic fertilizers, because they are considered more practical (see BSWM 1997).

The BFS was initially implemented on more than 100 demonstration sites, each about 0.5 ha in size. For a more detailed discussion of these demon-

Keywords: balanced fertilization, strategy, BFS, economic impact, irrigated rice, Philippines, organic fertilizer

Table 1. Nationwide results of balanced fertilization strategy (BFS) in irrigated rice by yield category and by fertilizer group, 1st crop, 1997-98

Fertilizer group	Sites	No. of sites	Yield category (mt/ha, 14% moisture) High	Medium	Low	National average
1	Farmer's practice	23	5.47	5.50	4.26	5.00
	Demonstration sites		6.48	5.31	4.68	5.57
2	Farmer's practice		5.06	4.33	3.26	4.43
	Demonstration sites	70	6.29	5.22	4.51	5.51
3	Farmer's practice		4.52	4.80	3.67	4.31
	Demonstration sites	19	6.32	5.15	4.32	5.44
4	Farmer's practice		6.75	5.40	2.69	4.27
	Demonstration sites	12	7.10	5.44	4.55	5.27
5	Farmer's practice		5.35	5.19	3.83	5.07
	Demonstration sites	17	6.53	5.11	4.50	5.46
	No. of sites (%)	141	53	53	35	
			38	38	25	
	Farmer's practice		5.24	4.80	3.52	4.52
	Demonstration sites		6.42	5.23	4.52	5.39

Source: Bureau of Soils and Water Management

stration sites, see Concepcion *et al.* (1998). The promising results from these demonstrations led to the implementation of this technology on compact farms of 10 and then 20 hectares. From the agronomic standpoint, balanced fertilization was promising. Further evaluation was necessary to evaluate its economic impact. This economic evaluation is the basis of this paper.

THE DEMONSTRATION SITES

A total of 141 demonstration sites were planted in irrigated rice in the first cropping season of the crop year 1997-98, and 131 sites in the second cropping season. An economic survey was carried out, which covered both the demonstration sites and the adjacent farms representing farmers' current practices.

A cost and return analysis of the two groups (BFS and conventional) was done. A comparative analysis of these two groups in each of the five fertilizer groups was also carried out, to determine the economic impact of balanced fertilization. The economic contribution of this approach at the farm, community and national level was evaluated.

AGRONOMIC AND ECONOMIC IMPACT OF BFS

A. Farm Level

The agronomic results of irrigated rice production in five fertilizer groups were classified into three categories, namely: low, medium and high yield. The results are presented in Table 1 and Table 2. The average national data for each fertilizer group was used in this study, as the basis for economic evaluation of the impact of balanced fertilization.

The yield data in Table 3 shows that on average, the balanced fertilization strategy gave yields of at least 5 to 6 mt/ha on demonstration sites in each of the five fertilizer groups. This represents an additional yield of about 0.39 to 1.47 mt/ha, compared to conventional practices. On an annual basis, the new technology generated an extra yield ranging from 1.22 mt/ha in fertilizer group 5 to 2.47 mt/ha in fertilizer group 4. In value terms, it contributed US$231 (group 5) to US$487 (group 4) per hectare per year (Table 4).

Farmers adopting BFS required an additional investment ranging from about US$22 ha/year in fertilizer group 3 and US$189ha/year in group 4

Table 2. Nationwide results of balanced fertilization strategy (BFS) in irrigated rice by yield category and by fertilizer group, 2nd crop, 1997-98

Fertilizer Group	Sites	No. of sites	Yield category (mt/ha, 14% moisture) high	medium	low	National average
1	Farmer's practice	40	5.44	4.44	3.60	4.52
	Demonstration sites		6.16	5.20	4.18	5.28
2	Farmer's practice		5.44	4.66	3.01	4.18
	Demonstration sites	50	6.72	5.25	3.77	5.07
3	Farmer's practice		6.07	4.47	2.70	5.49
	Demonstration sites	16	6.71	5.30	3.90	6.09
4	Farmer's practice		4.57			4.57
	Demonstration sites	4	6.04			6.04
5	Farmer's practice		5.68	4.70	3.26	4.43
	Demonstration sites	21	6.75	5.20	3.94	5.26
	No. of sites (%)	131	56	29	46	
			43	22	35	
	Farmer's practice		5.76	4.55	3.22	4.51
	Demonstration sites		6.51	5.23	3.92	5.22

Source: Bureau of Soils and Water Management

Table 3. Comparative yield of irrigated rice production on demonstration and conventional farms by cropping season and by fertilizer group, 1997-98

Fertilizer Group	Sites	Average yield (mt/ha) 1st crop	2nd crop	Incremental yield (mt/ha) 1st crop	2nd crop	Annual
1	Farmer's practice	5.00	4.52			
	Demonstration sites	5.57	5.28	0.57	0.76	1.33
2	Farmer's practice	4.31	4.18			
	Demonstration sites	5.44	5.07	1.08	0.89	1.97
3	Farmer's practice		5.49			
	Demonstration sites	19	6.09	1.13	0.60	1.73
4	Farmer's practice	4.27	4.57			
	Demonstration sites	5.27	6.04	1.00	1.47	2.47
5	Farmer's practice	5.07	4.43			
	Demonstration sites	5.46	5.26	0.39	0.83	1.22

Table 4. Comparative gross crop income from irrigated rice production on BFS demonstration sites and conventional farms by cropping season and by fertilizer group, 1997-98

Fertilizer Group	Sites	Gross Crop Income (US$/ha)		Incremental income (US$/ha)		
		1st crop	2nd crop	1st crop	2nd crop	Annual
1	Farmer's practice	1,026	1,101			
	Demonstration sites	1,143	1,286	117	185	302
2	Farmer's practice	909	803			
	Demonstration sites	1,130	974	221	171	392
3	Farmer's practice	866	1,197			
	Demonstration sites	1,094	1,327	228	130	358
4	Farmer's practice	876	879			
	Demonstration sites	1,081	1,161	205	282	487
5	Farmer's practice	966	841			
	Demonstration sites	1,040	998	74	157	231

Table 5. Comparative production cost of irrigated rice production on BFS demonstration sites and conventional farms by cropping season and by fertilizer group, 1997-98

Fertilizer Group	Sites	Production cost (US$/ha)		Incremental cost (US$/ha)		
		1st crop	2nd crop	1st crop	2nd crop	Annual
1	Farmer's practice	403	586			
	Demonstration sites	426	592	23	6	29
2	Farmer's practice	535	404			
	Demonstration sites	582	448	47	44	91
3	Farmer's practice	503	567			
	Demonstration sites	499	593	(4)	26	22
4	Farmer's practice	306	341			
	Demonstration sites	409	427	103	86	189
5	Farmer's practice	440	311			
	Demonstration sites	472	376	32	65	97

Note: BFS: Balanced fertilization strategy

Table 6. Fertilizer usage on BFS and conventional farms by fertilizer group, first crop, 1997-98

Fertilizer Group	Fertilizer rate (kg/ha)					
	Farmers' practice			BFS demonstration sites		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	89.04	20.46	18.14	90	21	21
2	86.13	24.38	24.11	91	24	14
3	113.20	0	0	91	24	14
4	90.75	16.25	18.00	79.5	24	14
5	90.40	28.20	16.80	91	24	14
Average	93.90	17.86	15.41	88.50	23.40	15.40

Notes: BFS: Balanced fertilization strategy; Applied with 5 bags of commercial organic fertilizers.

(Table 5). In the case of fertilizer group 3, a lower investment was needed during the first cropping season.

Fertilizer usage on both BFS sites and conventional farms in the five fertilizer groups is summarized in Table 6. The equivalent cost of these fertilizers is presented in Table 7.

The additional capital requirements needed for BFS were recouped, since farmers realized an additional gain of US$135/ha in fertilizer group 5, and as much as US$335/ha in fertilizer group 3 (Table 8). In terms of net profits, the BFS farmers made substantial earnings from extra yields, despite the higher costs.

Translated into net cost-benefit ratio, BFS technology ranged from a break-even result in the case of fertilizer group 5, to an additional US$0.30 profit per dollar investment in fertilizer group 3. However, a net loss of US$0.03 per dollar investment in fertilizer group 4 was noted (Table 9).

B. The Community

Farming communities from the demonstration sites realized aggregate additional farm earnings of US$19,398, from the additional yield of about 118 mt of unpolished rice. The urban community benefited from the extra rice supply, which provided enough for a year consumption of about 746 persons.

C. The National Economy

The BFS demonstration sites covered a total area of 136 ha, which together contributed US$24,335 worth of rice. While the farming community retained the option to prepare their own organic fertilizer on their own farms, most farmers preferred to buy commercial organic fertilizers. The BFS technology led to additional sales of about US$1,039 worth of commercial organic fertilizers.

CONCLUSION

The BFS demonstration project proved to be economically viable on sites only 0.5 hectare in size. It provided substantial benefits from the standpoint of the farmer, the community and the economy as a whole. The total area of 136 ha of BFS demonstration sites provided an average additional rice supply of 0.87 mt/ha/season from each site, enough to meet the annual consumption needs of five persons. It increased profits by an average of US$179ha/season, 79% of which went to the farmers themselves.

On a per site basis, the BFS technology brought the greatest benefit to fertilizer group 4, in terms of the rice yield and its equivalent monetary value. However, there is a declining net benefit per dollar investment in fertilizer group 4. This need not be discouraging, if we look further into the initial

Table 7. Average production costs (US$/ha) of irrigated rice farming on BFS and conventional farms by cropping season and by fertilizer group, 1997-98

Items	1st crop		2nd crop	
	Farmers' practice	BFS demonstration	Farmers' practice	BFS demonstration
Fertilizer group 1				
Material inputs				
Planting material	26	26	15	15
Fertilizer	59	81	65	70
Farm chemicals	31	26	41	25
Labor	266	272	392	409
Other costs	21	21	73	73
Total	403	426	586	592
Fertilizer group 2				
Material inputs				
Planting material	31	31	25	26
Fertilizer	56	81	54	83
Farm chemicals	28	28	30	30
Labor	420	441	246	261
Other costs			49	48
Total	535	582	404	448
Fertilizer group 3				
Material inputs				
Planting material	31	26	21	21
Fertilizer	70	83	93	113
Farm chemicals	13	19	10	10
Labor	287	281	406	412
Other costs	102	89	38	38
Total	503	499	567	593
Fertilizer group 4				
Material inputs				
Planting material	15	15	15	15
Fertilizer	44	76	44	79
Farm chemicals	15	23	21	37
Labor	232	294	261	296
Other costs				
Total	306	409	341	427
Fertilizer group 5				
Material inputs				
Planting material	36	29	22	22
Fertilizer	59	87	47	93
Farm chemicals	40	37	29	32
Labor	249	263	197	217
Other costs	56	56	17	12
Total	440	472	311	376

Notes: 1US$ = 39 Philippine Pesos (Nov. 1998)
BFS = Balanced fertilization strategy

Table 8. Comparative net crop income from irrigated rice production on BFS and conventional farms by cropping season and by fertilizer group, 1997-98

Fertilizer Group	Sites	Net crop income (US$/ha)		Incremental gain (US$/ha)		
		1st crop	2nd crop	1st crop	2nd crop	Annual
1	Farmer's practice	623	514			
	Demonstration sites	716	694	93	180	273
2	Farmer's practice	373	398			
	Demonstration sites	549	526	176	128	304
3	Farmer's practice	364	629			
	Demonstration sites	594	734	230	105	335
4	Farmer's practice	569	538			
	Demonstration sites	672	734	103	196	299
5	Farmer's practice	526	529			
	Demonstration sites	568	622	42	93	135

Note: BFS: Balanced fertilization strategy

Table 9. Comparative net benefit cost ratio from irrigated rice production in BFS and control sites by cropping season and by fertilizer group, 1997-98 by cropping season and by fertilizer group, 1997-98

Fertilizer Group	Sites	Net benefit/cost ratio		Added benefit		
		1st crop	2nd crop	1st crop	2nd crop	Annual
1	Farmer's practice	1.55	0.88			
	Demonstration sites	1.68	1.17	0.13	0.30	0.24
2	Farmer's practice	0.70	0.99			
	Demonstration sites	0.94	1.17	0.24	0.19	0.23
3	Farmer's practice	0.72	1.11			
	Demonstration sites	1.19	1.24	0.47	0.13	0.30
4	Farmer's practice	1.86	1.58			
	Demonstration sites	1.64	1.72	-0.22	0.14	-0.03
5	Farmer's practice	1.20	1.70			
	Demonstration sites	1.20	1.65	0.01	-0.05	0.00

Note: BFS = Balanced fertilization strategy

Table 10. Organic matter content and yield on irrigated rice farms before and during the BFS project by cropping season and by fertilizer group in selected sites 1997-98

Fertilizer Group	Location	Item	Cropping season	Organic matter (%)	Yield (mt/ha)
2	Lag-on Daet, Camarines Sur	Before	BFS TD	3.27	4.90
		During BFS TD	DS 1997	3.90	6.10
			WS 1998	*	6.10
	Pob. Ilaya, Cuartero, Capiz	Before BFS TD		2.51	*
		During BFS TD	DS 1997	3.37	5.68
			DS 1998	**	*
	San Isidro, Sta. Fe Leyte	Before BFS TD		4.02	4.25
		During BFS TD	DS 1997	2.08	5.40
			WS 1998	**	*
	Mangidnid, Plaridel Misamis occidental	Before BFS TD		3.80	2.73
		During BFS TD	DS 1997	2.98	4.55
	Usocan, Plaridel Misamis occidental Tipolo, Plaridel Misamis occidental	Before BFS TD		2.43	3.20
		During BFS TD	Ds 1997	2.85	5.30
			WS 1998	**	7.30
	Banay-banay Davao oriental	Before BFS TD		1.50	5.90
		During BFS TD	WS 1997	2.13	5.60
			DS 1998	2.00	6.80
			WS 1998	**	*
	Sinayawan, Hagonoy, Davao Sur	Before BFS TD		1.43	5.90
		During BFS TD	WS 1997	2.68	6.80
			DS 1998	2.32	5.90
			WS 1998	**	6.60
3	Mangino, Gapan, Nueva Ecija	Before BFS TD	WS 1997	2.98	2.00
		During BFS TD	WS 1997	3.06	6.10
			WS 1998	3.34	5.50
5	Tawagan Norte, Labangon, Zamb. Sur Region 9	Before BFS TD	DS 1997	2.55	5.60
		During BFS TD	DS 1997	3.02	7.07
			WS 1998	**	7.55
	Aupagan, Butuan City	Before BFS TD	DS 1997	2.73	5.00
		During BFS TD	WS 1997	3.41	7.07
			DS 1998	3.40	7.20
			WS 1998	**	*

Notes: WS = Wet season (1st cropping)
DS = Dry season (2nd cropping)
* To be harvested.
** Analysis in progress

environmental results of the BFS technology. A comparison of the changes in the soil organic matter content before and during the BFS implementation in the first cropping season of 1997-98 showed considerable improvement in OM content in all the soil fertilizer groups (see Concepcion *et al.* 1998). Table 10 shows the increase of organic matter content over time in some sites.

Further evaluation of BFS on larger farms of 10 and 20 ha is needed, to determine the economies of scale in implementing this project. In addition, the environmental impact of the BFS technology requires further study.

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