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Organic Fertilizer Use in Nigeria: Our Experience

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Introduction

Research on the use of organic manure for arable crop production in Nigeria dates back to more than half a century starting with the pioneering work of hartley and Greenwood (1933). The main thrust of these early studies was focused on the nutrient supplying power of farmyard manure (FYM) and the test crops used were cotton, sorghum, millet and green gram. In their study, they compared the soils treated with 4.5 t FYM / ha and NPK fertilizers applied together at the rates of 29.5 kg N/ha (applied as NaNO3), 13 kg $P2O_5$ (as single superphosphate), and 50 kg K2O/ha (as KCl). These studies showed that the yield of crops grown on FYM and NPK were comparable and that when they were applied together, the yields were higher than that obtained by the FYM alone. Phosphate levels seemed responsible for the higher yields recorded. Following these observations, a series of studies were initiated at Samaru (Sub-humid northern Guinea Savannah) and Kano (semi-arid Sudan Savannah) to test what combination of FYM, N, P, and K would maintain satisfactory yields. Baker et al. (1977) and Lombin and Abdullahi (1978) further carried out long-term experiments and arrived at the amounts of FYM to be applied to various low-yielding cultivars available to farmers at that time. In general, it was shown that an application rate of 5 to 10 tons of FYM per ha gave appreciable yields even though the soils were still capable of receiving more.

Fertilizer requirement of Nigeria was put at 1.2 million tons in 1985-1987 period and the demand has increased since then. While the country's total fertilizer supply increased from 750,000 tonnes in 1988 to 1.65 million tonnes in 1994, the supply drastically reduced to 835,000 tonnes in 1995. This trend continued since then (Obigbesan 1999). Current fertilizer use in the country is far below the world average. With the removal of subsidies and the epileptic functioning of the existing five fertilizer complexes in the counry, the hope of meeting the future demand of fertilizer is rather bleak. Sobulo and Aduayi (1990) realized that "the future of agriculture in fertilizer use will lie on development of organic based fertilizers" which will in turn provide the required nutrients as well as enhances the soil organic matter content, water holding capacity and improved physical quality.

Since 1980s, University of Ibadan has revitalized the researches on the organic manures and development of organo-mineral fertilizers and their applications in the country by adopting a multidisciplinary approach and some of the main findings are summarized in this chapter.

Early Studies on the Use of Organic Manure

The published works on the organic manure use in the humid forest zone of south-west Nigeria were rather scanty perhaps due to several problems such as Tsetse fly infestations combined with lack of adequate livestock to provide the required organic waste that could have been used as base material. Working with Chinese yams in south-westrn Nigeria, Agboola and Obigbesan (1975) reported that a combined application of 20 kg N/ha and 5t FYM/ha or 10 kg N/ha applied together with 20 t FYM/ha raised tuber yields to about the same level, and both combinations gave much higher yields than when either FYM or N was applied alone. They concluded that yam may not be capable of utilizing the single application of inorganic fertilizers rather would prefer slow continuously releasing nutrients where organic manures stand out. This was further confirmed by Cooker (1982) who concluded that FYM performs better than mineral fertilizers. In a study carried out by Adeoye et al (1991), compost made from household kitchen waste supplemented with urea was found to yield larger size yams ranging between 13 to 42 kg and one of the yams weighing 35.2 kg was exhibited at the Oyo State Trade Fair in that year. This has received commendation from visitors to the fair.

Agboola and Obigbesan (1975) further showed that cowpea grown on a field, which had been previously cropped continuously for ten years, yielded significantly, better when inorganic fertilizer P was applied together with FYM than when either of them was applied alone. Organic matter has liming effect on soils. In a study to investigate the response of upland rice to different combinations of NPK, FYM and the effect of supplementing inorganic fertilizers with organic manure, Akpomudjere and Omueti (1991) reported the grain yield of upland rice to increase in the following order: Inorganic fertilizer > FYM > FYM. The workers suggested an

application rate of 7t FYM/ha in combination with 30 kg N/ha, 15 kg P2O5/ha and 15 kg K2O/ha for upland rice production.

As a result of inadequate supply of FYM in the humid forest zone, alternate materials were sought. A survey of 45 different waste materials was carried out for N, P, K, Ca, Mg, Zn, Cu, Fe and Mn contents (Agboola et al 1981, Titiloye et al 1985). Sawdust seems to offer some prospect as evident from the studies of Olayinka (1982) who showed that sawdust amended with inorganic fertilizer (NH4OH and H3PO4) has yielded better maize yield and sawdust-based poultry waste yielded the best yield. Other investigators (Obatolu 1995, Solomon and Ogeh 1995) also reported various alternate sources of organic manure.

Developments in Organo-mineral Fertilizer Researches in Nigeria

Use of 'organic manures', 'compost', 'bio-fertilizer' and 'farmyard manure' 'crop residues', or dungs of domestic animals has been an age-old practice among the agricultural communities in West Africa, including Nigeria. In Kano, refuse, stable manure and market sweepings were disposed of by burning in incinerators, or mixed with nightsoil and converted into compost. Wastes arising from cattle, donkey, horse, sheep and goat rearing were carefully conserved by the Kano farmers and put back on their farms. A recent nation-wide survey by Sridhar (1989) revealed that some composting had been done in Kaduna, Kano, and Maiduguri areas in the past, but that it is no longer practiced on a large scale. The only large scale composting plant operated in Kano between 1936 and 1942 was under the supervision of Dr. Gilles. Nightsoil and city wastes were used. The survey further revealed that stalks of various crops (corn, guineacorn, sorghum), rice husks, wheat, straw, vegetable peelings, cotton stalks, grasses, cocoa and banana leaves, excreta from poultry, cows, piggery, sheep and goats, ashes, and wastes from slaughterhouses, breweries and other industries which process organically rich materials and other materials were being used in various parts of the country. However, these methods were followed more empirically and in practice the increase in crop yields were marginal and there were long waiting periods between the crops. The potential resources of these organic manures in Nigeria, surprisingly, are not explored to the fullest extent.

After independence and particularly after the start of oil economy, farmers have abandoned the practice of waste utilization and went ahead for chemical fertilizers. In spite of it, an average Nigerian farmer is unable to procure and apply the recommended quantity of fertilizer and is satisfied with about 1 bag per hectare as against 4 to 5 bags by his counterpart in the neighbouring countries. Recently, the Government has banned importation of fertilizer and relied on domestic supply, which is a favourable policy. The domestic supply is limited and the farmers are handicapped by the shortage of imported fertilizers. This situation has helped the farmers to look inward.

In some parts of the country, the waste utilization has been going on but without any scientific approach to convert into compost, which is rich in plant nutrients and hygienic. This has resulted in certain misconceptions such as: the waste utilization on farm is hazardous due to pathogens, they emit bad smells, they promote fly infestation, and uneconomical due to their bulkiness, which demand large storage space and high transportation and labour costs.

To meet these challenges, the initial work on composting of organic biodegradable wastes was carried out since 1984 at the Division of Environmental Health of the College of Medicine under the direction of Professor Sridhar whose initial experiments were conducted at Swiss Federal Institutes of Technology (EAWAG) at Zurich/ Dubendorf. The laboratory scale experiments were translated into larger and community based studies at University of Ibadan and University College Hospital campuses, Ajibode village, Shasha market, and Elesu village around Ibadan. The volume of wastes handled ranged from 100 kg to 3 tonnes and a variety of materials such as city refuse, animal wastes, brewery wastes, water hyacinth, sawdust, etc were used (Sridhar et al. 1994). Till 1987, work on the organic fertilizer was limited to converting the biodegradable community wastes into resources such as fertilizers and livestock feeds. It was felt that there is a need to use this end product for agricultural development on a large scale to convince the end users and promote nationally. A linkage was thus developed between the Division of Environmental Health of the College of Medicine and the Department of Agronomy at the beginning of the year in 1993. The Organo-mineral fertilizer Research Group was formed with the core group consisting of Professor J. A. I. Omueti, who later became the Head of Agronomy; on 27 November 1993, Dr. G. O. Adeoye, Agronomist, and Professor M. K. C. Sridhar (Head of Environmental Health). The first batch of corn produced on the compost made from University of Ibadan Campus waste was presented to Professor Ayo Banjo who acknowledged the quality of the little gift emerged from the campus waste. Since then this has been the longest multidisciplinary collaborating team that used to meet every Friday deliberating on

the progress made by the postgraduate students and planning newer researches. Several postgraduate students from the Departments of Agronomy, and Environmental Health Division of the Preventive and Social Medicine were benefited through stimulating interactions. This group is further strengthened with the joining of Professor Bamiro and Engr. Fadare from the Mechanical Engineering Department who took care of the design and fabrication of the machinery required for the commercialization of the technology.

Proper composting of wastes especially the aerobic type in windrows, has proved (Sridhar et al. 1985) very effective in reducing such problems and enhancing crop yields. Two commonly used composting methods were experimented and valuable data were collected (Yinda and Adeoye, 1995). The results showed that windrow system is more efficient and the time required may be reduced significantly (Table 2). A C: N ratio of 25 to 30 is shown to be ideal while using a mixture of wastes in the urban centres. Poultry and Cattle wastes are particularly rich in nitrogen and they can be effectively mixed with wood scrap or market / municipal solid wastes. However, the application of composts to crops in the humid tropics as in Nigeria is accompanied by: a high rate of nutrient losses even when they are properly incorporated into the soil, fragile nature of tropical soils with their low activity clay, low water holding capacity and low organic matter, and seasonal torrential rains which cause leaching of nutrients and erosion of soils. These problems have been circumvented through improved techniques and supplementation of other mineral resources available in the country.

Conversion of Organic Wastes Into Organo-Mineral Fertilizer Pellets

Further elaborate studies conducted by our "Organo-Mineral Fertilizer Research Group" (the authors of this paper) at University of Ibadan, has revealed that composting is a feasible way of converting the available organic wastes into organic manures, it can be supplemented with other plant nutrients, and can be converted into pellets. John et al (1995, 1996) showed that the pellets which can easily be handled by small scale farmers to carry and use on their farms can be simple, cheap and has the added advantage of slow release of the nutrients when applied to the soil and the volume will be reduced drastically for easy handling by the farmers. A simple manually operated pelletizing machine was fabricated and used. It is designed for preparing 32 pellets with dimensions 6.4 cm long, 2.0 cm diameter with a volume of 20.11 cm3 and each weighed 29.5 g when dried. The freshly prepared pellets may be sun-dried and stored before use. The pellets were stable even after two years of storage under tropical humid conditions as in Ibadan. The colour of the dried pellets was dark reddish brown and can vary depending on the binding agent used in the process. The advantage of pelletization is in the reduction of weight and volume of the original composts. The reduction in volume of the freshly made and that which was air-dried compost used here was 70.5% and 54.5%. The corresponding weight reductions for the same were 58.2% and 28.6%.

This work was appreciated by the Ministry of Science and Technology. Through the Raw Materials Research and Development Council, the design of the pelletizer has been improved in 1996 to work semi-automatically and to produce more pellets (Sridhar, Adeoye, as Consultants with RMRDC, Fadare as a postgraduate student with the Mechanical engineering Department on the project and Omueti, as Team Leader). Professor Bamiro has been named as Chairman of the joint UI/RMRDC team. This pelletizer was given due recognition in the form of awarding 1996 National Merit Award for this multidisciplinary team work (University of Ibadan Gazette 1997). Tthe Vice Chancellor address while receiving the Chief Executive of RMRDC in his office. The project produced pellets.

Organo-mineral Fertilizer Pilot plant at the University of Ibadan

This is a joint venture project for commercial production of organo-mineral fertilizer between University of Ibadan and Raw Materials Research and Development Council, Abuja. The plant was located in a 2 ha plot on Barth Road. It was originally designed to produce about 3 tons of finished product per day. Unfortunately, the RMRDC could not release the funds on time and as scheduled. Due to paucity of funds, the structures were designed with a roof using rejected roofing sheets and minimal inputs such as blocks and cement. The windrows were 1.5m x 1.5m x 10m and the partition walls were improvised.. Professor Omueti has used his ingenuity in sourcing the funds. The raw materials processed were poultry waste, cow dung, sawdust, water hyacinth and sorted city refuse. Some other inputs such as kaolin and bentonite were supplied by the RMRDC as part of their contributions. Sokoto rock phosphate was used to supplement P and urea was used to supplement N. There was no need to supplement K (Ogazi and Omueti 2000). However, cocoa pods, water hyacinth and plantain wastes were found to be good sources of K and techniques were devised to enrich the element as shown by Adeoye

et al (2000). Supplements were added when necessary to enrich the composts to a nutrient level of 90, 60, and 40 kg ha, N, P, and K, respectively. Successful runs were made and various types of composts produced. The composition of typical samples and the soils used are given in Tables 3 and 4. The plant is expected to go into production by early 2001 (Omueti 2000).

Organo-Mineral Fertilizer Use in Crop Production

A variety of crops such as yams, cassava, maize, green amaranth, sunflower, a variety of beans, and horticultural crops were grown with the organo-mineral fertilizer. The ornamental plant cultivators in all the major urban enters are traditionally the immediate users of the organic manure. Northern States have already known about the benefits of composting. They only need training of improved technology and mineral supplementation to suit the varying ecological zones and soil types. From the greenhouse and field trials, the rate of application of organo-mineral fertilizer was shown to be between 2.5 to 7.0 t/ha depending on the crop. This application rate has yielded better crops as compared to those grown on inorganic fertilizers such as N, P, K, formulations alone. Studies with N, P, and K fertilizers using maize indicated that optimum grain yield could be achieved at fertilizer application rates of between 100-200 N kg/ha, 40–66 kg P/ha and 20-90 kg K/ha depending on the variety of the soil. Similar increased yields were described in various publications from our group cited under references. Further use of the organo-mineral fertilizers were also tried for mushroom cultivation (Adeoye et al. 1998).

The organo-mineral fertilizer samples produced were field-tested using maize and cassava as test crops. The samples were distributed to 15 States of the Federation for trials in 1998 as planned at the inception of the study. The results obtained by Ogazi and Omueti obtained on the site are shown in Tables 5 and 6. The crop growth and yield were monitored at periodic intervals at the site and also at Ajibode field site and the responses obtained by Omueti et al. (1996) (unpublished data) for maize and cassava. . Some samples were distributed free to the funding Agency, RMRDC who have their own field test sites. They have also confirmed the quality of the finished products. More recently (1997-98 planting season) John carried out studies on the effect of N and P supplemented organo-mineral fertilizer on performance of maize, weed infestation and the residual effects. Poultry manure and sawdust have played very important roles in the quality of the finished product. An interesting observation is on the significant yield of the second maize crop at the application rate of 5 t/ha without addition of mineral fertilizer from from 31.8 to 53.7 % and 48.2 to 57.8% in 1998.

Pace Setter Organic Fertilizer Plant for a Market in Ibadan

While the researches were going on at the University of Ibadan, the merit award and the success has reached the Government of Oyo State who invited the Group to initiate a similar plant but of a commercial size at one of the major markets in Ibadan. The concept of this plant was brewing over a period of time when Ibadan was named as one of the cities to be shaped into a model city under the "Sustainable Cities Programme" of UNCHS / UNDP. Professor Sridhar was a member of the Waste Management Working Group and was closely associated with several waste management strategies being discussed and adopted. The idea of organo-mineral fertilizer development was accepted in principle as one of the viable options. Various stakeholders were involved in decision taking process, viz. Communities, Local and State Government, Tertiary Institutions, NGOs, Voluntary Associations and others in Ibadan. The team volunteered to take up this challenge but Professor Omueti could not join the team due to his other commitments. However, he extended his moral support. On December 18, 1997 the Project Coordination Department of the Oyo State Government endorsed the commencement of the "Pace Setter Organic Fertilizer Plant". It was successfully completed and handed over to the then Military Administrator Col. Usman on July 16, 1998.

This plant was designed to process about 20 tons of mixed market waste per day with the resultant 10-12 tons of finished product. The finished product is amended with other essential plant nutrients in required amounts before bagging. The windrows measure each 2 m wide, 1.5 m high and 10 m long. The facility has storage cubicles for various raw materials generated in the market, a borehole, workers' change room, office, toilets, and machines for sieving, pulverizing, mixing and bagging. Plans are on to convert the powder into pellets for easy transportation and handling by the farmers. The technology is indigenously developed and the machines are fabricated locally within Ibadan. When full in operation, the present capacity of 200 bags/day can be increased further to meet the growing needs. The plant is currently producing 2 grades of Fertilizer: General or B Grade for ordinary soils to increase organic matter content and yield second

Table 2. Comparison of composting methods commonly practiced in respect of maturation time

Materials used	Pit system No. of days	Windrow system No. of days
Cowdung + Refuse	78	56
Poultry droppings + Refuse	70	56
Brewery waste + Refuse	88	63
Refuse alone	90	56
Mean No. of days to maturity	81.5	57.8

Table 3. N, P, and K content of composted materials

Nutrients Material	N%	P%	K%
Sheanut cake	2.30	0.16	2.55
Palm kernel cake	2.80	0,15	0.58
Poultry manure + Sawdust	2.36	2.14	2.30
Cow dung + Sawdust	0.54	0.80	0.85
Cow dust + Sorted refuse	0.46	0.57	0.75

Table 4. Pre-cropping soil physico-chemical properties of Barth road soils, University of Ibadan,

Parameter	Soil test value
Sand %	80.60
Silt %	10.00
Clay %	9.40
PH value	5.00
Organic carbon %	0.16
Total N %	0.04
Bray 1-P ppm	0.13
Exch. K cmol kg-1	0.60

crop; "A" grade for growing crops such as yams, cassava, maize, vegetables, flower/ornamental plants, and a variety of other crops for enhanced yields and soil sustenance. Plans are on to go into other special grades to suit different soils and crops in various climatic zones in the country. At various stages expert advise was also sought from eminent Scientists like Professor Agboola, Professor Sobulo and Institutions such as IAR &T and others. By July 1, 1998, the plant produced 5,450 bags (50kg capacity). The product is of proven high quality has been attested to by IITA, IAR&T, Oyo State Ministry of Agriculture, and Local Farmers Groups. The mean levels of major nutrients depending on the Grade A or B are: N 1.5-3.5%; P2O5 1.0-1.5%; K2O=1.5-2.0%. The Oyo State Government seemed to have invested about N7,887,960 and it is currently put under the Governor's Office.

Table 5. The effect of organo-mineral fertilizer on Maize cob yield under maize-casava intercrop applied at an application rate of 2.5 t ha-1

Treatment	Cob without husk	Husk t/ha	Maize cob with husk t/ha
Control	0.29	0.16	0.44
Mineral fertilizer	0.54	0.33	0.89
OM-SNC	0.58	0.26	0.85
OM-PKC	0.65	0.28	0.91
OM-PM/SD	0.71	0.31	1.08
OM-CD/SR	0.73	0.32	1.05
OM-CD/SD	0.78	0.27	1.06
SNC	0.58	0.32	0.88
PKC	0.61	0.24	0.84
SE	0.08	0.03	0.10

Control=Zero fertilizer; Mineral fertilizer (Rock phosphate + Urea + Murite of potash); PM=Poultry manure; SR=Sorted refuse; CD=Cow Dung; PKC=Palm Kernel Cake; SD=Sawdust; SNC=Sheanut cake; OM=Organo-mineral (supplemented with local minerals)

Table 6. The effect of pre-bagged organo-mineral fertilizer on cassava yield under maize-cassava intercrop at an application rate of 2.5t /ha

Treatment	tuber	stem	biomass
Control	2.00	3.20	5.20
Mineral fertilizer	4.80	6.08	10.93
OM-SNC	6.40	5.60	12.00
OM-PKC	5.25	4.48	9.73
OM-PM/SD	8.73	7.20	15.93
OM-CD/SR	6.50	6.50	13.00
OM-CD/SD	10.10	7.85	18.03
SNC	4.50	4.09	8.59
PKC	4.17	4.58	8.75
SE	1.54	1.63	3.02

Control=Zero fertilizer; Mineral fertilizer (Rock phosphate + Urea + Murite of potash); PM=Poultry manure; SR=Sorted refuse; CD=Cow Dung; PKC=Palm Kernel Cake; SD=Sawdust; SNC=Sheanut cake; OM=Organo-mineral (supplemented with local minerals)

The plant has further attracted the attention of the Federal Ministry of Agriculture, State Environmental Protection Agencies, Federal Ministry of Environment, Urban Development Bank, UNICEF, UNDP, and UNCHS in Nairobi. Some of the visitors from UNICEF New York, Abidjan and Mauritania commended the plant.

The Federal Ministry of Environment has adopted Organo-mineral fertilizer production from the wastes as a viable strategy for sustainable management of wastes. UNICEF has taken it up at community level in 8 areas in Ibadan and Lagos. Federal Ministry of Agricultural has designated IAR&T as the Agency to control the quality of various Organic and other fertilizers produced in the country. The Oyo State Government has recently embarked in upgrading the plant for sustainable production and as a source of regular income. In 1998, the Ibadan Waste Management Authority and Sustainable Cities Project were awarded independently the "Best Practice" awards for the innovation they have used in the waste management practice in Ibadan.

Future Outlook

Obatolu (1995) put it succinctly as: "The use of organically sourced fertilizer materials is expected to come in as a compliment for mineral fertilizer which is becoming extremely expensive and difficult to get for the average Nigerian and indeed most third world farmers. The use of mineral fertilizers is particularly at low ebb amongst Nigeria tree crop farmers. In a survey, Obatolu and Osaiuyigbe (1984) recorded that only about 6% of tree crop farmers use mineral fertilizer on tree crops. The situation is even worse now". Many entrepreneurs are currently trying to produce organic fertilizers and there is a great export potential in the western and other African countries. There is a need to formulate and improve the organic fertilizers to suit various soils in the country's five ecological zones. The soils vary in their characteristics with respect to pH, organic matter content, and availability of plant nutrients, ECEC and erosion related problems. There is also a need to develop organic fertilizers to suit various crops and cropping systems in various parts of the country. The technology it self is dynamic and one should look into upgrading with the changing patterns. Quality and cost are the watch words in the future development.

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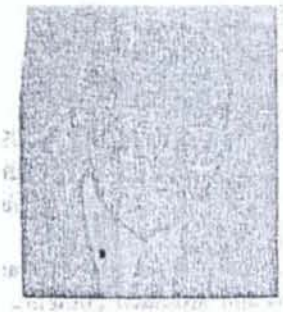

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