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COMPARISON OF THE ECONOMIC PERFORMANCE OF CROPPING PATTERN TRIALS AND FARMERS' PATTERNS

Cropping systems researchers attempt to design and test experimental cropping patterns in a manner that leads eventually to the recommendation of new patterns having a good chance of adoption. At the testing stage realized performance of pattern trials on farmers' fields, under farmers' management with researcher supervision, is interpreted either for the purposes of recommendation or for redesign. Economic performance of cropping pattern trials has forward and backward linkages in the Design-Test-Introduce sequence.

As the research sequence is repeated each year at a given site, the mix of research effort gradually shifts from design and redesign activities to preproduction testing and introduction activities. Also the information mix used by researchers changes. If baseline surveys and other pre-design activities have been carried out, a large proportion of the information used at first concerns the performance of farmers' present cropping patterns, and the performance of pattern components elsewhere. The latter is derived from the literature and experience of researchers. Performance data on experimental patterns later becomes available and is heavily relied upon for redesign and making recommendation. Experimental patterns may be adopted by farmers, even before formal recommendation of the patterns, and this provides information on the post-adoption performance of new patterns under farmers' management.

The purpose of this note is to interpret information from cropping pattern trials and post-adoption performance of patterns in its backward linkage to re-design and its forward linkage to recommendations. Interpretation of post adoption data is beyond the scope of usual analyses of economic performance of cropping patterns in that the latter are usually conducted (or assumed to be conducted) before adoption. The problem seems relevant because unexpectedly substantial adoption of new patterns has taken place at Philippine sites within the first and second years of research. Farmers have copied new crops and techniques in pace with researchers' trials.

Furthermore, at least one national cropping systems program has included the most common farmers' patterns in their research design; that is, they have executed farmers patterns with farmers' management under researcher supervision. The "Cropping Pattern A," in field tests conducted by the Central Research Institute for Agriculture is the farmers' present pattern.

Recommendations from cropping pattern trials

To recommend a new cropping pattern researchers wish to be assured that the pattern will produce more than farmers' present patterns and that it will be accepted by farmers. Productivity is an easy test based

upon evidence in a cropping pattern trial. Acceptability is more difficult to ascertain, but a projection that new patterns will be more profitable than farmers' present patterns is considered a sufficient test of acceptability. Leaving aside the question of how to measure profitability, the projection of comparatively post-adoption profitability is usually based upon three items of information: (1) profitability of the cropping pattern trial, (2) profitability of farmers' present cropping patterns, and (3) expected changes in profitability brought about when the farmer manages the new pattern on his own, as compared to when he manages it under researcher supervision with input levels planned by researchers. Items (1) and (2) are respectively estimated from the trials and from farm records. If the new pattern has never actually been grown by farmers on their own, then item (3) must be estimated by looking at different patterns presently grown; or, assume a maximum possible rate of decline in profitability.

The latter course was chosen by the Working Group as a standard procedure. It is assumed that if the net profitability of a cropping pattern trial is 30 percent more profitable than farmers' present patterns, it will be accepted. Thirty percent of net profit is assumed to represent a maximum rate of decline in profitability when farmers adopt a pattern, pluw a margin sufficient to induce adoption.

In 1976-77, two experimental cropping patterns were tried on rainfed lowland with a shallow water table. The results are shown in tables 1 to 4, along with the performance of major patterns presently grown by farmers on this land type.

Farmers grew a combination of patterns, most commonly TPR (transplanted rice) followed by mungbeans. We can assume this is the best pattern to compare for the purposes of recommendation, partly because it is the most common pattern and partly because it is most similar to the rice-dryland crop combination in the experimental patterns. The researchers were trying to determine if an additional dryland crop could be grown before rice-mungbeans, or if mungbeans might be replaced by sorghum.

Rice-sorghum achieves a net return of 87% greater than farmers' rice-mung, and by established criteria it can be recommended for introduction to farmers. Green corn-rice-mungbeans performs more poorly, with a net profit below farmers rice mungbeans and therefore should not be recommended for introduction.

Other criteria for recommendation

Other criteria for recommendation have been suggested that may be considered as an alternative or supplement to the 30 percent rule.

Risk. Banta has suggested that the net profitability of an experimental pattern should be higher than the farmers' pattern expected to be replaced. But also, to account for risk, the net profitability must be sufficiently high to additionally pay the materials cost plus interest the previous year, in case of crop failure. In the case of rice-sorghum,

assuming 12% annual interest, its net profit should be 1766 pesos per hectare. This criteria is met. It is also met by the farmers' patterns, at least indicating no contradictory behavior by farmers.

Another treatment of risk is simply to repeat the trial additional years. After three years of trials, patterns can be recommended if they were profitable at least one year, but qualified by the percentage of years in three they met the 30% rule.

Returns to resources. In Iloilo, the rice-rice pattern trials have consistently shown both higher net returns and higher returns to labor and material costs. This never occurred in Pangasinan and may in fact be unusual. Incidentally, the rice-rice pattern is the one case in IRRI's experience of wide-scale early farmer adoption. Input levels on cropping pattern trials are typically higher than farmers' levels. If farmers are applying inputs precisely at the point where their marginal rates of return begin to decline, and researchers apply levels only slightly higher, it is feasible that average rates of return could be higher at the experimental level than at the farmers' level for similar technologies.

This condition is unusual, however. The Iloilo case likely results from more efficient technology. It is the general case that average rates of return at higher input levels will be lower. Therefore, it is not alarming that rates of return to resources on experimental patterns are lower than those of farmers' patterns.

Rates of return to resources should be regarded as a secondary criteria, after net returns criteria are met, to be interpreted with respect to farmers' resource availability and their values in alternative uses. The simpliest approach is to assume that farm labor and cash resources can be freely purchased and sold on village markets. In this case the secondary criteria requires that rates of return to resources should be higher than market rates. In Pangasinan labor can earn 1 peso per hour, and cash can be assumed to earn a maximum of 20 percent in a crop season. All farmers and experimental patterns meet these criteria.

If it is unreasonable to assume perfect markets for farm resources, researchers recommend patterns based upon their relative rates of return to labor and materials, compared to farmers' ralative resource availability. A farmer with large amounts of available labor compared to cash would theoretically prefer patterns offering relatively high rates of return to cash, and vise versa. However, this depends upon his alternative uses of cash and labor on the farm and their rates of return in those activities.

A more rigorous test for acceptable returns to resources would require an analysis of all farm activities using a technique such as linear programming. This approach is now being tried at IRRI with the objective of determining how effective are our simpler tests. It is being tried at the cropping pattern trials in Lampung, Indonesia as well.

Redesign based upon cropping pattern trials

Researchers may wish to redesign patterns that appear unprofitable in order to improve their economic performance. The same may be true of profitable patterns in order to better assure their acceptance. Improvement of pattern performance can be often accomplished by making adjustments in input applications. Redundant or low productive inputs may be evident from either relatively high absolute levels of input use compared to other experimental patterns and farmers' patterns on the same land class. Relatively low rates of returns to a resource may also indicate downward adjustments in the resource would improve performance.

Comparison of the performance of a pattern across land classes may reveal on what land class the pattern produces best and where input requirements are lower or greater. However, as the research objective is to find recommendable patterns for a given land class the information is best interpreted as an aide to improving a pattern's performance. For example, higher yields in a well-drained land class may indicate that performance can be improved by better tilth, or moving a crop to a drier period, on a less well drained class. Nonetheless, a pattern may be recommendable choice on a land class that is evidently suboptimum for its performance.

In the Manaoag pattern trials, green corn yielded well on the deep water table (Table 8), but failed on the shallow water table (Table 1). Field observations of water logging confirm the conclusion indicated by differential performance on the two land classes that green corn needs to be better drained when planted on a shallow water table. Redesign to plant green corn on ridges, earlier in the season, or not at all, are possible solutions.

Disaggregating labor data by operation is more helpful to this kind of analysis than the manner in which they have been presented here. Disaggregate data from these same trials indicate that labor time for each tillage operation for rice are much higher on the shallower water table. The economic performance of rice might be improved if fewer operations are performed, say by deleting a plowing.

Within land classes on both water table levels, labor and materials costs on experimental patterns are far higher than on farmers' patterns. Material costs are 3 to 5 times higher and labor costs are anywhere from the same to twice as high as that on farmers' plots. Higher labor costs are partly accounted for by higher yields requiring more harvest labor, but the material costs may be redundant, or earning a low marginal return. Researchers should review levels of material inputs, with the objective of reducing them. Component technology trials should perhaps be conducted if the productivity of present levels is in doubt. (Fertilizer trials in Manaoag were in fact conducted in 1977-78 for this purpose and it was found that excessive levels were applied in 1976-77).

Use of post-adoption information

Farmers' adoption of experimental patterns places the trials in a different light. Acceptability would appear no longer to be a question. Redesign and testing might continue if it is felt that a greater margin of profitability might assure adoption in dissimilar environments where potential profit may be less than where the patterns were tried.

The adoption of new patterns also provides an opportunity to define more precisely the relationship between cropping pattern management and performance in trials, and management and performance when patterns are adopted by farmers. The tendency of farmers to apply fewer inputs and get lower yields than researchers has been mentioned. This phenomenon is central to the constraints studies conducted by the International Rice Agroeconomic Network.

It is not a matter of reason but of expediency that cropping systems researchers have not investigated the "why" of lower inputs and yields of new patterns under pure farmer management. Rather, the decline in performance of new patterns is regarded as an unavoidable feature of technology transfer, for which the 30% rule compensates when patterns are reviewed for possible recommendation.

The question remains, might recommendations be more sound, or might yields be further improved if study is undertaken of the factors that bring about performance declines when new cropping patterns are not supervised by researchers.

The Manaoag data indicate that net returns of the rice-mung pattern are 4.6 times greater on trials than on farmers' fields, material costs are 4.8 times higher, and labor costs are double. Higher fertilizer, insecticide, and herbicide costs all contribute to the higher costs.

I am likely incorrect to conclude that, upon adoption the performance of new patterns always changes in the manner seen above. In Iloilo, it appears that on average, farmers reduce labor by half, leaving cash inputs nearly the same, and up with 2/3 the yield of pattern trials. Without considering "why" the changes occur in performance, considerable work is needed to better predict and measure them.

As a final note at least in the case of the 1976-77 Pangasinan trials, it appears that there may be greater scope for increasing production through higher input levels in the deep water table areas. In figure 1 total returns are plotted against total costs, for all farmers' and experimental patterns. The experimental patterns in deep water table areas generally reflect a technology that provides higher levels of production, at higher levels of costs, but not much less efficiently than farmers' patterns at low input-output levels. The results imply that yet higher levels of inputs might be applied with profitable results. Higher levels of inputs with the kinds of technology being used in the shallow water table areas would not appear to be profitable.

Issues for comparable cropping systems network studies

A number of points have been made in this note, not too conclusively, about the objectives, methods and assumptions of analysis of cropping pattern trials. Comparable, network wide comparisons of the performance of cropping patterns might be undertaken for the following purposes:

1. To validate criteria used for pattern recommendation

2. To further develop and demonstrate the use of pattern trial information for redesign activities

3. To provide researchers with greater knowledge of the ranges and tendencies of key measures of pattern performance

4. To better identify the relationship between cropping pattern trial and post-adoption performance.

Table 1. Performance of existing and experimental rice cropping patterns shallow water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Class[a]	Cropping Pattern Crop[b] 1	2	3	Observations (no.)	Crop yield (t/ha) 1	2	3	Rice Equivalent yield[c] (t/ha)
1 - F	TPR	-	-	6	1.16	-	-	1.16
2 - F	TPR	TPR	-	17	2.28	1.63	-	3.91
3 - F	TPR	Mung	-	24	1.82	0.27	-	2.90
4 - F	TPR	Tomato	-	10	2.31	3.77	-	6.08
3 - BF	TPR	Mung	-	8	2.84	0.31	-	4.08
5 - E	WSR	Sorghum	-	3	3.89	1.22	-	5.11
6 - E	GC	TPR	Mung	4	0	3.75	0.33	5.07

[a] A different numbers are assigned to different crop combinations. Also, "F" denotes farmers present patterns observed through farm record-keeping; BF denotes the best 1/3 of the "F" observations in terms of net income, and E denotes experimental patterns managed by farmers on their fields under researcher supervision.

[b] TPR - transplanted rice, WSR - wet seeded rice, GC - green corn.

[c] Based on the following price weights: rice, 1.0; green corn, 0.2; mung, 4.0; tomato, 1.0; sorghum, 1.0.

Table 2. Material inputs used in existing and experimental rice cropping patterns, shallow water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Cropping pattern class	Cash cost for material input (₱/ha), by crop														
	Seed			Fertilizer			Insecticide			Herbicide			Others[a]		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1 - F	171	-	-	68	-	-	6	-	-	-	-	-	-	-	-
2 - F	117	104	-	140	147	-	27	24	-	-	3	-	-	-	-
3 - F	114	175	-	145	-	-	16	23	-	2	-	-	-	-	-
4 - F	125	-	-	199	42	-	11	37	-	-	-	-	-	-	-
3 - BF	146	170	-	138	-	-	31	30	-	5	-	-	-	-	-
5 - E	102	17	-	520	455	-	152	98	-	112	119	-	-	-	-
6 - E	23	66	130	556	452	339	-	229	271	-	122	188	-	21	-

[a] Soil treatments e.g. Zinc sulfate and Iron oxide.

Table 3. Labor and total variable costs of existing and experimental rice cropping patterns, shallow water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Cropping pattern class	Labor costs by crop				Materials costs by crop			
	1	2	3	All	1	2	3	All
1 - F	771	-	-	771	245	-	-	245
2 - F	1047	842	-	1889	284	278	-	562
3 - F	942	319	-	1261	277	198	-	475
4 - F	1058	1606	-	2664	335	79	-	414
3 - BF	1361	399	-	1760	320	200	-	520
5 - E	1875	459	-	2334	886	689	-	1575
6 - E	178	1971	628	2777	579	890	928	2397

Table 4. Costs and returns of existing and experimental rice cropping patterns, shallow water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Cropping pattern class	Obser-vations (no.)	Gross returns	Labor costs	Total materials costs	Net returns	Return per man hours	Return/₱ materials cost	Crops per year
1 - F	6	1518	771	245	502	2.8	6.2	1
2 - F	17	5091	1889	562	2640	5.1	9.0	2
3 - F	24	3300	1261	475	1564	4.4	6.9	2
4 - F	10	5626	2664	415	2546	2.2	13.6	2
3 - BF	8	5335	1760	520	3055	5.7	10.3	2
5 - E	3	6834	2334	1576	2924	2.0	4.3	2
6 - E	4	6631	2778	2398	1455	1.3	2.8	3

Table 5. Performance of existing and experimental rice cropping patterns, deep water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Class	Cropping Pattern Crops 1	2	3	Observations (no.)	Crop yield (t/ha) 1	2	3	Rice equivalent yield (t/ha)
1 - F	TPR	-	-	6	1.89	-	-	1.89
2 - F	TPR	Mung	-	27	1.04	0.23	-	1.96
2 - BF	TPR	Mung	-	9	1.45	0.26	-	2.49
2 - E	TPR	Mung	-	10	3.37	0.68	-	6.09
4 - E	GC	TPR	Mung	3	13.4	3.59	0.33	7.59
5 - E	TPR	Sorghum	-	4	3.31	1.82	-	5.13

Table 6. Materials inputs used in existing and experimental rice cropping pattern, deep water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Cropping pattern class	Cash Cost for Material Input (₱/ha), by crop														
	Seed			Fertilizer			Insecticide			Herbicide			Other		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1 - F	132	-	-	63	-	-	19	-	-	3	-	-	-	-	-
2 - F	114	147	-	114	-	-	9	49	-	1	-	-	-	-	-
2 - BF	120	150	-	111	-	-	11	57	-	-	-	-	-	-	-
2 - E	57	156	-	520	355	-	213	544	-	123	93	-	32	-	-
4 - E	30	55	118	733	486	473	79	139	233	-	136	268	-	31	-
5 - E	56	31	-	528	434	-	119	196	-	120	88	-	32	-	-

Table 7. Labor and total variable costs of existing and experimental rice cropping patterns, deep water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Cropping pattern class	Labor Costs by Crop				Materials Costs, By Crop			
	1	2	3	All	1	2	3	All
1 - F	1075	-	-	1075	217	-	-	217
2 - F	806	387	-	1193	238	196	-	434
2 - BF	1031	431	-	1462	242	207	-	449
2 - E	1618	863	-	2481	945	1148	-	2093
4 - E	555	1492	577	2624	842	847	1092	2781
5 - E	1704	594	-	2298	855	749	-	1604

Table 8. Costs and returns of existing and experimental rice cropping patterns, deep water table areas, Manaoag, Pangasinan, Philippines, 1976-77.

Cropping pattern class	Observation (no.)	Gross returns	Labor costs	Total materials costs	Net returns	Return per man hour	Return/₱ materials cost	Crops per year
1 - F	6	2459	1075	217	1167	3.0	17.3	1
2 - F	27	2321	1193	434	694	2.2	5.3	2
2 - BF	9	3363	1462	449	1452	2.8	7.5	2
2 - E	10	7768	2481	2093	3194	2.1	3.7	2
4 - E	3	8501	2624	2781	3099	2.0	3.1	3
5 - E	4	7017	2298	1604	3115	2.1	4.4	2