

## **TAKING WATER TO WETLANDS: AN EXPERIMENT WITH SMALL IRRIGATION FOR RESOURCE POOR FARMERS**

Theme Area: Management of Water Resources

Gabriel S. UMOH

Department of Agricultural Economics & Extension

University of Uyo, Uyo, Nigeria

[gsumoh@hotmail.com](mailto:gsumoh@hotmail.com)

+234(0) 803 356 4817

<http://www.gabrielumoh.com>

### **Abstract**

**Introduction:** In Africa, except for Madagascar, South Africa and a few countries in northern Africa, the potential for irrigation has not been effectively tapped (Technical Centre for Agricultural and Rural Cooperation, CTA, 2004). In Nigeria, agriculture remains a critical component of the economy. Over 70% of the population is engaged in agricultural activities. The country has one of the best agro-ecology to grow variety of crops (Oriola, 2009). It is endowed with an environment characterized by fair to good soils. In spite of these endowments, only 50% of the country's estimated 71.2 million hectares land is put to use due to water constraint (Aremu and Ogunwale, 1994). Most farmers practice rainfed agriculture which depends on water supply from rainfall. However, output per hectare has been reducing due to erratic rainfall distribution, among other factors. Thus, irrigation is an important requirement for increasing agricultural production and productivity in the country.

Nigerian agriculture is practiced on both upland and wetlands. Wetlands are areas of marsh fern, peatlands or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or flowing, maritime water, the depth of which at low tide does not exceed six meters (Ramser Convention on the Conservation of Wetlands of International Importance, 1971). It is classified broadly into three groups- inland valleys, river floodplains and mangrove swamps (International Institute for Tropical Agriculture, IITA, 1990). A total of 2,988,000 hectares of Nigerian land is wetland. This comprises 858,000 hectares of mangrove swamp and 2,130,000 hectares of fresh water swamps. A lot of rice, sugarcane and vegetables and recently, wheat and other high value crops are cultivated in the wetland.

Wetland farmers operate under extreme environmental conditions, particularly in the current climate variability and long term change. They experience droughts at certain years and flooding. In the northern part of the country, long periods of drought are common while the 3-4 months dry period is experienced in the south. Government realized the need for irrigation for wetland agriculture and attempted to provide this through a national wetland agriculture development projects- River Basin Development Authority (1973) and National Fadama Development Project I (1992-1995). These efforts have not been sustained due to skepticism about taking water to wetland, particularly in the southern region which is expected to receive rainfall in most parts of the year. The belief is that being a transition between dryland and water bodies, the wetland does not need irrigation. The focus of each of these projects has been changed from irrigation supply to flood control and poverty alleviation respectively.

**Methods/Materials:** The study which culminated in this paper was conducted in two phases. The first was the intervention phase which consisted of provision of small irrigation facilities and

other farm inputs including training to farmers in 6 locations (states) in the Niger Delta region under the European Union funded Micro-projects Programme in Six States of the Niger Delta (MPP6) in 2007. The intervention was designed to encourage resource poor farmers to improve small irrigation and to lay a credible and reliable foundation for exploiting the dry five months of idle time of small farmers to grow vegetables on the banks of ponds, rivers and small lakes that abound in the Niger Delta. The second phase consisted of the selection of two of the six project communities/locations for detailed study of the impacts of the intervention on farmers' crop output, income, productivity and welfare. The study was conducted in 2013 (5 years after) using Akai Effiwat community in Cross River State and Ata ObioAkpa community in AkwaIbom State, all in Nigeria. The data obtained from the second phase of the study were analyzed using simple descriptive statistics and ordinary least square methods of regression analysis. The welfare indicator used was monthly household food expenditure. The performance of project participant-farmers was compared with those of non-participants.

**Results and Discussion:** The result of the study show increase income to wetland farmers who irrigated their farms. Farmers earned up to 150% of income from sales of dry season vegetable produced from their irrigated fields. Productivity parameters indicate higher productivity of planting materials, fertilizer and labour among irrigators. They were found to be important determinants of crop outputs whereas only labour and fertilizer were determinants of crop production among non-participants. Average per caput monthly food expenditure was higher among participants/irrigators than non-participants.

**Conclusion:** The study shows that outputs from wetland agriculture can be enhanced through irrigation. Improved outputs, income and welfare of farmers arising from irrigation justify the need to take water (irrigation) to wetland, particularly the resource poor wetland farmers. However, the timing of water supply needs to match the dry season when residual water is insufficient. In addition, irrigation technologies need to be improved and made appropriate to wetlands environment to ensure sustainability

## Introduction:

In Africa, except for Madagascar, South Africa and a few countries in northern Africa, the potential for irrigation has not been effectively tapped (Technical Centre for Agricultural and Rural Cooperation, CTA, 2004). In Nigeria for instance, agriculture remains a critical component of the economy. Over 70% of the population is engaged in agricultural activities. The country has one of the best agro-ecology to grow variety of crops (Oriola, 2009). The dry northern savannah is suitable for sorghum, millet, maize, groundnut and cotton while the middle belt and the south are best for cassava, yam, plantain, maize and sorghum and cash crops such as oil palm cocoa and rubber. Low-lying seasonally flooded areas are increasingly producing rice. The main cash crops in the south are oil palm, cocoa and rubber. Notwithstanding these endowments, only 50% of the country's estimated 71.2 million hectares land is put to use due to water constraint (Aremu and Ogunwale, 1994). Most farmers practice rainfed agriculture which depends on water supply from rainfall. Output per hectare has been reducing due to erratic rainfall distribution, among other factors. Thus, irrigation is an important requirement for increasing agricultural production and productivity in the country.

Nigerian agriculture is practiced on both upland and wetlands. Wetlands are areas of marsh fern, peatlands or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or flowing, maritime water, the depth of which at low tide does not exceed six meters (Ramsar Convention on the Conservation of Wetlands of International Importance, 1971). It is classified broadly into three:- inland valleys, river floodplains and mangrove swamps (International Institute for Tropical Agriculture, IITA, 1990). A total of 2,988,000 hectares of Nigerian land is wetland (Table 1). This comprises 858,000 hectares of mangrove swamp and 2,130,000 hectares of fresh water swamps. A lot of rice, sugarcane and vegetables and recently, wheat and other high value crops are cultivated in the wetland.

**Table 1: Distribution and Extent of Wetland in Nigeria**

Coastal Saline Wetland(Mangrove)			Fresh Water Wetland ( Floodplain)		
Name	Extent (Hectare)	Percentage	Name	Extent (Hectare)	Percentage
Niger	617,000	71.91	Niger Delta	1,177,000	55.26
Cross River Estuary	95,000	11.07	Niger River	8150	0.38
Imo & Qua Iboe River Estuary	36,000	4.2	Benue	242,000	11.38
Others	110,000	12.8	Cross River	250,000	11.44
			Imo River	26,000	1.22
			Lake Chad	55,000	2.50
			Ogun/Osun	380,000	17.80
<b>Total</b>	<b>759,000</b>			<b>2,130,000</b>	<b>100.00</b>
<b>Total Wetlands Area = 2,889,000 hectares.</b>					

Source: Nigeria Environmental Study/Action Team (1991); Umoh, G. S. (2008)

Historically, Nigerian governments have been investing in the development of wetlands agriculture. The first of such efforts was in 1933 when the colonial administration established pilot swamp rice farms in some locations in the present Niger Delta region (WARDA, 1954). However, irrigation was not a component of this particular national effort. The first attempt to provide irrigation for wetland farming was in the River Basin Development Authority (RBDA)

established in 1973. The mandate of RBDA was to develop both surface and underground water resources for multi-purpose use; control floods and erosions and manage watersheds; develop irrigation schemes for the production of crops and livestock; construct and maintain dams, dykes, polders, wells, boreholes, irrigation and drainage systems; and provide water for reservoirs, wells and boreholes; among others. The River Basin Development Authority has passed through many changes both in number and focus. The initial number was 11 at commencement in 1973. The number was increased to 18 in 1984. In 1985, it was rechristened River Basin and Rural Development Authority (RBRDA). In order for its activities to reflect the new name, its functions were expanded to include improving the quality of life of the people. The number of RBRDA was further reduced to 9 in 1987. To date, assessments of the RBRDA have all pointed to its failure to achieve targets and set objectives. For, instance, Blench(1993) report that RBRDA and other large irrigation schemes have fallen well short of their projected targets due to lack of experience with formal irrigation technology, poorly planned and designed projects, lack of farmer involvement in their planning and design, and institutional and political constraints. Similarly, Iwukchukwu and Igbokwe cited in Agber, *et al* (2013) and Emeghara (2010) attributed the failure of RBRDA to inconsistent government policies, political interference, inappropriate technology and paucity of funds.

The second episode in irrigation development for wetlands agriculture was the National Fadama Development Project (NFDP) which was set up by the Federal government of Nigeria with funding and technical support of the World Bank in 1992. The project has been implemented in phases with the focus changing in every phase. Phase I called National Fadama I (NFDPI) was implemented in 5 States of Nigeria. NFDPI focus was on providing boreholes and pumps to crop farmers through simple credit arrangements aimed at boosting aggregate crop output. The facilities were extended to group of farmers called Fadama User Groups (FUGs). This first phase lasted from 1992 to 1995. The project was adjudged to be successful. The success of the NFDPI necessitated the continuation of the project as National Fadama Development Project II.

The second phase was implemented from 2005 to 2010 in 12 States. It focused on 5 components namely: (i) Rural infrastructure (ii) Pilot Productive Asset Acquisition Support (iii) Demand-responsive advisory services (iv) Capacity building and (v) Conflict Resolution. Instead of continuing with provision of irrigation and related facilities to wetland farmers, the thrust of NFDP II was on alleviating the ‘chronic state of poverty among beneficiaries in the 12 participating states, empower the communities through community-driven development (CDD) approach and thus lay the foundation for a private sector led economic development initiative in rural and urban areas of Nigeria’ (IFPRI, 2008). The third National development Project (NFPDIII) began in 2010 and is to last till 2015. It is implemented in the 36 States of Nigeria including the Federal capital Territory (Abuja). The Fadama III operation was designed to support the financing and implementation of 5 components designed to transfer financial and technical resources to the beneficiary groups in (i) institutional and social development; (ii) physical infrastructure for productive use; (iii) transfer and adoption of technology to expand productivity, improve value-added and conserve land quality; (iv) support extension and applied research ; and (v) provide matching grants to access assets for income –generation and livelihoods improvements.

It is obvious that the second and third phases of the National Fadama Development Project jettisoned irrigation which was the fulcrum of National Fadama I thus, leaving poor farmers’ need for irrigation, particularly for dry season farming unmet. Efforts aimed at providing irrigation have not been sustained largely due to skepticism about taking water to wetland. The belief is that being a transition between dryland and water bodies, the wetland does not need

irrigation. The skepticism is particularly strong about the southern region which is expected to receive rainfall in most parts of the year. The focus of each of the aforementioned wetland targeted irrigation projects had been changed from irrigation supply to poverty alleviation respectively. Investigation show that other irrigation facilities in the country are large-scale government owned scheme which are: (i) not targeted at the wetland farmers and, (ii) beyond the capacity of the small scale and resource poor farmers to management.

The skepticisms about the need for irrigation by wetland famers notwithstanding, studies revealed the need for irrigation in wetland including those in the southern part. For instance, it has been established that farmers who cultivate the wetlands in the southern operate between two extreme weather conditions in a given farming year. These are drought and flooding (Gwarry, 1995; Umoh, 2000). During the short dry season, the wetland soil could become so dry as leading wilting of crops due to extreme low moisture level in the soil. In such circumstances, farmers need irrigation to rescue the crops and remain in business. Farmers resort to hand watering using plastic containers, earthen wares or any container at their disposal. The tedium of carrying water manually during the dry season saps the energy of the poor farmers and further reduces their below-average output. Thus, the dry season is always an idle period for most farmers. The other extreme condition facing the wetland farmers is flooding in heavy rainy years. Extreme case of this was witnessed in 2012 nationwide flooding episode in Nigeria which affected mostly coastal communities.



Figure 1: Farmer hand-watering crops  
(Source: Umoh, et al, 2013)

As the world experiences climate variability and long-term climate change, the future will require that more water be allocated to food production. This will be for both the upland as well as the low land. Climate change may exacerbate or decrease current water stress for many developing tropical and sub-tropical countries including Nigeria. Therefore, agricultural water management to increase on-farm productivity is one step to adapt to increase uncertainty.

### **The Case Study: The Experiment with Irrigation in Niger Delta Wetlands:**

This experiment on small community-based, farmer-managed irrigation was a component of European Union Micro-Project Programme in Six States of the Niger Delta (EU-MPP6). The project was implemented in Nigeria from 2003 to 2008 and covered six states of the region (Abia, Akwa Ibom, Cross River, Edo, Ondo and Imo States).The decision to intervene in this sub sector of agriculture was informed by the fact that (i) farmers in the States traditionally grow crops during the rainy season when adequate surplus moisture is available; (ii) Vegetables are very scarce and costly during the dry season and (iii) the objective of alleviating poverty through the project could receive a major boost through adequate support for small irrigation dry season vegetable production. The small irrigation project in the area was therefore, designed to encourage resource poor farmers to improve on their traditional manual irrigation with the aim of laying a credible and reliable foundation for exploiting the dry five months of idle time of small farmers to grow vegetables on the banks of ponds, rivers and small lakes that abound in the region and other parts of Nigeria. The small irrigation project is one step above the “*jigo*” used in Northern Nigeria and the common bucket and various containers used primarily in Southern Nigeria to irrigate the farm. The objectives of the pilot small irrigation project were to (i) improve irrigation efficiency for existing farmers; (ii) improve yields and income of farmers and (iii) identify replicable model of intervention.

### **Design/Technology:**

The design of the small irrigation was aimed at making available to the resource poor farmers farmer-managed irrigation facility that is easy to establish and manage sustainably. Thus, the design of the small irrigation facilities as an intervention package was based on three important criteria viz: (i) availability of perennial water source and (ii) evidence of farming activities near the water body in the dry season and (iii) use of locally adaptable technology. The first and third criteria were informed sustainability considerations while the second was expected to make the project well fitted and suitable to the wetland environment.

The project consisted of three vital interrelated components – (i) provision of irrigation facilities (ii) provision of capital and operational inputs; (iii) capacity building.

**Irrigation Facilities:** Irrigation facilities provided included:

- (i) Engine pumps (Motorized pumps): Engine pumps with suction and discharge points. Two of these were provided per site;
- (ii) Stanchions: Not less than 4 stanchions were erected per site. The stanchions were erected to raise the reservoir (water storage tanks) to a level that would allow water flow by gravity.
- (iii) Reservoir tanks: A total of 4 no 1000 gallons plastic reservoir tanks were provided per project. These served as reservoirs for storing of water.
- (iv) Watering Hoses: 35m watering hoses with provision for extension also provided
- (v) Pressure Pipes: 7 no pressure pipes and risers

**Capital and operational inputs:** These included wheelbarrows and machetes, fertilizers – organic and inorganic, improved seeds, agro –chemicals and other sundry inputs.

**Training/Capacity Building:**

Training/capacity building was a major component of the small irrigation project. This was done through three principal actors namely a Technical Supervisor, a trainer and soil analyst. The work of the technical supervisor was to advice /guide farmers on inputs procurement, land preparation, pest control, fertilization and other cultural practices, irrigation and drainage and act as coordinator and focal point for the technical implementation of project. The trainer educated the farmers on organic composting, improved land preparation methods; efficient method of fertilizer application; nursery practices and improved soil management practices, irrigation and drainage. The soil analyst conducted soil test and recommended appropriate measures for managing the soil for optimum crop yield. The soil test and training on the technical aspects of the project was carried out prior to commencement of farming operations. This was to provide the farmers with the requisite knowledge and skills for more efficient farming activities.

The training of participants in the small irrigation projects was not restricted to only the technical aspects of water supply and crop production. In order to ensure sustainability of the project, Project Management Committee (PMC) was set up from among the farmers/participants. Members of the PMC were democratically selected among project participants and it cuts across gender and generation. The committee in the various projects was trained on group dynamics and leadership, fundraising, basic book keeping among others. It was considered that knowledge and skills acquired from the training will empower the groups to continue to sustain the project after the external agency supporting them (MPP6) has withdrawn.

The small irrigation facilities were located in six communities, one each in Six States of the Niger Delta (Abia, Akwa Ibom, Cross River, Edo, Imo and Ondo States) in 2007 as part of the European Union Micro projects Programme in Six States of the Niger Delta. The intervention

was designed to encourage resource poor farmers to improve small irrigation and to lay a credible and reliable foundation for exploiting the dry five months of idle time of small farmers to grow vegetables on the banks of ponds, rivers and small lakes that abound in the Niger Delta.

### **Water Management:**

Although the project aimed at making water available to the farmers for crop production at a time of lack (dry season), it is also important to discuss the approach employed by the farmers in managing this scarce resource. The sources of water for irrigating the field were perennial streams. Water was pumped from the streams to the reservoir tanks from where, through pipes laid from the tank stand to many locations in the farm, it was distributed via plastic hoses. Water was pumped into the reservoirs whenever the farmers noticed shortage of water. The field was irrigated twice a day in rotation. The farmers grouped themselves into 2; one group watered their crops in the morning and the other in the evening. The morning and evening irrigation regimes also correspond with the time the farmers attended to their crops in the field. Each participant contributed money for fueling and maintenance of the generating set and other accessories.

### **Impact Evaluation Study**

Five years after the establishment of small irrigation projects two of the six project communities/locations were selected for detailed study of the impacts of the intervention on farmers' crop output, income, productivity and welfare. The study was conducted in 2013 at Akai Effiwat community in Cross River State and Ata Obio Akpa community in Akwa Ibom State, all in Nigeria.

#### **Akai Effiwat Small Irrigation Project:**

Akai Effiwat is located in Odukpani Local Government Area of Cross River State. It is found along Uyo – Calabar Road, about 25 kilometers from Calabar. The project is on about 2.5 hectares of wetland on the flood plain of the Akai Effiwat river bank. The land is gently sloping and the soil is highly well aggregated and has moderately high available water capacity. Soil analysis shows that it has moderately high soil organic matter, low total Nitrogen, effective cation exchange capacity and moderately high saturation base. The land suffers from lingering over-flooding thus making the land uncultivable during the rains but can support profitable dry season vegetable production.

Akai Effiwat is a typical farming community inhabited by both aborigines and migrant population mainly from Akwa Ibom State. Both men and women, young and old, are deeply involved in all aspects of agriculture – crop cultivation, livestock rearing, agro processing and sales. Farmers depend on the major markets in neighbouring communities to dispose of agricultural commodities at reasonable prices.

There is abundant land for agricultural purpose in Odukpani Local Government Area and in Akai Effiwat community. This has attracted farmers from neighbouring states to this community. There co-exists a tradition of community as well as individual (private) land ownership in Akai Effiwat community. The land for the small irrigation project is owned by the community and distributed to participating farmers by the community leader. The land could be described as both sufficient and unencumbered.

The main crops cultivated by participants in Akai Effiwat project are fluted pumpkin, okra, cucumber, tomatoes, pepper, water leaf and green (*amaranthus spp*).

Akai Effiwat Small Irrigation Project in Cross River State is a typical fadama farm model. The key distinguishing feature of the *fadama* is that the land is seasonally flooded. The land suffers

from lingering over-flooding thus making the land uncultivable during the rains but can support profitable dry season vegetable production. The project is on about 2.5 hectares of wetland on the flood plain of the Akai Effiwat river bank. The land is gently sloping and the soil is highly well aggregated and has moderately high available water capacity. Soil analysis shows that it has moderately high soil organic matter, low total Nitrogen, effective cation exchange capacity and moderately high saturation base.

**Ata ObioAkpa Small Irrigation Project:**

The project is located about 2.5 hectare fringes (lower slope position) of the floodplain of the Obio Akpa River along Abak – Ikot Okoro Road, Ata Obio Akpa in Oruk Anam Local Government Area, Akwa Ibom State. It shares a common boundary with Akwa Ibom State University. The soils are derived from sandstone parent material and are generally sandy in texture and well drained.

The land is owned an extended family in Ata Obio Akpa. But over the years, needy crop cultivators have been getting plots of land on lease from the land owners. Such beneficiaries cut across members of Ata Obio Akpa community and neighbouring villages. The plot reverts to the landlord after one cropping. However, each participant can obtain plots of land once he/she applies on time and is able to pay for the land.

The main crops cultivated by participants in the Ata Obio Akpa project are vegetables, mainly fluted pumpkin followed by water leaf, okra and garden egg. Some few adventurous farmers were already planting, maize, pepper and yam.

Unlike Akai Effiwat Project, this project (Ata Abio Akpa) is not under any serious threat of either flooding or drought. Obio Akpa River rarely overflows its banks. Crop cultivation is done on the bank of the river and irrigation facilities were sited on the bank of the river as well. The river provided a perennial source of water supply for farming activities which are carried out all year round.

**Data Collection:**

The data used in the study were collected from both the project participants and non- participants in the two project communities –Akai Effiwat and Ata Obio Akpa. Two types of data collection methods were used namely (i) administration of structured questionnaire and (ii) Focus Group Discussion.

Focus Group Discussion: Data collection began with Focus Group Discussions involving the Small irrigation project participants in each of the two project communities. Discussions were held with two groups in each community. These were the male group and the female group. Each group consisted of 5-8 discussants. Their perspectives were obtained on the impacts of projects on crop outputs/yields, income and welfare of their households/families as well as the sustainability of the project.

Administration of Questionnaire: Administration of questionnaire began with stratification of the farming population in each community into 2- small irrigation project participants (irrigators) and non-project participants (non- participants). The next stage involved the random selection of 20 respondents from each stratum for administration of questionnaire. This gave a sample size of 80. Interview schedule was used in collecting data from the respondents.

**Data Analysis:**

The qualitative data obtained from the Focus Group Discussions were analyzed using methods of qualitative data description. Household monthly food expenditure was used as indicator of welfare. This was computed as the monetary value of all foods from all sources consumed by a



household in a month. The performance of project participant (farmers) was compared with those of non-participants.

Productivity was measured by first carrying out regression analysis using the ordinary least square methods. It was postulated that the output,  $Q$ , of both irrigators and non-irrigators is function of basic crop production inputs thus:

$$Q = f(X_1, X_2, X_3, X_4, X_5, X_6)$$

Where  $X_1$  = planting materials in kilogrammes,  $X_2$  = quantity of fertilizer used,  $X_3$  = Amount of labour used (in man- days),  $X_4$  = Quantity of irrigation water used (in litres),  $X_5$  = area of wetland cultivated (in hectares), and  $X_6$  = quantity of agrochemicals used. The estimated equation was of the Cobb-Douglas form as shown:

$$\ln Q = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + \mu_i;$$

$\ln$  = natural log,  $b_0$  = intercept,  $b_1 - b_6$  are the coefficients of the respective production input and  $\mu$  = stochastic error term to be estimated.

From the production function, we derived the conventional neoclassical test of productivity/economic efficiency. The rule of the test is that the slope of the production function (MPP) should be equal to the inverse ratio of input price to output price at the profit maximization point. This is given, for instance as:

$$MPP_{la} = P_{la}/P$$

Where  $MPP_{la}$  = the marginal physical product of labour,  $P_{la}$  = the price of man day of labour, and  $P$  = the output price.

$MVP_{la} = K$ ; where  $MVP_{la}$  = marginal value product of labour,  $K$  = numerical constant.

Given the level of technology and prices of both inputs and outputs, productivity of resource was ascertained by equating the marginal value product (MVP) to respective marginal factor cost (MFC) of the resource. A farmer is said to be productive in the use of a resource if there is no significant difference between the MVP and MFC. Therefore, in this study we applied this principle and compare the marginal products of the inputs found to have statistically significant influence on the output with the marginal factor cost (unit input price) to arrive at the conclusion of productivity or otherwise of the respective input.

### **.Results and Discussions:**

**Crop Output:** The impacts of the small irrigation intervention on the crop outputs, income and welfare of the participants (irrigators) was gleaned from the discussion of the members of the Focus Group and field observations. These were relied upon since the farmers do not keep records of their farming activities but could recall and report their observations. In terms of outputs, discussants reported of higher yields and bumper compared with what obtained before the project. A bundle of fluted pumpkin harvested from the project site was sold at N50 same size used to be sold at N20 during the rainy season. At Akai Effiwat, during the rainy season (the peak of crop and vegetable production), a bundle of fluted pumpkin sold for ten naira (N10.00), in the dry season it went for one hundred naira (N100.00) thus giving the farmer extra ninety naira (N90.00) per bundle as additional profit or margin.



Fig.2: Healthy Crops & bumper harvest at Akai

Evidence of improved crop growth could be observed in the field (Fig 2). The impact of the project is manifest on. And, the participants are responding to increase income from their activity by expanding the hectares of land cultivated. Due to enhanced income some of the project's participants have

diversified their portfolios. In Ata Obio Akpa, one of the participants, Emmanuel Johnny has added fish pond to his enterprise. In addition, the number of farmers cultivating at the project site has increased from 25 to 50. The total land area under cultivation has been expanded from 3 to 5 hectares. According to the discussants, one of the best things to happen to them was the small irrigation project. They were quick to point to improved skills and knowledge of crop and soil management which they acquired through the project. This, according to them has led to higher yields and crop outputs. They are able to earn sufficient money from the farm business to take care of their family needs. Emmanuel Johnny, Chairman, Project Management Committee, Ata Obio Akpa project captures the impacts of the project thus:

*Farming is good. We harvest a lot from the farm. People now know this place as vegetables centre. People come from the cities and neighbouring communities to buy from us here in this farm. With the training I received, I am also cultivating vegetables in my compound and my number one customers are the university students who reside in our community. I added fish farm to the farm, but had to stop because of too much pilfering. Proceeds from the farm are enough for my family needs. I don't regret doing farm business and I will keep expanding it.*

### **Impacts on Productivity:**

As earlier stated, the starting point of assessing productivity was to estimate the production function for the project participants, non-project participants and all the farmers (pooled data). The results are presented in Table 4. The regression results indicate that planting materials and labour have positive effects on outputs of project participants (irrigators). The two inputs were statistically significant at 1% level. In the same vein, labour, irrigation water and area of land cultivated were significant at 10% although there was an inverse relationship between the hectares of land cultivated and crop outputs of irrigators. The value of the adjusted coefficient of multiple determination reveals that about 66% of the variation in crop outputs of the irrigators is accounted for by the inputs (explanatory variables) included in the model.

For the non-project participants (non-irrigators), only fertilizer was found to be positively related to output. The result indicates that a one unit change in the amount of fertilizer used would raise output by 1.006kg. This means that there is increasing return to fertilizer as used by non-irrigators. The value of adjusted coefficient of multiple determination points to the fact that about 67% of the variation in the crop output of non-irrigators is accounted for the variables included in the model.

The data from both groups of farmers were pooled and an irrigation dummy introduced before analysis. The irrigation dummy (1= irrigation, 0= no irrigation) was introduced to ascertain if the differences observed in the production function of the two sets of farmers is by chance or otherwise.

**Table 4: Regression Result: Cobb Douglas Function**

Variables	Project participants/Irrigators	Non-Project participants/Non-irrigators	All farmers(pooled data)
Constant	-4.646 (-1.869)	3.369 (1.308)	-1.125 (-0.541)
Planting materials	0.473 (4.859)***	-0.89 (-1.095)	0.50 (0.736)
Fertilizer	0.665 (3.027)***	1.006 (6.135)***	0.093 (0.309)
Labour	0.866 (2.116)*	-0.536 (-1.697)	0.559 (4.057)***
Irrigation water	0.336 (1.928)*	-0.080 (-0.579)	0.745 (4.649)***
Land	-0.419 (-1.849)*	0.62 (0.229)	0.008 (0.036)
Agrochemical	0.089 (0.912)	-0.48 (-0.410)	0.001 (0.100)
Dummy			-0.051 (-0.261)
	Adjusted R <sup>2</sup> = .655 Standard Error =.21398 F-ratio =13.001	Adjusted R <sup>2</sup> =.667 Standard Error =0.25674 F-ratio = 14.010	Adjusted R <sup>2</sup> = .566 Standard Error =0.31217 F-ratio = 15.548

\*\*\* = significant at 1% level, \*\* = significant at 5%, \* = significant 1%.

To further assess the input productivity arising from application of irrigation on wetlands, some productivity parameters were computed. These are the marginal physical product (MPP) and marginal value product (MVP) (Table 5). In Cobb-Douglas production function, the coefficients are the direct elasticity of the variables. In the light of this, we interpret the results of this analysis to imply that the values of the coefficient of the variables are the responsiveness of crop outputs to the change in the respective production input. However, as the rule is, only those variables that were found to be statistically significant were considered. For the irrigators, the finding is that a change in the amount of irrigation water supplied to the farm would increase output by 0.336kg. Similarly, a unit change in the quantity of planting materials, fertilizer and amount of labour would increase outputs by 0.473kg, 0.665kg and 0.866kg respectively while an increase in the size of land cultivated would lead to reduction in output by 0.419kg. The unit price of irrigation water, fertilizer, planting materials, labour and plot of land were N4/litre, N34/kg, N300/kg, N750/manday and N5000/plot respectively. The unit price of output was N700/kg. When the marginal physical products of the various inputs were compared with the unit input/factor cost, irrigators were found to be productive in the use of irrigation, planting materials and fertilizer. They were not productive in the use of labour and land. Non-irrigators were productive in the use of fertilizer whereas all farmers combined were productive in the use

of irrigation water but not in the use of labour. The marginal value products (MVPs) of irrigation water, fertilizer and planting materials were greater than their marginal factor costs (MFCs) indicating productive use of these inputs.

**Table 5: Productivity Parameters**

Farm Input	Marginal Physical Product (MPP)	Marginal Value Product (MVP: MPP x Py) (N)	MVP-MFC	conclusion
<b>(A) Project Participants(Irrigators)</b>				
Planting materials	0.473	331.1	31.1	Productive
Fertilizer	0.665	465.5	431.5	Productive
Labour	0.866	606.2	-143.8	Not productive
Irrigation	0.336	235.2	231.2	Productive
Land	-0.419	-293.3	-5293.3	Not Productive
<b>(B) Non-Project participants(Non-Irrigators)</b>				
Fertilizer	1.006	704.2	670.2	Productive
<b>(C) All Farmers</b>				
Irrigation	0.559	391.3	387.3	Productive
Labour	0.745	521.5	-228.5	Not Productive
<b>Marginal Factor Cost:</b> (i) Labour = ₦750; (ii) Irrigation Water = ₦4(₦100/25litres); (iii) Fertilizer = ₦34/kg(₦850/25kgbag); (iv) Land = ₦5000/plot; Planting materials = ₦300				
<b>Unit Output Price (Py):</b> ₦700/kg (in grain equivalent)				

**Impact on farmers' Welfare:**

The ultimate measure of the impacts of intervention such as the small irrigation is not the productivity and output of farmers, but the difference in economic welfare relative to what would have happened had the intervention not been undertaken. Although, there are several measures of welfare, the method employed in this study is household food consumption expenditure. In comparing the monthly food consumption expenditure of project participants and non-participants, it was found that the welfare of the project participants was relatively better than those of non-participants. Using per caput monthly expenditure, a project participant spent an average of ₦5165.40 translating to \$1.1 dollar per day while per caput food expenditure was less one dollar a day (N154.30/day=\$0.96). Going by the assumption that an individual who spends less than a dollar a day lives below the poverty line, it can be inferred that on account of food consumption, irrigation has enhanced the welfare of farmers.

**Table 6: Household monthly food expenditure**

Respondents	Average Expenditure(N)	Expenditure per caput (N)
Irrigators/Project Participants	27,520	5,165.40
Non-Irrigators/Non-project participants	22,494	4,629.10

\$1.00 = ₦160

**Conclusions:**

This study has shown that outputs from wetland agriculture can be enhanced through irrigation. Improved outputs, income and welfare of farmers arising from irrigation justify the need to take water (irrigation) to wetland, particularly the resource poor wetland farmers. However, there are certain fundamental issues that on impinge on the sustainability of small irrigations for the poor which need the attention of any agency interested in replicating this, particularly in developing countries. These fundamental issues are:

**The technology:** In designing the project, the conclusion was that the technology was simple enough for the farmers to adopt and use. However, experience shows that the type and quality of equipment need to be considered in relation to the environmental conditions, especially, the sites of the project. While the technology of the small irrigation is simple and appears easy and inexpensive to manage its sustainability is of concern. For instance, barely 5 years after intervention, the water supply system in Akai Effiwat had ceased to function. The tank stands made up of galvanized pipes and located in water-logged portion of the farm had collapsed thus adversely affecting water storage and reticulation. In Ata Obio Akpa, the location of the tank stands appears appropriate but the group has not been able to maintain the generating set which they used in pumping water from the river. The set supplied as part of the intervention developed fault severally and had been replaced with new one. This too did not last and the farmers have reverted to hand watering. Therefore, appropriate and suitable location should be selected for the tank stand. Where the tank stand consists of steel, it should be sited away from water-logged area to avoid rusting. In addition, small irrigation interventions could explore the option of using solar power or wind power where suitable

**Management capacity:** It was found that although some individual farmers are doing well by utilizing skills acquired through the project, the Project Management Committees set up at the two locations were found not to be functioning at the optimum. It seems that therefore, that it is the external actor (the EU MPP6) which sustained the farmers’ interest in the project. At the exit of the external actor, the farmers seem to have reverted to the initial situation. A previous study (Baron and Noel, 2008) has found that even when users could realize gains from collective management, collective action needed to achieve it rarely emerged on its own and institutional setting at the local level is not sufficiently developed to sustain the gains from collective management. Thus, to make an intervention of this kind sustainable, farmers require continuous mentoring and training on the use group management, and maintenance of the facilities. Because this scheme uses motorized pumps, provision should be made to support farmers to the point where they are economically stable and can run the motorized scheme on their own.

Agricultural water management can provide a win-win solution to the provision opportunities to secure crop production. This case study of community-based, farmer-managed small irrigation as reported in this paper has important lessons which can be utilized in addressing water needs of agriculture in a fragile environment such as the wetlands. First, it has demonstrated the possibility of establishing farmer managed irrigation. This gives the farmer the opportunity of controlling utilization of water according to his/her needs. This is a departure from most other irrigation projects which are large, government- owned facilities. In the latter facilities, the

controllers and managers of the irrigation scheme are often separate from the end users of the facility (farmers). The lesson here, therefore, is that it is possible to have small irrigation facility designed to suite a given environment and that can be owned and managed by individual farmer. This model of irrigation can be replicated in similar agro-ecosystem.

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