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Research Article

Soil Evangelization: Learning from School Cocoyam Project in Southeast Nigeria

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Abstract

Soil evangelization, an awareness campaign to attract youths to study soil science and address soil fertility challenges to sustainable crop production was extended to two primary and two secondary schools, respectively, in Southeast Nigeria, participating in school cocoyam project (SCP), under the aegis of cocoyam re-birth initiative of the National Root Crops Research Institute, Umudike. The aim was to develop the capacity of the youths for soil fertility recapitalization and the very rapid multiplication of cocoyam. The approach involved participatory result demonstration of Gocken Rapid Multiplication Technology using micro cormels and micro setts of ≤ 7 g of cocoyam, planted on a 5 m x 4 m plot in each location at 50,000 plants/ha. Organic and inorganic fertilizers were applied. Results showed that there were 14.2. 50.0, 55.8, 48.5 and 58.3% improvements in soil pH, total N, organic matter and exchangeable K, respectively, over the initial soil nutrient status. Total corm + cormel yields ranged from 14.5 - 19.7 t/ha. The highest significant (p = ≤ 0.05) yield (19.7 t/ha) was obtained at Okposi while the lowest yield (14.5 t/ha) was obtained at the Abua Kingdom. Seed harvest multiplication ratio (SHMR) ranged from 25 - 35. It was concluded that SCP is a proven strategy to promote soil evangelization and cocoyam production.

Keywords: Cocoyam Re-birth; Crop Production; Soil Evangelization; Youth

Introduction

Cocoyam (*Colocasia* and *Xanthosoma* spp) is among major root and tuber crops (cassava, sweet potato and yam) in Nigeria. Cocoyam is not attacked by goat and sheep and it is the only fully edible crop, because the corms and cormels are eaten in various food forms while the leaves and flowers are commonly used as spice to garnish and flavour food [1]. Cocoyam is recommended in ethno medicine and in clinical medicine for the treatment of diabetes, heart disease and cancer [2-4]. This is because it has medium glycemic index (63.1 ± 2.5.) to permit gradual digestion and absorption of their carbohydrates and a more gradual rise in blood glucose and insulin levels [3]. Ilonzo [2] reported that diabetic patients placed on a diet of roasted cocoyam (tannia) eaten with palm oil for three months would regain their health. In clinical health management, Kundu., *et al*. (2012 found a novel potential therapeutic agent derived from a taro extract that potently and specifically inhibits tumour metastasis. FAO [5] revealed that small starch granules of cocoyam (1 - 4 µ) are better sources of raw starch for the production of biodegradable plastics than those from cassava (15 - 17 µ), yam (10 – 70 µ) and potato (50µ) to enhance environmental quality. FAO (1990) also reported that cocoyam is nutritionally superior to competitor roots and tubers like cassava and yam in terms of digestibility, contents of crude protein and essential minerals, such as Ca, Mg and P.

Challenges of cocoyam production

Research on root crops started in Nigeria in 1924 when a Provincial Research Farm for the Eastern Region (PRF) was established at Umudike [6]. Despite the fact that most rural people in the eastern, western and northern regions, in the colonial era, depended on cocoyam as a major staple food, emphasis on research was focussed on cassava and yam. Throughout the colonial era, cocoyam never attracted serious research attention in Nigeria. It took 35 years (1924 - 1959) after the establishment of the PRF at Umudike, to categorize cocoyam among major food crops because cocoyam was included, for the first time, in the revised 1969 edition of the "Technical Bulletin on Recommended Farm Practices for Major Food Crops in Eastern Nigeria" by the defunct Republic of Biafra. In the original edition of 1959 [7,8], cocoyam was conspicuously absent. When the PRF was upgraded to a Commodity Research Institute in 1975 as the National Root Crops Research Institute (NRCRI), effective research started on cocoyam in 1976. Sustainable production of cocoyam in Nigeria is threatened by apathy (neglect), diseases especially taro leaf blight and cocoyam root rot blight complex, declining soil fertility, scarcity and high cost of planting materials, as well as frequent changes in leadership [9,10]. For instance, the senior author who championed cocoyam re-birth initiative from 2008 to 2014 disengaged from the employment of NRCRI, Umudike and joined the Michael Okpara University of Agriculture, Umudike in 2014. Enwelu., *et al.* [11] assessed the constraints to cocoyam consumption in selected communities in Enugu State, Nigeria. Their findings showed that major constraints to cocoyam consumption were scarcity of the product, increased disease outbreaks as a result of climate change and low research interest to boost production.

Soil evangelization (SE)

Soil evangelization is a holistic transdisciplinary approach to raise awareness about the importance of soil resources and its management to enhance ecosystem conservation and food security [12,13].

Objectives of SE

- To raise awareness about the importance of soils in response to International Year of Soils calls for action by the International Union of Soil Science and the Soil Science Society of Nigeria.
- To present soil evangelization as soils re-birth and campaign to enhance passion for soils.
- To arouse a positive attitudinal change in perception, use and management of soil resources by all stakeholders.
- To build the capacity of farmers, students and others on proven soil management technologies as agents for the dissemination of the technologies, and
- To attract more youths to study soil science in higher institutions in Nigeria.

School cocoyam project (SCP)

Agriculture has a social image problem, and there is a decreasing interest among youth (school children) in entering agricultural-related fields due to the persistent perception of agriculture as an out-dated field with minimal financial returns. According to FAO [14] global population is expected to increase to 9 billion by 2050, with youth (aged 15 - 24) accounting for about 14% of this total, and the rural youths are the future of food security. In developing countries, access to knowledge information and education is often worse in rural areas than in urban areas, and this discrepancy is observable as early as a primary school [15]. The Federal Secretary, Ministry of National Food Security and Research, Government of Pakistan, Islamabad, Pakistan lamented during a regional workshop on youth and agriculture, on the declining interest of youth worldwide to remain in rural areas and take up agriculture [16].

The youths have the potential to play catalytic roles in soil evangelization to further enhance diffusion and adoption of novel soil-based technologies. Against this background, the progenitors of soil evangelization and cocoyam re-birth embarked on a school cocoyam project (SCP) as a pragmatic and socially acceptable strategy for effective youth empowerment through capacity building to enhance awareness campaign and dissemination of proven soil and cocoyam technologies. Cocoyam re-birth is a new holistic approach to the perception, research, production, utilization and marketing of cocoyam in Nigeria [17]. To sustain and disseminate soil evangelization and make incandescence the “ignited fire” of cocoyam re-birth [18], it becomes imperative to involve the youths in the awareness campaign. A major component of the SCP is result demonstration of Gocken Rapid Multiplication Technology (GRMT) developed by Drs G.O. Chukwu and K.I. Nwosu in 2009 for very rapid multiplication of cocoyam [19].

SCP focussed on primary and secondary schools with the following objectives:

- To inculcate in the youth the love for sustainable soil management and agriculture;
- To arouse in them interest for cocoyam, the “Nigeria’s giant crop”;
- To build their capacity in soil health management and cocoyam production,
- To prevent youth restiveness and violence by diverting their attention and energy to agriculture through soil evangelization and cocoyam re-birth; and
- To involve the youths in dissemination of improved soil-based cocoyam technologies.

Materials and Methods

Choice of site

The study was conducted in Abia, Ebonyi, Enugu, Imo and Rivers States, in the southeast and south-south geo-political zones of Nigeria. The soils are dominated by Ultisols and few Alfisols [20]. The choice of schools that participated in the project was purposive. Schools that participated in the SCP under the aegis of the Cocoyam Re-birth Initiative applied formally to the Executive Director of the NRCRI Umudike, requesting to participate and got approval. Based on the approved requests and willingness to meet the following conditions, schools were included in the project.

- Provision of land for demonstration of Gocken Rapid Multiplication Technology. (GRMT)
- Provision of organic manure (poultry manure, goat manure, etc) to complement NPK fertilizer to be provided by the Institute.
- Provision of labour for the project.
- Security of the demonstration plot.
- Willingness to adopt the technologies learned and put them into effective use.

In the case of schools in Rivers State, the case was a bit different. It was a collaborative project involving the Nigeria Liquefied Natural Gas (NLNG), the Anpez Centre for Environment and Development (ANPEZ) and the NRCRI, Umudike. Here, five primary schools and two cooperative societies participated. The overall objective was to empower the host communities of the NLNG through agriculture, using cocoyam project as a case study. The schools that participated in the demonstration are shown in Table 1. The experimental design was a randomized complete block design. The numbers of participating schools are regarded as replications. In this case, out of the 12 schools that participated, results from four schools (four replications) are presented. The GRMT was demonstrated as the latest agronomic management for very rapid multiplication of cocoyam and sustainable soil health management. Soil health, also referred to as soil quality by the United States Department of Agriculture (USDA) [21] is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. The GRMT was reported by Chukwu [17] to give a higher yield and a higher multiplication ratio than cocoyam minisett technology and guarantee improvement in soil health.

State	Schools that Participated
Abia	Ibeku High School, Umuahia
	Olokoro High School, Olokoro
	National Root Crops Resarch Institute, Umudike, Primary School.
Ebonyi	Federal Government Secondary School, Okposi
Enugu	Awgu High School, Nenwe, Aninri LGA
Imo	Queen of Apostles Secondary School, Okwueze Amuro, Okigwe .
	Mbaise Girls' High School, Onicha, Ezinihite Mbaise.
Rivers (Abua Kingdom)	State School Elok
	State School Emoh
	State School, Omokwa
	Community Primary School, Odaga
	Community Primary School, Omelemai

Table 1: Schools that Participated in the Project.

Demonstration sites

Land preparation was carried out by the pupils and students according to the practice in their area. Two land preparation methods (mound and ridge) were prevalent. At each site 5 m x 4 m plots were marked out. Planting materials were micro cormels and micro setts of ≤ 7 g (Plate 1). Pre-cropping soil samples were randomly collected from each plot at 0 - 30 cm depth and composited. The spacing was 1 m x 0.2 m to give plant densities of 50, 000 plants/ha, respectively.

Plate 1: Micro cormels and micro setts.

After demonstrating each activity, the school children were allowed to practice what they learnt. Plate 2 shows cutting of cocoyam cormels into microsetts by the students and pupils. Planting was done in May each year, from 2009 through 2012.

Plate 2: Students from Federal Government College Okposi (left), Mbaise Girls' Secondary School, Ezinihite (middle) and NRCRI Umudike Primary School (right) cutting cocoyam cormels into micro setts.

At planting (Plate 3), poultry manure was applied at the rate of 4 t/ha in a grove at the crest of the ridge or on mounds as sustainable management to recapitalize the soil of depleted nutrients.

Plate 3: Planting operation at the primary and secondary schools.

Six weeks after planting NPK 15 15 15 fertilizer was applied at the rate of 400 kg/ha, by spot application. These activities were done by the students to acquire the relevant skills in sustainable soil management and cocoyam production (Plate 4).

Plate 4: Application of poultry manure before planting by the students of Queen of Apostles Secondary School, Okwueze, Amuro in Imo State (left), demonstrating the application of NPK fertilizer by Dr G.O Chukwu (middle) and application of the fertilizer by pupils of State School, Emoh, in Abua Kingdom, Rivers State (right) after the demonstration.

Second hand weeding and earthening up (Plate 5) were done at 8 weeks after planting. The earthening up was done to heap up soils around the base of the plants to cover exposed emerging cormels or exposed corms by soil erosion and to increase effective feeding and bulking area.

Plate 5: Earthening up in progress

Final weeding was done at 16 weeks after planting. Harvesting was done at 7 months after planting.

Seed harvest multiplication ratio (SHMR) was calculated as total yield divided by the quantity planted. The yield data were subjected to statistical analysis using analysis of variance. Significant differences between means were detected using Least Significant Difference at 5% level of probability (Lsd ≤ 0.05). Post- cropping soil analysis was done to ascertain the effect of the soil amendments on soil health.

Laboratory analysis

Soil sample preparation involved air-drying at room temperature and crushing the air-dried samples gently with a wooden roller before sieving with a 2-mm sieve. Particle size distribution was analyzed following the modified hydrometer method [22], using sodium hexametaphosphate (calgon) as a dispersant. Total N was determined by the micro Kjedahl wet oxidation method [23]. Available P was determined by Bray - 2 method [24]. Organic carbon was determined by the method of Nelson and Sommers [25], and this was converted to organic matter by multiplying the percentage carbon by 1.724 (van Bemmelen factor). Soil pH was determined in soil: distilled water ratio of 1:2.5 using Bechman's zeromatic pH meter [26]. Exchangeable bases were extracted with neutral 1N ammonium acetate (NH4OAc) solution. Ca and Mg were determined by EDTA titration while K and Na were determined using flame photometry. Exchangeable acidity was determined by KCl extraction following the procedure of Mclean [27]. cation exchange capacity (ECEC) was obtained by summation of total exchangeable bases (TEB) (Ca, Mg, K, and Na) and exchangeable acidity EA). Base saturation was calculated by multiplying the quotient obtained after dividing TEB by ECEC by 100.

Result and Discussion

Results from four schools (State School, Emoh, Abua Kingdom, Federal Government College, Okposi, Mbaise Girls' Secondary School, and NRCRI Primary School) are presented. Results of pre-cropping soil analysis of the locations are presented as table 2. The results showed that the soils are loamy, acidic, medium in available P and organic matter but suffer multi-nutrient deficiencies in total N and exchangeable K which are below the critical levels (< 0.15% N) and (< 0.2 cmol/kg K) established in the southeast agro-ecological by Enwezor., *et al*. [28].

Selected Soil parameters	Location of schools			
	Abua	Okposi	Mbaise	Umudike
Textural class	Sandy loam	Sandy clay loam	Sandy loam	Sandy loam
Soil pH (H_20)	4.56	5 .50	4.80	4.80
Total N (g/kg)	0.60	1.00	0 .80	0.90
Organic matter (g/kg)	18.5	19.2	21.7	23.0
Available P (mg/kg)	18.4	10.8	19.0	18.6
Exchangeabke K (cmol/kg)	0.09	0.24	0.06	0.08
Exchangeabke Mg (cmol/kg)	1.20	1.24	1.20	1.35
Exchangeabke Ca (cmol/kg)	1.60	2.36	1.46	1.84
Exchangeabke Na (cmol/kg)	0.20	0.11	0.12	0.11
Exchangeabke acidity (cmol/kg)	1.60	1.42	1.68	1.64
Effective CEC	4.69	5.37	4.52	5.02
Base saturation (%)	65.9	73.6	62.8	67.3
Soil classification: USDA Soil Taxonomy World Reference Base	 Ultisol Acrisol	 Alfisol Luvisol	 Ultisol Acrisol	 Ultisol Acrisol

Table 2: Pre-cropping soil analysis of project sites at 0 – 30 cm depth.

Where na: Not Applicable; Effective CEC: Effective Cation Exchange Capacity.

Soil health improvement	Soil (H_20)	Total N (g/kg)	Organic matter (g/kg)	Available P (mg/kg)	K^+ (cmol/kg)
Mean pre-cropping soil nutrient	4.90	0.80	20.6	16.7	0.12
PM (4/ha)+ NPK(400 kg/ha)	5.60	1.20	32.1	24.8	0.19
Improvement in soil fertility over pre-cropping value	0.70 (12.5)*	0.40 (33.3)	11.5 (35.8)	8.10 (32.7)	0.07 (36.8)

Table 3: Influence of GRMT on improved soil health.

* Number in parenthesis ( ) represents % improvement over pre-cropping value**.**

According to Fairhurst., *et al*. [29] all soil properties which are amenable to change through investment and which affect long term crop productivity may be regarded as assets which can be recapitalized. Soil recapitalization is defined as the replenishment of soil fertility as nutrients are added to the soil [30]. Post-cropping soil analysis (Table 3) showed there were 12.5. 33.3, 35.8, 32.7 and 36.8% improvement in soil pH, total N, organic matter and exchangeable K, respectively, over the initial soil nutrient status. The improvement in soil pH value from very strongly acidic to strongly acidic and increase in nutrient elements and organic matter contents after post-cropping (recapitalization), came from the combination of nutrients supplied by PM + NPK fertilizers. Percentage establishment was > 80% across locations and survival count ranged from 80 - 84% (Table 4).

Growth and yield parameters	Location of schools				Lsd (0.05)
	Abua	Okposi	Mbaise	Umudike	
Percentage establishment	85	89	84	86	NS
Survival Count (%)	80	84	80	81	NS
Yield of corms (t/ha)	4.20	5.94	3.87	4.00	1.20
Yield of cormels (t/ha)	10.7	13.8	10.4	12.3	1.24
Total yield (Corm + cormel) (t/ha)	14.9	19.7	14.3	16.3	0.97
Seed harvest multiplication ratio	28.0	35.0	25.0	33.0	5.00

Table 4: Selected growth parameters and yield of Cocoyam NCe 010 across locations.

Both the percentage establishment and survival count did not differ significantly ($p \leq 0.05$) among locations. Total corm + cormel yields ranged from 14.5 - 19.7 t/ha. The highest significant (p = ≤ 0.05) yield (19.7 t/ha) was obtained at Okposi while the lowest yield (14.5 t/ha) was obtained at Abua. SHMR ranged from 25 - 35. This could be attributable to the integrated plant nutrient management which is an integral part of the GRMT. This, probably, guaranteed adequate supply of nutrients to satisfy crop requirements at crop development stage and midseason stage when cormel initiation and bulking are expected to be at maximum. The results corroborated the observation of Chukwu [31] who reported that GRMT could solve twin problems of declining soil fertility by soil recapitalization [30] and low multiplication ratio in cocoyam. The active participation in the SCP by the school children by carrying out the farm operations themselves after demonstration (Plates 2 - 5) showed that their capacities were built in soil fertility recapitalization and cocoyam production. It also showed that the SCP could be a pragmatic strategy to bridge gap in access to knowledge information in developing countries, especially, in rural areas at early primary school age.

Conclusion

School children can play active roles in sustainable soil management and crop production. The GRMT is a proven technology for soil fertility recapitalization of lost nutrients and very rapid multiplication of cocoyam. It is expected that the youths will apply the capacity they built in this project to promote soil evangelization and cocoyam production in southeast Nigeria.

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