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Impact of International Institute of Tropical Agriculture Banana (*Musa* sp.) Production Technologies on Small Holder Farmers in Southern Nigeria

[1]B.O. Faturoti, [2]A.R. Ajayi, [2]P. Baiyeri and [2]M.C. Madukwe
[1]SARO Agro Allied Limited, P.M.B. 1490, Okesha, Ilesha
[2]Department of Agricultural Extension, University of Nigeria, Nsukka, Nigeria

Abstract: *Musa* sp. hybrid based technologies developed by International Institute of Tropical Agriculture to reduce harmful effect of Black *Sigatoka* disease *Mycosphaerella fijiensis* and increase food production, farmer's welfare and promote enterprise development in *Musa* sp., were massively disseminated through the network of Agricultural Development Program in Southern Nigeria. Five farmers in each of the three states were randomly selected in year 2000 for delivery and evaluation of *Musa* hybrids and associated technology (sucker multiplication, agronomic and post harvest utilization techniques). As a result of farmer-to-farmer spread, the technologies was expected to have spread to other farmers in the project farmers' neighborhood within the six years period from initial dissemination; this study was designed to evaluate the social impact and income profile from the technologies on the primary farmers and others who received the technologies from them (secondary farmers). Data were collected with validated structured questionnaires and interview schedule from 165 farmers (15 primary farmers and 50 other randomly selected beneficiary secondary farmers from each of the three study states). Data analysis involved the use of frequency distribution, percentage, means and Chi-square statistics. Statistical significant socio-economic status increases, were recorded in eleven out of thirteen social impact variables evaluated and a positive relationship was established between awareness and utilization of new varieties the null hypotheses tested were rejected. Two major sources of income (suckers and fruits) were identified; sucker sales from 74 respondents who specialized on sucker production was ₦2, 158,220 in 2005-2006 while income realized from fruit sales rose from ₦24, 920 ha^{-1} in 2000 to ₦174, 263.20 in 2006. Total sales from *Musa* sp. fruits increased from ₦7, 002,754 in 2000 to ₦48, 967,952 in 2006. Moreover, land under *Musa* sp. production increased from 99 ha^{-1} in 2000 to 281 ha^{-1} in 2006. The study concluded that the project impacted positively in increased food, enterprise development and increased *Musa* sp. production in the study area.

Key words: *Musa* sp. hybrids, enterprise development, delivery and evaluation, innovations

INTRODUCTION

The objectives of the International Agricultural Research Centers (IARC) such as the International Institute of Tropical Agriculture (IITA) are to generate appropriate technologies for improving productivity, farmer's welfare and household food security (CGIAR, 1995). Food security is defined as access by all people at all times to enough food for active and healthy lives (FAO, 2002). There has been increasing need to assess the impact of agricultural research at farmers' level in Sub Saharan Africa where social concerns are higher and more pressing than anywhere else in the world to determine who benefits from technological change and in what specific ways (Derman and Whiteford, 1985; FAO, 1990; Demery *et al*., 1993). *Musa* sp. is among the most important staple food crops in the humid forest zone of West and Central Africa. The possibility of maintaining continuity of supply throughout the year makes *Musa* sp. a basic component of the farming system in many areas of Sub Saharan Africa (Obiefuna, 1991). Malnutrition rarely occurs in areas where *Musa* sp. is widely grown, since they are rich in many essential nutrients such as iron, zinc and beta-carotene; it can also be processed to substitute many staple crops such as yam (*Discorea* sp.) and cassava (*Manihot* sp.) (Thompson, 1995).

The outbreak of Black Sigatoka disease *Mycosphaerella fijiensis* (a *Musa* leaf spot disease) in the early 1980s threatened the livelihood and welfare of the millions of Sub Saharan Africa of which Nigeria is inclusive (Gauhl *et al*., 1993). The market price of the crop in Nigeria has gone up dramatically as a result of reduced production caused by the disease. Yield loss of 30-50.0%

Corresponding Author: B.O. Faturoti, SARO Agro Allied Limited, P.M.B. 1490, Okesha, Ilesha

was recorded in Nigeria and Cameroon making the disease a major threat to the farm economy in West and Central Africa (Jeger *et al*., 1995; Craenen, 1998). To counteract the serious threat posed by Black Sigatoka disease to *Musa* sp. production in Nigeria, the International Institute of Tropical Agriculture (IITA), in collaboration with other International Agricultural Research Centers (IARCs) embarked on the development of high yielding and disease resistant varieties that yielded 100% than the best landrace (Tenkouano *et al*., 2002). In the year 2000, IITA launched a large-scale delivery of improved plantain and banana hybrids to smallholder farmers in 11 states of Southern Nigeria (Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ogun Ondo Oyo and Rivers) in collaboration with numerous public and non-public extension bodies such as Agricultural Development Program in the states Shell Petroleum Development Company (SPDC) and National Agip Oil Company (NAOC). Apart from disseminating the hybrid planting materials, this study also disseminated improved agronomic practices such as, manuring, weed control, pruning, propping and sucker multiplication as well as post harvest processing, utilization and packaging of products like chips, flour, confectioneries beverages and alcohol. The project adopted farmer participatory and community based technology delivery approach (Coxhead and Buenavista, 2001). Fifteen thousand seedlings of the improved varieties were released into farming system in the Nigeria plantain-growing belt through the Agricultural Development Agencies in the 11 states from 2000-2003 (Lemchi, 2003). The 11 states were later zoned into three operating zones called Plantain Resource Training Centers (PRTC) for ease of coverage by the disseminating institutions with zonal headquarters at Abia, Edo and Ogun state covering the three Southern geo-political zones of Nigeria represented in the 11 states (South-east, South-south and South-west). These PRTC's have a high volume of innovations supply and back stopping from the disseminating institutions, therefore, the impact of these hybrids and associated technologies on the income profile and the social impact in these three resource centers need to be evaluated. Impact in this study is defined as change in status or situation of the respondents attributable to the programme over time. The study relied on social impact assessment as proposed by Campell (1990), Carley and Derow (1980) and Cernea (1991), in response to the limitations of the traditional economic analysis. Social impact analysis represents an effort to analyze the real or potential impact of technologies on specific groups of people. It was stated further by Campell (1990) that it requires analysis of changes that occur in the lives of people as a result of adopting innovations or new policy interventions. It helps to determine how far a technology has been successful in meeting social and economic objectives and how well such technologies satisfy the needs and aspirations of households or other larger social units in the target population.

An evaluation model called Targeting Outcomes of Programs (TOP) presented by Bennett and Rockwell (1995), as an integrated approach to planning and evaluation. TOP uses a single model to target outcomes, track the extent they are achieved and evaluate program performance towards achieving them. It measured impacts by collecting information on people reaction, changes in knowledge, attitude, behaviors and ultimately the social, economic and environmental condition, which are targets of the social impact approach used in this study.

This study therefore set out to assess the social impact of the IITA *Musa* based technologies in three Southern states of Nigeria.

Specifically, the study was designed to:

- Describe the personal characteristics of the small-holder farmers who were involved in the IITA banana and plantain improvement programme
- Determine the impact of the IITA banana and plantain improvement programme on the social status of the small-holder farmers
- Determine the relationship between awareness and utilization of banana and plantain hybrid technologies
- Determine the income profile of small-holder farmers who are involved in the IITA banana and plantain improvement technologies
- Determine the major constraints to the effective utilization of the IITA banana and plantain improvement programme

Hypothesis:

- There is no significant increase in respondents' status and income profile before and after the project
- There is no significant impact of the IITA *Musa* sp. hybrids based technologies on the respondents
- There is no significant relationship between awareness and utilization of *Musa* sp. hybrids among the respondents

MATERIALS AND METHODS

Dissemination of International Institute of Tropical Agriculture (IITA) *Musa* sp. hybrids, improved agronomic practices and post harvest processing and utilization in eleven states of Nigeria targeted the *Musa* sp. growing

belt of the country, which can be classified into South-West, South-South and South-East of Nigeria. The study was conducted in 2006 in three states of Nigeria (Namely, Abia, Edo and Ogun), which were selected because of their being Plantain Resource Training Center (PRTC) zonal headquarters established by IITA to facilitate easy delivery of *Musa* sp. hybrids technologies, this gave them an edge over other states in *Musa* sp. innovation development and dissemination. The villages selected in each state are Abia (Etiti-Ulo, Ubakala, Ndoro, Ihie-Ukwu, Nkata-Ibeku villages), Edo (Okada, Eyaen, Sabongida-ora, Irrua, Ivue villages) and Ogun (Odeda, Okerala, Igbogila, Iworo, Egbe).

Population and sampling procedure: The population of this study comprised two sets of *Musa* sp. hybrids farmers, that is, primary farmers (5 farmers from each of the 3 states) and secondary farmers (who established hybrid plot from suckers purchased or received from primary farmers). The project started with 5 *Musa* sp. producer farmers in each of 3 states of Abia, Edo and Ogun, each farmer represented a village. Each Agricultural Development Program in their respective states selected the farmers from the list of 25 *Musa* sp. producer they compiled. Three criteria which guided the final selection of farmers are:

- Availability of enough land resources for trial design
- Membership of a farmer group to allow for easier spread of disseminated technologies
- Strategically located site along areas frequently passed by people and other farmers

Field days and field of the farmers visits were regularly (twice a year) organized at each of the 5 farmers site on the project (15 in 3 states, therefore it was hypothesized that within a short period of time (2-3 years), a primary farmer would have spread or introduced the new *Musa* sp. technologies to 30-50 other interested farmers (otherwise called secondary farmers). This indicated that within 2-3 years of the existence of the 55 pilot farmers, 1650-2750 secondary farmers should have been established in the 11 project states.

To select secondary farmers, each primary farmer had an obligation to the project to record the quantity of suckers sold or given out and addresses of beneficiaries, from this record with primary farmer a list of 25 secondary farmers in each village were collated. From this list, 10 secondary farmers were selected from each village through simple random sampling by the researchers and enumerators from the Agricultural Development Program. Therefore, a total of 165 respondents (15 primary farmers and 150 secondary farmers) were included in the study (Table 1).

Table 1: Composition of population and sample

Type of farmers	Abia Pop	Sample	Edo pop	Ogun sample	Pop	Sample	Total sample
	----------(No.)----------						
Pilot farmer	25	5	25	5	25	5	15
Secondary farmer	150	50	150	50	150	50	150
Total	175	55	175	55	175	55	165

Source: Field survey (2006), Pop: Population

Instrument for data collection: Data were collected from the respondents through the use of structured questionnaire and Interview schedule. The instrument was divided into five sections according to the objectives of the study. Section one dealt with respondent's personal bio-data and socio-economic characteristics, section 2 recorded the respondent's social status before and after the project using recall technique and baseline data collected at project inception from the primary farmers. Questions in section 3 bothered on comparison of levels of awareness with actual practice or utilization while sections four and five ascertained the income profile from the technologies and major constraints to *Musa* technologies effective utilization, respectively.

Data analysis: Data collected were subjected to statistical analysis using the Special Package for Social Science Research (SPSS) version 10. Frequency distribution, percentage, mean statistic, t-test statistic and Chi-square statistic were used to validate the objectives of the study and test the hypothesis.

RESULTS AND DISCUSSION

Personal characteristics of the respondents: As shown in Table 2, the respondents' personal characteristics revealed that there were more respondents in the productive class as 77.9% respondents were between the ages of 31-60, while 22.1% were in the age bracket of 61-70 (retired or dependant age). There were more male respondents (83.1%) than females (16.9%), with predominantly single (66.9%) respondents. The household size revealed a relatively high frequency for people with household more than five. Household size of 5-10 people is 67.5%, while 1-4 people were 32.5%. There were more educated respondents 79.2% though majority had only primary and secondary education. These characteristics have implications on technology adoption and impact, as active, educated and large family size have been found to favor adoption (Lemchi *et al*., 2005; Faturoti *et al*., 2006).

Impact assessment variables: t-test statistics for comparison of mean revealed significant statistical difference in the means of 11 out of 13 impact related variables considered in the study. Eleven variables

Table 2: Personal characteristics of the respondents (n = 154)

Personal characteristics	Percentage	Mean
Age		
31-60	77.9	51
61-70	22.1	
Gender		
Male	83.1	
Female	16.9	
Marital status		
Married	33.1	
Single	66.9	
House hold size		
1-4	33.1	6.0
5-10	66.9	
Type of education		
No school	4.5	5.7
Primary	51.3	
Secondary	27.9	
Tertiary	16.2	

Source: Field survey (2006), n = 154

Table 3: Differences in mean of farmers socio economic factors before and after IITA plantain and banana based technologies

Variables	Mean before 2000	Mean 2006	t-value
No of dependants	5.00	7.00	7.518*
Children school fees	₦83, 239.72	₦175, 870.77	2.025
No. of wife	1	1	2.411
Feeding pattern	1.31	1.04	6.588*
Savings in bank (₦)	₦76, 242.42	₦3, 092,651.5	2.279*
Annual income (₦)	₦54, 322.03	₦74, 576.27	8.246*
Vehicles/motorcycle owned (No.)	0.00	1	8.020*
Loan funds (₦)	₦9,974.35	₦24, 632.48	3.087*
Total hectares	2.74	4.48	9.487*
No. of farmlands	2.09	2.22	3.584*
Area of land used for plantain (ha)	0.686	1.951	10.479*
Sucker market	1.89	1.50	9.418*
Average harvested bunch (No.)	195.00	696.00	9.900*

Source: Field survey (2006). *Significant ($p<0.05$); $1 = ₦ 120

with significant means are No. of dependants, family feeding pattern, savings in bank, estimated annual income, No. of vehicles/motorcycle, loan funds, total hectares, No. of farmlands, area of land used for plantain, sucker market and average bunch harvested, their means were significantly higher in 2006 (after project life) than before 2000 (before project life). These have implications for impact, as more dependants may be an indication of more expendable income and increased capacity to cater for more mouths. The general increase in variables measured suggests an improvement in the social and economic life of the respondents and increased resources (Jahnke *et al*., 1987) especially when the condition in 2000 was related as a ratio of 2006 (Bennett and Rockwell, 1995). Increase in variables such as savings in bank, estimated annual income, land area increase and average bunch harvested in 2006 over 2000 gave leading impact indices as more resources, funds and social welfare improvement in terms of job increase and disposable income are linked to the project. However, children school fees and number of wife were not statistically significant among the respondents in the period under review (Table 3).

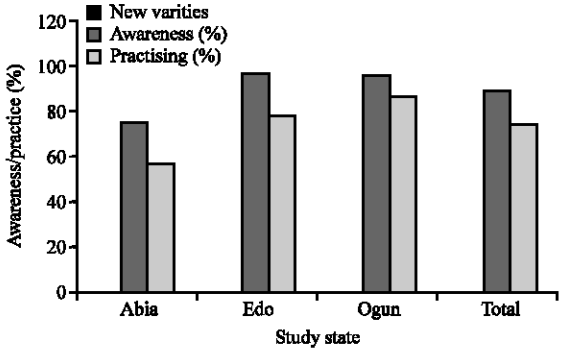

Fig. 1: Pattern of adoption of new varieties

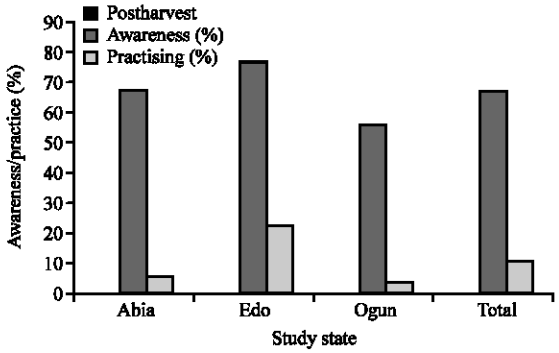

Fig. 2: Response to post harvest innovation

Relationship between awareness and utilization of plantain and banana hybrid technology: Chi-square analysis revealed positive significant relationship between awareness and utilization of some disseminated technology whose impacts are being measured in the 3 states of this study, though this relationship is inconsistent across variables and state. The two main technology disseminated (new varieties and post harvest) showed that the relationship between awareness and acceptance is evolving as there were differences but not significant enough to be reflected statistically, however post harvest innovation was revealed to be poorly utilized this is not unconnected with the generally low awareness of this technology. The constraints encountered in the utilization of disseminated technology also gave insight into the low ratio of utilization of post harvest technology to awareness (Table 4, Fig. 1, 2).

Constraints in technology utilization: A number of constraints were recorded as obstacles to practice of disseminated technologies, which explains the close gap between awareness and utilization of most of the technologies in the study. Four major constraints were identified as being common across respondent's class

Table 4: Statistical relationship between awareness and utilization of plantain and banana hybrid technology

Variables	Level of awareness (No.)	Level of utilization (No.)	Chi- square value
Planting time			
Abia	35	21	14.66*
Edo	52	41	9.29*
Ogun	28	28	-
Weeding			
Abia	40	36	18.46*
Edo	48	36	9.29*
Ogun	29	29	14.98
Pruning			
Abia	47	46	14.56*
Edo	48	31	5.77
Ogun	25	24	3.31
Mulching			
Abia	35	31	8.88*
Edo	40	29	8.86*
Ogun	27	27	11.89
Sucker cleaning			
Abia	14	12	27.09*
Edo	47	21	5.78*
Ogun	23	19	-
Hot water			
Abia	9	6	22.07*
Treatment			
Edo	22	8	4.78*
Ogun	22	14	6.72
Fertilizer/manure			
Abia	43	21	5.79
Edo	52	38	7.09
Ogun	22	17	8.93
Post harvest			
Abia	37	3	1.54
Edo	42	12	1.99
Ogun	13	1	1.12
New variety			
Abia	41	31	13.52*
Edo	53	43	0.58
Ogun	19	17	2.48
Debudding			
Abia	30	19	18.92*
Edo	35	20	17.96*
Ogun	11	1	0.485
Desuckering			
Abia	27	24	19.20*
Edo	47	28	9.71*
Ogun	22	18	0.29
Propping			
Abia	32	28	20.28*
Edo	34	23	24.42*
Ogun	10	9	8.36

*Significant at 0.05. Source: Field survey (2006)

and states. The constraints are capital (44%), labor (19%), skills (10%) and technology complexities (19%) while 8% respondents had all the constraints against technology practice (Fig. 3). In an earlier study, it was asserted that major constraints to technology adoption also served as the main motivation to adoption as drive to fulfil the constraints led to trial and eventual technology adoption (Faturoti *et al*., 2006).

Plantain and banana income profile: Data revealed two major source of income generation from the project in the

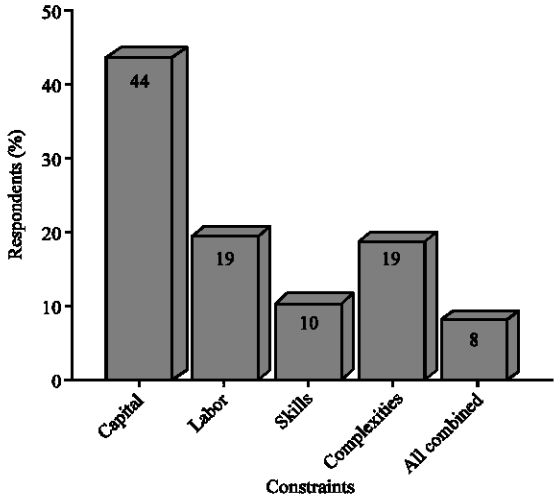

Fig. 3: Constraints to technology practice

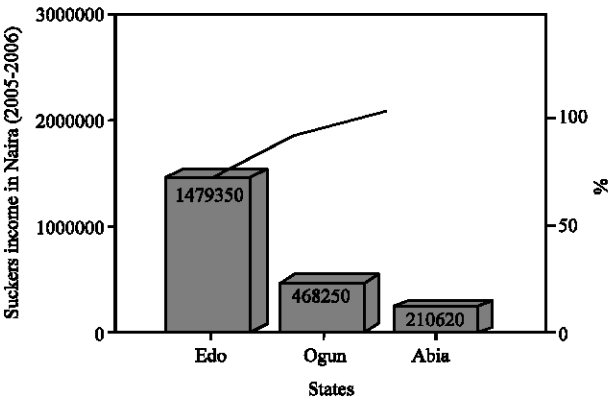

Fig. 4: Income profiles from sucker sales by respondents

study area. The two income sources are plantain and banana sucker sales and sales recorded from plantain bunch (fruit) sales. Clean planting material is central to profitable plantain and banana enterprise and assist in further dissemination of the disease resistant hybrids. The pilot project in 11 states disseminated 50,000 suckers free during the project period (2000-2003), whereas in 2005-2006 alone the respondents have sold 43,165 suckers at an average of ₦50; this translates to ₦2, 158,220 recorded from sucker sales. This is no doubt a major impact as sucker production has translated to an enterprise, thus engaging more people in agro-allied business in the community. Area under plantain and banana production in the study area increased from 99 ha in 2000 to 281 ha in 2006 (Fig. 6). Income realized from plantain bunch sales was ₦24, 920 ha^{-1} in 2000 that is a total of ₦7, 002,754. In 2006 income per hectare increased to ₦174, 263.20 ha^{-1} and a total of ₦48, 967,952, this showed about 700% increase in income profile over 6 years period (Fig. 4, 5).

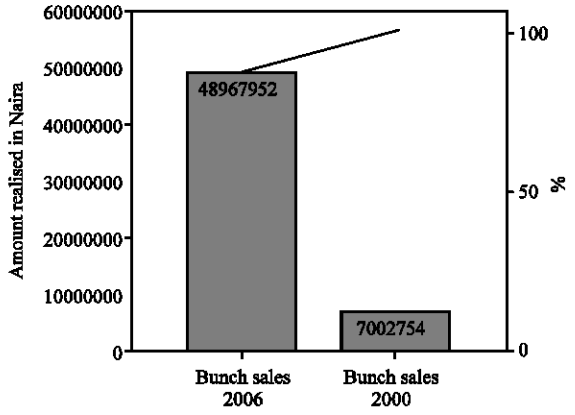

Fig. 5: Income profile from sales of plantain and banana bunch N = 119 (2000) and N = 130 (2006)

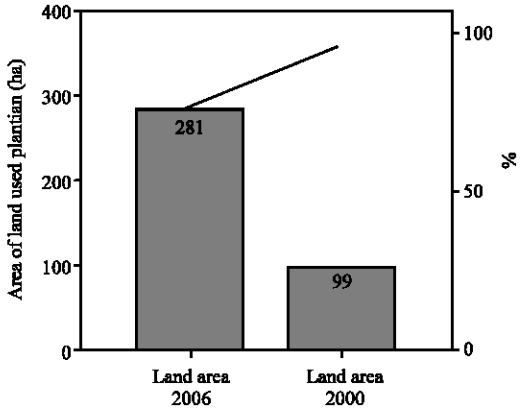

Fig. 6: Area of land used for plantain production 2000: before project, 2006: after project

CONCLUSIONS

Rapid social and economic growth linked to *Musa* sp. production, marketing, enterprise development and utilization were recorded in the study area. The general increase and or improvement recorded in the social indices evaluated, where eleven variables (no of dependants, family feeding pattern, savings in bank, estimated annual income, no of vehicles/motorcycle, loan funds, total hectares, no of farmlands, area of land used for plantain, sucker market and average bunch harvested) out of thirteen variables showed significant increase in 2006 over year 2000 attested to positive project impact.

A major impact of the project is increase in food supply as recorded through improved family feeding, development of enterprise for sucker production and the increase in land area used for plantain which led to increase in labor use and consequently reduced unemployment rate in the community. Land under plantain production rose from 99 ha in year 2000 to 281 ha in 2006; this increase was attributable to increased rewards from *Musa* production that led to commensurate income increase of nearly 700% in the 6 year periods. Income from fruit sales per hectare also increased from ₦24, 920 in year 2000 to ₦174, 263.20 in 2006. Sucker sales also increased income profile, in 2005-2006 alone; the sum of ₦ 2, 158,220 was realized from sales of suckers. The impact of this is not in the income profile alone but a boost to dissemination of disease free high yielding plantain and banana varieties that will further reduce disease spread, increase yield and sustainability. Hartmann (2004), emphasized that making choices that contributes to poverty alleviation along research for development continuum is a sure way to eliminating poverty. He stated further that, these choices should be brought together in an approach that focuses on local production, wealth creation and risk reduction as an instrument against hunger and poverty. Efforts should be made at counteracting the obstacles recorded against utilization to allow for more usage of the technology and better impact of the programme.

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