PROGRESS AND PROBLEMS IN ATTEMPTING CHANGES IN RICE VARIETIES AND RICE TECHNOLOGY AT THE FARM LEVEL IN TWO COUNTRIES OF WEST AFRICA*

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INTRODUCTION

Two West African countries, Sierra Leone and Nigeria, have initiated separate agricultural projects aimed at developing a field tested package of practices for improving rice production. A field-proven set of improved practices would form the basis for accelerated production campaigns. The International Institute of Tropical Agriculture (IITA) is assisting the Governments of Sierra Leone and Nigeria in establishing a systematic program of farm level testing of varieties and improved management practices in various rice ecosystems.

The Need for Accelerating Rice Production

Among the 13 countries of West Africa, Nigeria and Sierra Leone are among the top three in terms of total rice hectarage and total rice production (1). In 1973 Nigeria produced 514,000 tons from 284,900 hectares while Sierra Leone produced 487,000 tons from 354,000 hectares. Rice is grown by 85 percent of Sierra Leone farmers and it is the staple food of the country (2). In Nigeria rice ranks only ninth among food crops, and consumption is below that of several other staples; but production is below consumption and rice is imported (3).

In spite of these production statistics, the discrepancy between production and demand and the trends in the near future in the two countries warrant critical

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attention. In Sierra Leone, food production accelerates at 2.4 percent annually. However, the annual growth of demand for rice is much higher, being 3.68 percent annually. The Ministry of Development and Economic Planning suggested that to satisfy the increasing demand, the annual growth rate of rice production should be increased to 6.5 percent (4).

In Nigeria, the growth rates of demand and farm production for rice present a similar problem. The annual growth rate of food production accelerates at 2 percent while the demand accelerates at 6.4 percent. The Nigerian Federal Ministry of Agriculture and Natural Resources suggested that the annual growth rate of rice production should be increased to 11.5 percent in order to cope with the increasing demand (3).

Two Approaches to Accelerating Rice Production

The "All Sierra Leone Co-ordinated Agronomic Trials on Farmers' Fields" was begun in 1975 under the joint auspices of the IITA/FAO Sierra Leone Rice Project and Ministry of Agriculture and Natural Resources (MANR). The Rice Research Station at Rokupr serves as the headquarters for the Project. The objectives are to test the recommended varieties against the local varieties under two levels of management and to develop fertilizer recommendations for various ecosystems in which rice is grown. In 1976, an economic component was added to the Project to form the "All Sierra Leone Co-ordinated Agronomic Trials and Rice Farm Survey". The economic component is to compare the profitability of the traditional versus recommended methods of rice cultivation. The farm level testing in Sierra Leone in 1975 was conducted in four ecosystems: dryland, inland valley swamp, mangrove swamp, and boliland.

In Nigeria, the Federal Department of Agriculture has launched the National Accelerated Food Production Project (NAFPP) which aims to accelerate the production of rice and five other major food crops (maize, cassava, sorghum, millet, and wheat). The major activities cover testing of new practices at farm level, training agricultural officers and farmers, providing feedback and direction for new applied research needs, and helping in organization of farm support systems. Under the NAFPP's integrated approach, improved practices such as high yielding varieties, fertilizers, pesticides, credit and management will be made available to farmers at the appropriate time and place, when the accelerated production campaign begins in the middle of the 1975-1980 period (5).

The rice program of the NAFPP is testing improved varieties and improved management practices such as fertilizer application, plant-spacing or method-of-planting, and herbicide application, using the minikit and production kit approach on farmers' field. Three ecosystems are involved: dryland; non-irrigated seasonally flooded swamp (fadama or hydromorphic); and irrigated swamp conditions. These three ecosystems were selected because they have higher yield potential than the other two ecosystems -- floating rice and mangrove swamp rice -- and because there has already been considerable research work done on the first three ecosystems. Dryland rice in Nigeria and Sierra Leone is defined as grown under rainfed conditions on freely-drained soils; it is usually under shifting cultivation.

Review of Constraints to High Yield

The major constraints to high yield faced by the rice farmers in Sierra Leone and Nigeria can be summarized as follows:

1. Poor soils combined with non-usage of fertilizers or poor fertilizer management;
2. Poor weed management;
3. Poor water control and management under lowland conditions;
4. High labor input limiting all good crop husbandry;
5. Unavailability or delayed arrival of inputs such as, fertilizers, pesticides, and credit;
6. Inadequate land preparation in swamps;
7. Minor element toxicities and deficiencies;
8. Low plant population due to wide spacing, low seed rate, and scattered or random planting;
9. Diseases and insect pests;
10. Low yield potential of locally adapted varieties.

The Sierra Leone project and the rice program of the Nigerian NAFPP have been geared towards testing research findings on farmers' fields to determine how to overcome the varietal and managerial constraints listed above. Thus, these projects aim to develop a field-tested, economically viable package of practices for different ecosystems in which rice is grown. In Nigeria, the feasibility of introducing low cost farm implements for land preparation, seeding, weeding, pest control, and threshing is also under consideration with the assistance of the agricultural engineering section at IITA.

Unique Features of the Two Projects

Two important features distinguish the Sierra Leone and Nigeria approaches from the conventional approach to research and extension. These features are: (1) an effective feedback of information linking researchers, extension workers and farmers through farm-level testing of varieties or other practices,

and, (2) a crop-oriented training component for participating staff.

Using Sierra Leone's coordinated on-farm trials or Nigeria's NAFPP minikit and production kit approach, the testing of new research findings or the adoption of an improved practice is speeded up. In both cases, the trials are supposed to be closely supervised by extension agents from the Ministry of Agriculture and Natural Resources who have received intensive training on the improved methods of rice production. On-farm trials provide researchers with a direct view of the practicability or impracticability of their research, which is most useful as feedback to influence their further research.

In Nigeria, participating farmers are actively involved in testing and ultimately selecting improved practices, thus, hopefully, contributing to the rapid transfer of new technology.

The key difference between the programs of the two countries is that in Nigeria the on-farm work is both testing of a package and at the same time promotional for it. Whereas, in Sierra Leone, the on-farm testing is primarily research-oriented, with no organized promotional component. Thus, in Nigeria, packages are developed on experiment stations and taken directly into farm minikits and production kits in a two-step process. But in Sierra Leone there are three steps to the process, which are: (1) experiment station research; (2) on-farm research; and (3) promotion of on-farm tested research findings. There are advantages to both approaches, but where experiment stations do not represent the farm situation, the danger is that promotional attempts are made with packages which are not sufficiently superior at the farm level. This has happened for the case of "improved" dryland packages in Nigeria. Also in Sierra Leone the on-farm trials are revealing that no simple

package is good for most areas and that considerably more on-farm research testing is required. The finding that experiment-station dryland rice research recommendations are not readily usable at the farm level is a major positive contribution from the technology-transfer activities. Already this has resulted in re-examination of research needs and the development of new applied research activities geared to solving the problems limiting dryland rice farm yields (6, 7).

For irrigated and swamp rice, in Nigeria, however, the packages of practices are found superior by the farmer and are generating considerable farmer interest.

ACCOMPLISHMENTS DURING THE INITIAL PHASE

SIERRA LEONE

Under the "All Sierra Leone Co-ordinated Agronomic Trials" simple experiments were undertaken in 1975 with rice on farmers' holdings located in different agro-ecological conditions in the country in all the districts. It was the first exercise of its kind in the agricultural history of the country. There were four basic types of experiments conducted in 13 districts (8). These were:

(1) trials to study the relative performance of selected rice varieties in different agro-ecological regions under local and improved methods of cultivation,

(2) trials to study the response of rice to nitrogen,

(3) trials to study the response of rice to phosphorus and potassium at optimum level of nitrogen, and

(4) trials to study the response of rice to nitrogen, phosphorus and potassium in combination.

In general, usable results were much less than expected, because of the failure of the high level of logistic and supervision support required to manage numerous dispersed trials. However, great deal of information was gained on the problems of conducting on-farm trials in a West African country and on the discrepancies between on-farm experiments and experiment station experiments.

Dryland

Results from the dryland rice trials in Bonthe district showed that with improved practices all varieties yielded at least 100 percent more than under local practice (Table 1). The three recommended varieties, ROK 1, 2, and 3, averaged about 2500 kg/ha, while OS-6 and a local variety averaged about 1700 kg/ha under optimum management and fertilizers.

Table 1. Comparison of local and recommended practices on grain yield of five dryland rice varieties on farmers' fields in Bonthe District, Sierra Leone, 1975, wet season.

Practice and location number		Varieties						Percent change from local practice by location
		Rok 1	Rok 2	Rok 3	OS 6	Local	Mean	
1.	Local	1125	875	1375	875	875	1025	
	Recommended	2500	2000	2500	1750	1750	2100	+105
2.	Local	375	750	1125	375	600	645	
	Recommended	2500	2000	3000	1750	1750	2200	+267
3.	Local	1750	1500	1575	1250	750	1365	
	Recommended	3250	2500	3250	1750	2000	2550	+87
4.	Local	250	250	250	750	375	375	
	Recommended	2500	2500	2500	1375	1375	2050	+447
5.	Local	1750	875	1750	875	1375	1325	
	Recommended	3750	2500	2500	1750	2000	2500	+89
Mean								
	Local	1050	850	1215	825	750	938	
	Recommended	2900	2300	2750	1675	1775	2280	+143
Percent change from local practice with variety		+175	+171	+126	+103	+137		

Inland Valley Swamp

Results from the inland valley swamp trials conducted in Tonkolili District indicate that the increase in yield due to recommended practices is not as dramatic as under dryland conditions (Table 9). This indicates that the cultural practices being followed by the farmers are closer to recommended practice, except for the level of fertilizers. The local variety outyielded all but one (CP 4) of the recommended varieties under both local and recommended practice.

The overall performance of inland swamp rice is 1500 kg/ha under local practice and 2500 kg/ha under the improved practice. This indicates that with current cultural practices the rice yields in inland swamp could be increased by 60 percent with optimum fertilizer application.

Mangrove Swamp

In mangrove swamps in the Bonthe District, none of the recommended varieties outyielded the local variety under local practices (Table 3.) Except for ROK 4, which gave 34 percent increase in yield, the remaining varieties, including the local, did not yield better under the recommended practice. Other results in tidal swamps near Rokupr showed that CP 4 yielded higher by about 500 kg/ha under improved practice than under local practice but this varied with location in relation to proximity to the river mouth.

Table 2. Comparison of local and recommended practices on grain yield of five inland swamp rice varieties on farmers' fields in Tonkolili District, Sierra Leone, 1975, wet season.

Practice and location number		Varieties						Percent change from local practice by location
		Rok 5	Rok 6	Rok 7	CP 4	Local	Mean	
1.	Local	1053	1408	28	2375	2062	1525	
	Recommended	3525	1908	3026	2499	2687	2729	+79
2.	Local	1668	875	780	3000	1706	1606	
	Recommended	3062	1275	2703	3562	3246	2770	+73
3.	Local	1775	250	241	2562	1706	1307	
	Recommended	2163	441	995	3775	3246	2124	+63
4.	Local	1612	1750	993	2290	1846	1698	
	Recommended	1718	1940	1687	2525	2056	2185	+29
Mean								
	Local	1527	1071	686	2557	1830	1534	
	Recommended	2867	1391	2103	3090	2809	2452	+60
Percent change from local practice with variety		+88	+30	+207	+21	+54	+60	

Table 3. Comparison of local and recommended practices on grain yield of five mangrove swamp varieties on farmers' fields in Bonthe District, Sierra Leone, 1975, wet season.

Practice and location number		Varieties						Percent change from local practice by location
		Rok 4	SR 26	BD 2	CP 4	Local	Mean	
1.	Local	1500	2500	3250	750	2625	2125	
	Recommended	2850	1750	2625	750	1750	1945	-9
2.	Local	1875	2000	1250	1625	1375	1625	
	Recommended	2000	2500	2250	1875	1750	2075	+28
3.	Local	1625	1750	1625	2000	2000	1800	
	Recommended	2000	1750	2125	2125	2625	2125	+18
4.	Local	1125	1000	1375	1375	1625	1300	
	Recommended	1375	875	1500	1625	1250	1325	+2
Mean								
	Local	1521	1813	1875	1438	1906	1713	
	Recommended	2056	1719	2125	1594	1844	1868	+9
Percent change from local practice with variety		+34	-5	+13	+11	-3		

NIGERIA

The Nigerian NAFPP rice program has completed two years of planned activities which centered on:

(1) minikit and production kit trials which aimed to compare five new selections with a standard variety for minikits and to test the maximum yield of the selected minikit cultivar in production plots;

(2) training of field extension workers and farmers;

(3) helping researchers formulate new applied research projects;

(4) setting-up and guiding state steering committees;

(5) organizing national workshops, and

(6) engaging in limited foundation seed multiplication.

Minikits and production kits

In two years, 1974 and 1975, a total of 725 rice minikits and 45 production kits were planned in four of the former states, Western, Benue Plateau, Mid-Western and Kwara. The states achieved 63 to 98 percent of the target planned.

For upland rice, 14 cultivars were tested by farmers in 498 minikits in the former Western and Mid-Western States. Results indicate that the standard variety OS-6 remains the best dryland variety, although in some locations, FAROX 56/30 was slightly superior to OS-6 (Table 4). In 63 dryland minikits in the former Western State in 1974 TOs 2300 was slightly superior to OS-6 in some locations.

Six swamp varieties were tested in 1974 by farmers in 197 locations in the former Benue Plateau State. The results of irrigated and non-irrigated swamp rice minikits conducted in 105 sites in the former Benue-Plateau showed

that IR8, TOs 42, and TOs 78 yielded higher in most locations, than the standard SML 140/10. In the 1974-75 season under irrigated conditions only IR8 outyielded SML 140/10. However, the widespread use of IR8 was curtailed by its susceptibility to leaf blast, and for this reason, TOS 78 and TOS 42 were used in the 1975 production kits.

The first swamp rice production kit trials showed farmers the economic superiority of the improved package of practices. The average net profit obtained per hectare was ₦823.00 (US$1317) at Dep Irrigation Scheme and ₦1030.00 (US$1648) at Lonkat Irrigation Scheme.

The high yields which farmers can attain by growing rice on hydromorphic soils was clearly demonstrated during the 1974 NAFPP rice program where IR20 averaged 5870 kg/ha and SML 140/10 averaged 3259 kg/ha in 10 locations in the former Western State. The great potential for increasing rice production in Nigeria by bringing under cultivation large tracts of unutilized hydromorphic lands was highlighted recently (10).

Between 1972 and 1975, 14 production specialists completed a 6-month training course at IRRI or IITA under the NAFPP program. Most of these trained staff are holding key positions at the national and state NAFPP headquarters. A total of 254 junior and senior staff from seven former states have received five days of intensive training on improved methods of rice production, conducted in various states. In 1975 alone, more than 1400 rice farmers have been introduced to the accelerated rice program. Of the total, more than 400 farmers from four states attended farmers' training classes.

More than 310 scientists and extension leaders from state, national and international institutes and research agencies, three universities and state MANR and FDA field offices participated in reviewing NAFPP activities and

Table 4. Rice variety comparisons in 140 locations in Western and Mid-Western States upland minikit trials, 1975*

State/ Division	No. of Trials	Varieties								
		OS-6	FAROX 56/30	TOs 2583	TOs 4020	TOs 2578	TOs 2513	TOs 2327	TOs 4022	TOs 2300
WESTERN STATE										
Abeokuta	14	2545	2644	2213	2203	-	2144	-	-	1790
Akure	7	4536	4526	3176	3661	-	3808	-	-	3744
Ekiti	14	1672	2404	1671	1273	-	1606	-	-	1347
Ibadan	8	1296	1501	1369	1419	-	1066	-	-	916
Ijebu-Ode	3	2958	2564	2282	2436	-	2436	-		
Ilesha	15	2142	1875	1162	1124	-	1131	-	-	918
Ondo	1	2878	2404	1273	1347	-	1660	-	-	1671
Oshogbo	2	2398	2644	1214	1949	-	1218	-	-	1193
State Mean	(64)**	2341	3045	1834	1814	-	1825	-	-	1680
MID-WESTERN STATE										
Akoko-Edo	5	3292	3050	3192	2888	-	-	-	2784	-
Aniocha	7	3172	3069	2318	1568	-	-	-	1530	-
Benin-West	10	2260	2372	3192	1749	-	-	-	1682	-
Etsako	14	3320	3488	2774	2043	2660	-	2917	2565	-
Ika	8	3255	2790	2765	2256	-	-	-	2052	-
Ishan	15	2827	2437	1425	1663	2546	-	1634	1739	-
Isoko	6	1934	2167	-	1425	1520	-	1976	2138	-
Owan	6	4864	4557	4636	3354	4589	-	-	3515	-
Urhobo-East	5	3488	3720	-	-	2185	-	2185	2090	-
State Mean	(76)**	3157	3072	2900	2118	2700	-	2178	2233	-

* Yields on $50m^2$ calculated to kg/ha.

** Number in parenthesis refers to the total number of trials.

new research findings during the first and second NAFPP national workshops.

Constraints in the implementation during the initial phase

Attempts to conduct on-farm trials in Sierra Leone on a large scale have met with many difficulties. Training of personnel was and remains a major need. Many agricultural officers were trained in three different one-week courses, but training in greater depth is required. Since most extension officers are responsible for many projects, the follow-through to properly handle on-farm rice trials is often lacking. Transportation and operational funding difficulties remain critical. Organizational arrangements and fixing of responsibility between staff of different departments are difficult to work out in practice. The major constraints encountered were (1) inadequate supervision by the local officers, (2) lack of transport for field assistants and supervisors, (3) late provision of field supplies, (4) delayed payment of travel claims, limiting inspections, (5) inadequate initiative and hard work, for various basic causes, one of which was differing wage levels among districts (8).

Similar problems occurred in Nigeria and in addition, minikit site selection was sometimes faulty. Since minikits were largely farmer managed, some trials failed for lack of interest; others were lost due to faulty irrigation management; bird attack, termites or to other causes (9).

Much of the promotional activity was a loss, at least for dryland efforts, since practices being pushed were not sufficiently better for farmer acceptance.

DISCUSSION

What lessons can be learned from the problems and progress so far?

First, it appears that the rice ecosystems in West Africa are very complex and varied and that they are generally in a good balance with the total economic, social, cultural, biological and physical environment. Attempts to influence this balance towards higher yield in isolated context from the total system seems now, rather naive. A government or government officer may want more rice production but a farmer may want no more work and no more risk - both of which appear to go along with attempts to change rice production.

Second, practices which make only a little difference in yield, and this, not consistently, should not become part of a promotional operation. Changes which require only the adoption of new seed which yields higher without other change can become accepted most easily. To make changes in cultural practices, especially involving hard labor and complex organization of time and credit, great and consistent increases in profit would be needed.

Third, to develop packages of practices which could overcome the above points, considerable more on-farm testing and research will be needed, except for specific and limited situations.

Fourth, conducting on-farm testing and research that will pay-off is much more important and much more complex than conducting rather isolated research on experiment stations.

Fifth, even more important than the complexities of on-farm research is the need to develop the organizational, planning, budgetary, and political support and commitment required to do successful multilocation massive on-farm testing research and promotion for the peasant farmers.

Sixth, on-farm testing research should be developed, financed and controlled by a research organization and not be dependent upon multi-organizational agreements, committee meeting, budgets, logistic support etc.

Seventh, a clearer distinction is needed between research and testing and promotion.

Eighth, on-farm testing research is essential to good and useful research on experiment stations, in countries such as those in tropical Africa. This feedback from farm reality to researchers is probably the most valuable part of the on-farm testing and promotion conducted to date.

Ninth, if we consider that in Nigeria and Sierra Leone "improved varieties" are the recent dwarf varieties and "improved practices" are those which are imported from outside of Africa, then we should recognize that they have not been very successful in changing rice yields in either country to date. It should be clear that much more careful research and analysis of the local situation is needed before major changes will occur in West Africa.

Does all this mean that the attempts made are valueless? The answer is that these attempts have been extremely useful at many levels. If the lessons are learned well, much better research and development will occur on rice in Nigeria and Sierra Leone, and hopefully in other African countries, which will lead to better and more profitable rice farming and rice production.

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