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Agrolyser for Cassava: Lessons learned

Cybernetics (Nigeria) Ltd.

International Institute of Tropical Agriculture – Institut international d'agriculture tropicale – www.iita.org

Agrolyser for Cassava: Lessons Learned

Research from IITA, NRCRI, UI, Lagos State ADA, and Imo State ADP

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Abbreviations and Acronyms

ADA	Agricultural Development Authority
ADP	Agricultural Development Program
CMD	Cassava Mosaic Virus Disease
CMD project	Pre-emptive Management of the CMD in Nigeria Project [for 12 States in Southern Nigeria. IITA was lead executing agency]
CEDP	Cassava Enterprise Development Project [IITA is the lead agency but funded by USAID and SPDC]
ICP	Integrated Cassava Project [CMD project + CEDP]
ha	hectare
HQCF	High Quality Cassava Flour [unfermented]
IITA	International Institute of Tropical Agriculture, Nigeria
mm	millimetre, millimeter
m	meter, metre
NACRDB	Nigerian Agricultural Credit and Development Bank
NRCRI	National Root Crops Research Institute, Umudike, Nigeria
₦/kg	Nigerian Naira per kilogram
₦	₦ 130 = US$ 1 (approx.)
RIART	Rivers State Institute of Agricultural Research and Training, Onne.
RTEP	Root and Tuber Expansion Program [Federal Dept of Agriculture, Abuja]
t	metric tonne; 1000 kg
UI	University of Ibadan, Ibadan, Nigeria

Collaborators

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Contents

Preface

A combination of **macro** and **micro** nutrients is absorbed by crops from the soil during the course of regular growth. Continuous cropping creates nutrient deficiency rectified through bush fallow in ancient times and fertilization in modern times. Conventional compound fertilizers NPK contain only **macro** nutrients— Nitrogen, Phosphorus, and Potassium. Conditions that make **macro** nutrient (compound fertilizer) application necessary, makes **micro** nutrient (Agrolyser) fortification imperative, as both types of nutrients are simultaneously depleted during crop production.

Nigeria's fertilization policy concentrates on replenishment of **macro**, to the exclusion of **micro** nutrients. This leaves attainment of optimum agricultural productivity at a nutritional disadvantage ab-initio. When crop nutrition is incomplete, farmer's harvests and profits are correspondingly incomplete. There is urgent need for a policy re-orientation to address crop nutrition from a holistic perspective of **macro** and **micro** nutrient fertilization to reverse the current trend and make agriculture a profitable venture.

Although required in small quantities, the absence of Micronutrients and secondary elements (calcium, zinc, sulphur, boron, manganese, magnesium, copper, sodium, iron, and molybdenum) have devastating effects on crop performance, negatively affecting such productivity indicators like yield, storability, maturity, nutritional value, and other agronomic

parameters. This concept is analogous to the human need for balanced nutrition containing carbohydrates, proteins, fats and oils, minerals and vitamins--a "*square meal*" that contains the four major food categories in equal proportions".

Agrolyser Micronutrient Fertilizer (AMF), is a **patented, made-in-Nigeria**, balanced micronutrient formulation that contains *all* ten micronutrients and secondary elements in scientifically determined optimum quantities to assist crops attain their full genetic potentials resulting in **higher yield, longer storability, faster maturity and increased nutritional value content**. The economic analysis of AMF use clearly indicates more than 13 times return on investment for maize at the farmers level.

Over the last twenty-three years, AMF has demonstrated its potential to positively affect productivity indicators at the research, on-farm-adaptive-research, large-scale, and peasant farmers level in **all** agroecological zones of Nigeria. Agrolyser advantage has been demonstrated on a wide range of cereals, legumes, and vegetables. There is evidence that some legumes like cowpea can be grown exclusively with Agrolyser. However, information on Agrolyser efficacy on cassava and other root crops are scanty and unorganized, thereby justifying the commendable IITA-led initiative to review existing data and chart a course forward in view of the recent goverment efforts to promote cassava export.

Agrolyser has been the subject of positive deliberations by three national workshops and has been approved by the National Fertilizer Development Centre (NFDC) of the Federal

Ministry of Agriculture and Rural Development (FMA&RD); the National Fertilizer Technical Committee (NFTC) of the FMA&RD; the Federal Ministry of Industry (FMI) and the Federal Ministry of Science & Technology (FMST), which recently granted a Nigerian PATENT facilitated by SMEDAN. Approval for national adoption and incorporation into the Nigerian agricultural scheme was granted by the 23rd regular meeting of the National Council on Agriculture (NCA), which called for indents, thereby making AMF eligible for Federal fertilizer subsidy.

The African Union Scientific, Technical and Research Commission (AU/STRC) has endorsed AMF for continental use and pledged assistance with introduction to neighboring African countries. The Director, Agricultural Sciences, FMA&RD has recommended [see Annex] that government should promote AMF adoption with similar vigor as for the case of addition of iodine to salt to prevent goiter.

The unprecedented attention given to agriculture in the last eight years by the Obasanjo administration can only be complemented by the **No. 1 farmer and citizen** being the one to officially bequeath this home-grown technology to Nigeria and indeed the rest of Africa as a lasting legacy of meritorious service to the motherland.

Engr Pius Kole-James, P.E.
MD/CEO Cybernetics Nigeria Ltd

Compiler's Notes

For 23 years Agrolyser has been used in Nigeria mainly for cereal crops. Little evidence exists for the appropriate application on cassava. This is mainly because little effort has been made to conduct trials or that trials are in shelves that have not been published. There is therefore a need for all available data on trials involving Agrolyser in the hands of cassava researchers to be assembled because Agrolyser use has to be based on documented evidence.

Every chapter in the book is independent. The chapters can be read without consulting the others. The essence of the collection is to assemble the many separate experiences so that the lessons learned from these can guide our future action as regards the application of Agrolyser on a more general scale.

It was in a brief meeting of 1 December 2006 at IITA that it was decided that we should pool all the bits of research results and knowledge into a book to examine what we have learned so far in order to popularize the benefits to be derived from Agrolyser.

Prof. Malachy O. Akoroda
Integrated Cassava Project [CMD], IITA Onne

Executive summary

This book is a compilation of the result of six separate experiments from different researchers in different ecological/ geopolitical zones of the country between 2002 and 2006. While additional experiments are ongoing around the country, the results so far obtained from these multilocational trials point towards the positive influence of Agrolyser when used in combination with compound fertilizers or organic manure.

The soil and rainfall characteristics of the season need to be considered in the investigation of the effect of Agrolyser. Under some conditions the effect is larger in magnitude than in some others. An application rate of about 4 kg (14 bottles) Agrolyser per hectare is average. The optimum application rate so far determined is subject to modification as more information and data become available. Considering the variability in the soils and ecology of the country, and the fact that research has established the importance of micronutrients in crop production, one can envisage a situation where an agroecology specific Agrolyser recommendation can be made for various parts of the country.

Having said these, available evidence shows between 6 and 20% increase in root and stem yield of cassava are mostly likely. The leaf yield increase, which can be used for human consumption and forage is higher. In addition, laboratory analyses show higher protein and zinc contents of leaves, and higher zinc content of roots thus higher nutritional value, especially considering the demonstrated and established zinc deficiency in Nigerian women and children. Agrolyser alone

cannot and should not be applied without being mixed with a fertilizer material or manures. It is only in this supplementary role that its best effect is realized.

Chapter 1

Agrolyser as a Supplement to Fertilizers and Manures

Of the over 100 chemical elements on earth, only 16 are essential nutrients required for plant growth. These are shown in Table 1.

Table 1. Sixteen essential nutrients for plant growth.

Element	Symbol	Notes on application	Group
Carbon	C	Obtained from CO_2	1
Hydrogen	H	Obtained from H_2O	1
Oxygen	O	Obtained from H_2O	1
Nitrogen	**N**	Applied in fert & manure	2
Phosphorus	**P**	Applied in fert & manure	2
Potassium	**K**	Applied in fert & manure	2
Calcium	Ca	Applied in lime & fert	3
Magnesium	Mg	Applied in fert & manure	3
Manganese	Mn	Applied in fert & manure	3
Sulphur	S	Applied in fert & manure	3
Chlorine	**Cl**	Applied in fertilizers	4
Copper	**Cu**	Rarely or often not applied	4
Iron	**Fe**	Rarely or often not applied	4
Zinc	**Zn**	Rarely or often not applied	4
Boron	**B**	Rarely or often not applied	4
Molybdenum	**Mo**	Rarely or often not applied	4

Nutrient element imbalance results when the right amounts of each of these nutrient elements are not applied to the soil for crops to absorb. Such imbalance affects both the yield as well as the quality of the produce realised.

Micronutrients refer to the six elements at the bottom of the list

(Group 4). These are chlorine, copper, iron, zinc, boron, and molybdenum. The amounts required are so small that they are often neglected, despite their essential nature to crop growth.

Micronutrients are important to meet the needs of plants for balanced nutrition. Many farmers know and regularly make efforts to apply the three most needed elements namely N, P, and K (Group 2). These are only three out of a total of the 16 elements that have been found to be essential for all plants. Members of Group 1 occur naturally, group 3 are obtained often through organic manure and some other fertilizers. That farmers often care for the major three does **not** mean or imply that the other elements are not essential for good growth. The small amounts of micronutrients needed for good growth of crops may sometimes not be available and the crop may not give its best performance. Thus, micronutrients are as important as N, P, and K but the requirements are of a smaller level only in terms of quantities required.

The micronutrient content of Agrolyser as a naturally-occurring raw material is thus expected to vary in composition over space depending on where it was mined. The guiding principle in the use of any soil amendment is the ratio of the value of the incremental value of the output and the extra cost incurred by using the input. Once the right dose of Agrolyser is used, the resulting yield when sold at current market prices should exceed the extra cost of applying the input. Thus, this book seeks to measure the general effect of Agrolyser on the yield of cassava so that the general recommendation for its wide scale usage can be pinned on data available to us now. Yield is a complex

character of any crop production system. All factors in the system contribute to yield at small degrees and also catalyse the contribution of other factors. Thus, a change in yields of as small as 1% is important considering the growth rate that food must grow to meet growth in population. Sub-Saharan Africa food grows annually at about 2% but the population grows at about 3%. Thus, any increase in food supply from direct primary production activities arising from any factor of production is welcome.

An analysis of the sample available to us was that the Agrolyser contains 9 or 10 of the 16 essential nutrient elements required by all crop plants. The amount of the elements are shown below (Table 2).

Table 2. Analysis of Agrolyser at the IITA analytical laboratory.

Elements	Levels
N	0.17%
P	0.020%
Ca	16.80%
Mg	0.10%
K	0.18%
Mn	58.4 ppm
Fe	22.6 ppm
Cu	224.6 ppm
Zn	219.2 ppm

[ppm = parts per million = mg per kg]; [Client name: Akoroda. Code no: 2005041. Lab Id 200505049 Report.

Table 3. Nutrient content of Agrolyser based on analyses undertaken at two sources.

Nutrient element	Nat. Fertilizer Centre January 1991	Fed. Ministry of Health April 1986
Boron	–	–
Calcium	18.75–63.2%	190 g/kg
Copper	10 ppm	7.6 mg/kg
Iron	75 ppm	10 mg/kg
Magnesium	0.002–0.3%	7.8 mg/kg
Manganese	Trace	–
Molybdenum	–	–
Sodium	1.0%	–
Sulphur	–	–
Zinc	33–88.6 ppm	2.1 mg/kg
Nitrogen	Trace, 0.06%	–
Phosphorus	Trace, 0.07%	–
Potassium	0.01–0.32%	–

[ppm = mg/kg]

Source: Information and Product booklet for Agrolyser Micronutrient Fertilizer (AMF) by Cybernetics Nigeria Ltd.

Rotas Soilab Limited

ANALYST CERTIFICATE

(In accordance with Institute of Public Analyst of Nigeria Decree No. 100 of 1972)

CERTIFICATE NUMBER 00152

27th September 2002

Owner: CYBERNETICS NIG. LTD.
Lab. No.: RSL/02002/3V239
Sample type: Agrolyzer

	Total Nutrients				Water Soluble Nutrients		
	A	B	C		A	B	C
Ca (%)	38.12	34.04	43.88	Ca (%)	24.95	22.5	27.72
Mg (%)	0.63	0.48	0.44	Mg (mg/Kg)	750	625	820
Zn (%)	0.50	0.33	0.38	Zn (%)	0.32	0.15	0.17
Mn (mg/Kg)	10.0	10.0	12.0	Mn (mg/Kg)	3.00	2.00	4.00
Fe (mg/Kg)	51.0	50.0	49.0	Fe (mg/Kg)	19	21	20
Na (%)	2.02	1.85	1.95	Na (%)	2.88	2.69	3.09
Cu (mg/Kg)	1208	474	468	Cu (mg/Kg)	17	12	16
S (mg/Kg)	0.21	0.18	0.22	S (mg/Kg)	0.12	0.13	0.17
Bo (mg/Kg)	505.0	450.0	480.0	Bo (mg/Kg)	505.0	450.0	480.0

Comments

Sample A, B and C are similar sources of secondary and micro nutrients. The products are highly soluble 30 - 40% water soluble. The level of Ca and Mg (secondary nutrients is high compared to requirement of annual and perennial crops. The micronutrient levels of Zn, Cu, Bo and Fe are high relatively to crop requirement. Foliar application of fruit crops e.g. (Tomato, Citrus, Cashew and Oil Palm) could result in high flowering and good fruiting. 0.025% to 0.055 solution of the product will be suitable for many crops.

ROTAS SOILAB LTD. SIGNATURE

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Analyses of the Agrolyser samples by Rotas Soilab Limited, Ibadan, on 27 September 2002.

The analyses show that:

- the mineral nutrient element composition of the agrolyser is variable; characteristic of mined raw materials. Thus, applied dosages will be ranges rather than a fixed or single dosage.

- the agrolyser contains boron, sulphur, zinc, and traces of molybdenum.

Singh (2002) has noted that cassava removes the following micro-nutrients from the soil:

	Gram/hectare
Zn	45
Fe	120
Mn	45
Cu	5
Bo	15
Mo	–

The total micronutrients amounts removed by a 30 tonne root yield of cassava from all plant parts, according to Asher et al. 1980 are:

	ug/g
Zn	75
Fe	200
Mn	75
Cu	8
Bo	25

Table 4. Concentration of nutrients in the youngest fully expanded leaves of cassava at 2–5 months of age.

	Deficient	Critical	Normal	Toxic
		Percent		
Nitrogen	< 4.5	5.7	5.0-6.0	–
Potassium	< 1.0	–	1.2-2.0	–
Calcium	< 0.5	–	0.6-1.5	–
Phosphorus	< 0.2	0.4	0.3-0.5	–
Magnesium	< 0.2	–	0.25-0.5	–
Sulphur	< 0.3	0.32	0.3-0.4	–
		ug/g		
Iron	< 50	–	60-200	> 250
Manganese	< 50	–	50-250	> 1000
Zinc	< 35	35-50	40-100	–
Boron	< 15	–	15-50	> 140
Copper	–	–	7-15	–

Agricultural Soils of Nigeria

The soils of Nigeria are so diverse that no single recommendation is adequate for all forms. Their agroecologic zones make it essential that any recommendation of fertilizers and manures or any other soil amendment to soils is suitable only for a specific area in each of the zones. The frequent application of only NPK as inorganic fertilizers and the occasional use of manures does not help the farmer get a balanced soil condition

needed for crop growth and yields. Not all soils are crop-able. The portion that is crop-able has been put as being 15 percent of adequate fertility needing no fertilizers. These are small-scattered portions found all over the country in enclaves. Thus, it is important to note that we must do the general enhancement of the soils of medium to low fertility to obtain the best yields from them. One aspect of this enhancement is the use of NPK and micronutrients. Any small improvement from each element nutrient applied helps to enhance the suitability of the yield of cassava stem, root, and forage.

Soil testing as a regulatory practice for the level of fertility in farm soils is essential in crop farming aimed for high yields through the use of added soil amendments. Soil testing is key to the safe and economic use of all manures and fertilizers supply micro- or macro-elements. However, the adoption and use of soil testing as a practice is costly and has not become common in Nigeria as a result of few reliable laboratories that do such test across all the six geopolitical zones of Nigeria.

Chapter 2

Lagos State ADP Agrolyser trials

Field trials of Agrolyser [micronutrients] on Cassava in Lagos State conducted by the Lagos State Agricultural Development Authority [LADA] in collaboration with Cybernetics Nigeria Limited

Introduction

The need to improve the performance of cassava using mineral fertilizer has been recognized for a very long time. However, the inclusion of elements has been limited to just three of the 16 essential elements The three major nutrient element commonly supplied in the form of inorganic fertilizers are nitrogen, phosphorus, and potassium. It is also noted that the failure to supply complements of the micronutrient elements are worth investigating. Agrolyser is a micronutrient element formulation on sale by Cybernetics Nigeria Ltd. in Nigeria.

The Agrolyser is usually applied in combination with other fertilizers or manure; never alone. The rate is one bottle ground and well mixed with 25 kg of conventional fertilizer or one bottle to 50 kg manure. It is applied after weeding of the plots. For root and tuber crops, the recommended rate is five coca colá capfuls of agrolyser to one tier of NPK.

Thus, the invitation of Cybernetics to the IITA-CMD project to consider the use and promotion of the micronutrient elements

led to a visit to the trials ongoing in Lagos State.

Methodology

The team constituted to visit the plots comprised:

Mr Oladapo John Olakunlehin, Head, Extension Field Activities, LADA [08023066666]
Mrs Remi Onasanya, Cybernetics Nigeria Limited [gsm 08033574592; 01-7921371]
Dr (Mrs) O.S. Aribisala, Forage Specialist, University of Ibadan,
Mr Bunmi Olasanmi, PhD student of Cassava, Department of Agronomy, University of Ibadan
Prof. MO Akoroda, CMD Agronomist, IITA Onne

Before setting off for the field trip, the team paid a courtesy visit to the Program Manager of the LADA, Mr A.A. Adepoju and Dr Olayiwole Onasanya, [08023191180, 01-4920791; email: olayiwole@ yahoo.com] the Head of Component, Extension Services, and Mrs Biola Ayoade, [08023332093] the Head of Communications.

The two sites visited on **31 January 2005**, were farmers plots at two locations:

1. Mr Manu's farm at Gberigbe

Three separate 10 rows spaced at 1.5 m with ten plants in each row spaced 68 cm apart [9 to 10 plants per 6.5 m]; equivalent to 102 m^2 plots each received only one treatment. One plot each was established for each of three treatments without replication. The treatments were: 3 head pans of cured pig manure plus a

300 g bottle of Agrolyser applied by broadcasting to the soil once at land preparation before planting of cassava. This is equivalent to about **29.41 kg of Agrolyser per hectare**. One cassava variety [TMS 30572] was planted.

Sampling comprised a random selection of five plants from each of the three 100 m^2 plots were harvested by one worker. These were then partitioned into the leaf lamina, petiole, young green stems, brown backed stems, stumps, and tuberous roots and weighed.

2. The second plot visited [of Mr Alfa Mojeed at Ogbodu] was 4.3 months old (planted 20 September 2004). It had a length of 57 stands [1m apart] within the rows and with of 7 stands between rows that measured six meters [0.857m]. The soil had been cultivated for a long time and was considered poor in productivity/fertility. The two test plots had two cassava varieties TMS 30572 (*Agric*) and MS6 (*Ofege*)—an early maturing variety. The plots received a general application of animal manure [poultry], one-quarter bag (50 kg) of lime, and one-half 50kg bag of NPK fertilizer (*2000 naira per bag at that time*) on land that had long been cultivated and was considered to be low in soil fertility. About three-quarters of a 300 g bottle of Agrolyser was applied to 342m^2 of the land that is equivalent to **6.58 kg of Agrolyser per hectare**.

Three plants were randomly selected from each of the two varieties under each of the two treatments [with and without Agrolyser].

Results

Seven months after planting (MAP)

Gberigbe Farm

Mean performance per plant were based on five random plants taken at 7 months after planting at Gberigbe Lagos State in June–July 2004. The following parameter variables are:

Table 5. Comparison of effect of pig manure [pM], Agrolyser [Ag] on cassava plant growth at 7 MAP at Gberigbe, Lagos State, Nigeria.

Variables of cassava plants	Control (no pM, no Ag)	pM only	pM and Ag
Plant height (m)	1.42	2.19	3.73
Weight of stem (kg/plant)	**0.24**	**1.06**	**3.38**
Weight of fresh root (kg/plant)	0.880	2.340	3.000
Root dry matter content (%)	46.0	46.8	43.1
Dry yield of roots (kg/plant)	**0.405**	**1.095**	**1.293**
Number of roots/plant	7.0	7.8	15.0
Weight of stump (g/plant)	170	280	725
Weight of green forage (g/plant)	70	295	310
Weight of total forage (g/plant)	240	575	1035
Dry wt of total forage (g/plant)	**81**	**190**	**402**

The dry root yield of agrolysed plots were **18.1%** more than those without Agrolyser but received pig manure at 7 months after planting. A better effect of the Agrolyser will be determined at full crop harvest at 12 months of age.

Ogbodu Farm

This farm belongs to Alfa Mojeed.

Table 6. Height [cm] of cassava plants at Ogbodu farm under Agrolyser application at 4.3 MAP of two cassava varieties TMS 30572 and MS6.

	Agrolysed		Non-Agrolysed	
Part of field sampled	30572	MS6	30572	MS6
East	130	110	70	80
West	130	100	70	70
Center	90	115	100	75
Mean plant height	116.7	108.3	80.0	75.0
% change due to Agrolyser	**45.8**	**44.4**	-	-

The greenness of the leaves was obviously more in the agrolysed plots, and the foliage more dense also.

Cost of Agrolyser

One packet of 24 plastic bottles [300g net weight] cost 7000 Naira. Each of the bottles cost 300 Naira or equivalent to **one Naira per gram of Agrolyser**.

Discussion

It is obvious that the Agrolyser assists the vegetative performance of the cassava plant and that it is beneficial. The Gberigbe farm has applied a rate that is 4.47 times that applied at the Ogbodu farm. This disparity in the rates applied indicates

that there is work yet to do in determination of the appropriate rate of usage. The leaves of the agrolysed plots were greener and the shoots were more vigorous and taller leading to a higher incidence of lodging and the prevalence of rodent attack because of the shade created by the dense canopy formed in the Gberigbe farm. However, the plants at the Ogbodu farm were normal.

Conclusions and further work at end of visit

1. Analyze Agrolyser samples at IITA laboratory. To determine the extent of micronutrient content of samples.
2. Construct a cost-benefit analyses of the usage of Agrolyser to enable appropriate recommendation.
3. Assess the levels of use for different soils and cassava cultivation targeted for stem mainly or root and stem production.
4. Conduct trials with Agrolyser on soils without manure or NPK fertilizer as well as with both separately or combined particularly on used-up soils or frequently cultivated soils.
5. Determine the influence of Agrolyser on root components, e.g., starch content and quality of other derived products especially at harvest of fully mature plants at 12 months after planting.
6. Determine the management required for its long term usage
7. IITA-CMD and Cybernetics Nigeria Limited and other stakeholders should conduct trials to ascertain the best way to maximize the benefits of Agrolyser.

Ten months after planting (MAP)

Gberigbe (10 MAP harvest 29 April 2005)

Preliminary report to be considered with the report of 7 MAP results of 31 January 2005.

Before the team began real harvest work, the fields were inspected by Mrs Adetunji, Special Adviser to the President on Food Security and Dr A. A. Adeniji of RTEP and was later represented by Rev Adeleye.

Team: 10 persons worked for 6 hours.

1. Mr J. O. Olakunlehin [Head, Extension, Lagos State Agricultural Development Authority] represented Mr Adepoju, the LADA Programme Manager.
2. Ms *Alhaja* Owode [Extension agent, Lagos State Agric. Dev. Authority]
3. Rev. Adeleye [Root and Tuber Expansion Programme, Ijebu Ife, FDA]
4. Dr O.S. Aribisala [University of Ibadan, Ibadan].
5. Deacon Sunday Ojo [Cassava Growers Association of Nigeria].
6. Mrs Remi Onasanya [Cybernetics].
7. Prof. M.O. Akoroda [Cassava Mosaic Disease Project-IITA].

Methodology

A random sample of 35 plants of TMS 30572 were taken from each treatment plot to represent the soil only, pig manure applied, and the pig manure–agrolyser mix applied. The plant sampling required that each of six persons was to take some

rows in the same treatment plot and identify two representative plants from each of three rows of plants. Selected plants were partitioned and weighed both fresh and dry after oven frying at IITA Ibadan.

Results

Table 7 show the summary of the preliminary results. Note that the percentage change comparison is between the pig manure plot and the plot with pig manure and Agrolyser.

Table 7. Comparison of effect of pig manure [pM], Agrolyser [Ag] on cassava plant growth at Manu farm, Gberigbe, Lagos State Nigeria. Values are averages per plant basis (kg). Harvest at 10 MAP. 29 April 2005.

Variables of cassava plants	Control (no pM, no Ag)	pM only	pM and Ag	Percent change due to Ag
Percent root dry matter	38.63	32.48	36.67	+12.32
Fresh root wt	1.15	2.22	2.41	+8.56
Total root dry yield/ha	3318	5379	6598	+22.68
Fresh top forage wt	0.21	0.83	1.00	+20.48
Fresh stem and stump wt	0.50	1.19	1.97	+65.55
Total fresh top forage wt	0.71	2.02	2.97	+47.03

[35 plants sampled per treatment plot]

Tentative conclusions

1. Agrolyser improves the dry yields of roots by 22.68% [6598/5379]

2. Agrolyser improves the shoot weight by 47.03% [2.97/2.02]
3. These statements are valid for this trial and do indicate the pattern for the ecology represented by this site. It may not apply to other sites of other ecologies, that is why other site trials are needful to extend the recommendations.

The top forage, stem, and stump are useful for livestock feeding.

Twelve months after planting (MAP)

Gberigbe (12 MAP harvest 23 June 2005)

The same field was monitored earlier at the 7 MAP and at 10 MAP. The final harvest at 12 MAP was the conclusion of the crop trial. The attendance at the last harvest were as shown below:

ATTENDANCE LIST OF VISITATION TEAM:

PRESIDENTIAL INITIATIVE ON CASSAVA PRODUCTION AND EXPORT TO THE:
LAST (3rd) HARVEST OF CASSAVA TRIALS WITH AGROLYSER SUPPLIED TO THE LAGOS STATE AGRIC DEVELOPMENT AUTHORITY BY
THE FEDERAL MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

23/06/05

NAME	POSITION	SIGNATURE
1. Owoade R.T	Extension Agent	
2. Mr Abdullah A.S	Subject Matter Spe (SMS Crop)	
3. Mr Mujindade A.G	Seed Officer	
4. Mrs Emilobi V.F	Seed Officer	
5. Mrs Junaid Elizabeth	Farmer	
6. Prof. M. Akoroda	CMD-IITA	
7. Dr (Mrs) O.S Arisi-Sala	Forage Agronomist, University of Ibadan	
8. Mr Monu	FARMER	
9. Remi Onasanya.	Cybernetics Mng Ltd Field officer	

Results

It is noted that the change in stem and stump weights exceeds those for root, shoot [leaves, petiole and soft stem] as well

as total biomass. The pattern of change did not change even among the adjusted values.

For a minimum effect consideration, all data collected that were more than two-thirds of the mean were considered extreme values and thus, dropped for all three treatments before further analyses was conducted.

Table 8. Fresh weight of cassava plant parts at harvest at 12 MAP at Gberigbe (Average for 20 plants randomly selected from across the plot)

Treatment	root wt	p. stem wt	Shoot wt	stump wt	Plant biomass	Relative
Soil	1.1498	0.5323	0.7243	0.2763	2.6825	
Manure (Mn)	1.8075	0.7088	1.4725	0.3175	4.3063	1.000
Ag+Mn	3.5250	2.0725	2.6825	0.7100	8.9900	2.088
Ag+Mn/Mn	1.9502	**2.9242**	1.8217	**2.2362**	2.0877	

Table 9. Adjusted mean values from Table 8 above.

Treatment	root wt	p. stem wt	Shoot wt	stump wt	Plant biomass	Relative
Soil	0.818	0.415	0.521	0.209	1.962	
Manure (Mn)	1.034	0.333	0.895	0.198	2.459	1.000
Ag+Mn	1.938	0.878	0.988	0.415	4.218	1.715
Ag+Mn/Mn	1.874	**2.639**	1.103	**2.101**	1.715	

Dry matter from fresh roots

Fresh shoot, root, and stem materials wrapped in waterproof polyethylene transported in air-conditioned vehicles to reduce evaporation were electronically weighed just before dicing.

The samples were dried at IITA Ibadan in an electric draught air-oven at 60–70°C to constant weight.

Table 10. Dry matter content of roots.

Soil treatment	Root peel fresh wt	Peel dry wt	Percent dry matter
Soil only	133.3	25.7	19.28
Pig manure [PM] only	155.8	34.6	22.21
PM and Agrolyser	385.2	93.3	24.22
	Cortex fresh wt	Root dry wt	Percent dry matter
Soil only	200.18	52.1	26.03
Pig manure [PM] only	200.18	59.1	22.21
PM and Agrolyser	200.18	74.7	37.32

Dry matter percent of the roots—both the peel and cortex — were higher from PM+Agrolyser than from either soil only or pig manure only. However, the relevant comparison would be that between PM + Agrolyser and pig manure only. Thus, for cortex [peeled roots] it is:

37.32 – 22.21 = 15.11
15.11/22.21 = 0.6803 x 100 = 68.03%

This 68% rise in cortex dry matter was due to Agrolyser alone under the *soil* and *weather* of *that cassava crop* and for the *variety* grown [TMS 30572].

For peels, it is:
24.22 – 22.21 = 2.01
2.01/22.21 x 100 = 9.095%

There was a 9% change upward due to the application of Agrolyser.

Discussion
The fresh and dry yields show that the use of Agrolyser is beneficial. It raises the quality of the roots and peels; and increases the yield of plantable stems of the crop that would be sold as planting materials. These results are indicative of a positive influence from applying Agrolyser.

Analyses of the composition of cassava leaf lamina, petiole, stem, and roots at the 12 MAP harvest on 23 June 2005 from Gberigbe, Lagos State

Samples of the different parts were taken from Gberigbe in Lagos State, wrapped in poly-bags and deposited the same day at the IITA Crop Utilization laboratory at Ibadan.

Roots are usually processed into human food and livestock feedstuff.

Table 11. Composition of leaf, petiole, stem, and root of cassava from plots with soil without any soil amendment, with pig manure [pm]. and pig manure mixed with agrolyser [Ag] at Gberigbe in Lagos State in 2005.

Code	% M.C	% Ash	% Sugar	% Starch	% Protein	ppm Cu	ppm Zn	ppm Fe
				Leaf				
Soil	6.43	2.59	7.92	16.60	19.48	5.78	24.70	128.78
pm	6.42	1.55	8.45	14.57	23.71	4.38	29.31	123.62
pm + Ag	6.56	1.10	8.90	27.17	29.81	9.82	30.51	114.09
				Petiole				
Soil	8.30	2.90	7.31	33.19	7.02	11.55	28.32	48.14
pm	7.19	3.13	8.42	28.93	7.12	12.67	31.06	37.03
pm + Ag	5.54	5.50	5.96	34.43	7.06	11.58	21.25	57.88
				Stem				
Soil	5.16	2.51	6.30	30.90	6.05	15.14	27.54	83.21
pm	5.11	2.84	6.04	33.21	6.25	17.31	24.01	46.62
pm + Ag	3.54	4.38	4.70	32.93	7.01	16.29	16.90	58.01
				Root				
Soil	8.84	1.85	3.72	67.21	0.93	16.18	15.60	14.52
pm	9.23	2.03	4.73	68.39	1.51	11.94	19.25	16.18
pm + Ag	8.87	1.88	3.49	67.21	1.13	14.79	22.40	14.56

The roots of the manure and manure with Agrolyser treatments do not differ much in their content of ash, starch, moisture content, sugar, and protein.

The need to ensure that micronutrient levels are high in the roots or leaves [where they are consumed], soil amendments

using Zn containing materials is recommended. Agrolyser would help in this regard. The effect due to agrolyser is about 16.36 percent [22.4–19.25/19.25 x 100].

Considering the food intake in the form of cassava root products, Zn deficiency can be relieved in part by ensuring that the cassava roots are adequate in Zn when their fields are supplied with a normal dose of 4 kg of Agrolyser. Maziya-Dixon et al. (2004) reported the status of Zn deficiency in some representative states in Nigeria.

Table 12. Zinc status among mothers and pregnant women by state in Nigeria.

	Mothers			Pregnant women		
State	no.	PN	PD	no.	PN	PD
Akwa Ibom	512	88.3	11.7	88	79.6	20.4
Bayelsa	229	75.1	24.9	35	54.3	45.7
Bornu	376	78.7	21.3	87	74.7	25.3
Edo	261	92.3	7.7	43	86.0	14.0
Imo	362	93.1	6.9	101	79.2	20.8
Kaduna	332	41.3	58.7	65	16.9	83.1
Kano	371	66.6	33.4	70	57.1	42.9
Kebbi	198	34.3	65.7	52	28.8	71.2
Kwara	275	30.9	69.1	73	16.4	83.6
Nasarawa	205	58.5	41.5	44	31.8	68.2
Osun	329	95.4	4.6	71	43.9	56.1
Taraba	329	75.4	24.6	66	43.9	56.1

no.: number of observations; PN: percentage normal; PD: percentage deficient. [Maziya-Dixon et al. 2004]

Table 13. Zinc status among children under five years of age by state in Nigeria

State	no.	PN	PD
Akwa Ibom	174	93.1	6.9
Bayelsa	53	84.9	15.1
Bornu	106	89.6	10.4
Edo	97	93.8	6.2
Imo	126	93.7	6.4
Kaduna	95	64.2	35.8
Kano	121	69.4	30.6
Kebbi	34	41.2	58.8
Kwara	88	40.9	59.1
Nasarawa	102	64.7	35.3
Osun	98	94.9	5.10
Taraba	131	74.8	25.2

no.: number of observations; PN: percentage normal; PD: percentage deficient. [Maziya-Dixon *et al.* 2004]

Chapter 3

Effect of Agrolyser on roots and stems of cassava

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Aim: The improvement of root and stem yields using Agrolyser.

1. Umudike Agrolyser trial planted on 22 July 2005 with NPK (Table 14).

Table 14. Effect of inorganic fertilizer [NPK] and Agrolyser [Ag] on cassava root and plantable stem [PS] yield at Umudike planted on 22 July 2005.

NPK (kg /ha)	Ag (kg /ha)	PS wt (t)	Relative to 0-0	Fresh roots (t)	Relative to 0-0
0	0	2.8	1.00	21.8	1.00
0	2	3.3	1.17	22.4	1.03
0	4	3.3	1.17	24.5	1.12
0	6	3.0	1.07	29.6	1.36
400	0	6.6	2.36	35.9	1.65
400	2	7.4	2.64	31.8	1.46
400	4	5.7	2.04	30.0	1.38
400	6	6.8	2.43	34.5	1.58

2. Umudike Agrolyser Trial planted 25 July 2005: Battery cage poultry manure was applied to cassava.

Battery cage poultry manure was collected and left to air/sun-dry over 3 months. The manure was later oven dried before samples were taken. Manure was applied at 0 or 2 tonnes per hectare to field plots, together with 0, 2, 4, and 6 kg/ha of Agrolyser]. All field operations were manual. 20 plants were harvested in each of 3 replicates.

Table 15. Effect of dry manure [dM] and Agrolyser [Ag] on cassava root and plantable stem [PS] yield at Umudike during 2005/2006 season. Planted at 25 July 2005.

dM (t/ha)	Ag (kg/ha)	PS yield (t)	PS as % of the two best rates	PS as % of 0-0 (check)	Fresh Roots yield (t/ha)	Roots as % of two best rates	roots % of 0-0
0	**0**	2.2	50.00	100	21.8	88.98	100.0
0	2	3.7	84.09	168	20.4	83.27	93.6
0	4	4.4	100.00	200	24.5	100.0	112.4
0	6	3.6	81.82	164	20.0	81.63	91.7
2	0	3.8	67.86	173	29.5	104.98	135.3
2	2	3.1	55.36	141	23.5	83.63	107.8
2	4	5.6	100.00	255	28.1	100.0	128.9
2	6	2.6	46.43	118	27.5	97.86	126.2
	Mean	3.63	73.19	165	24.4	92.54	112.0
	SE	0.375	7.596	17.067	1.283	3.25	5.887

Discussion

Plantable stem yield was best at 4 kg application of Agrolyser. The root yield was also best at 4 kg/ha; but application of a higher levels of dry manure raised the yields generally. The trends were indicative of a positive Agrolyser effect but the small number of plants suggest a wider trial.

Chapter 4

On-farm evaluation of the productivity of yam/maize cassava intercrop using agrolyser micronutrient fertilizer as supplement to inorganic fertilizer (NPK) in Imo State [Nigeria]

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and O.N. Eke-Okoro

Proceedings of the Farming Systems Research and Extension.
REFILS of South-East Zone of Nigeria, 2003.

Objective: Evaluate the productivity of yam/maize cassava intercrop using Agrolyser and NPK.

An on-farm trial planted in April–June in 2002 at Okigwe, Orlu, and Owerri zones of Imo State ADP was harvested in 2003 at 12 months after planting. The trial was laid out in a randomized complete block design with 3 replicates in each zone.

Two doses of Agrolyser [300 g and 150 g] added separately to one dose of 300kg of NPK. Land was cleared, burnt and packed and mounds made at 1m apart into which were planted cassava. At the side of the mound, maize was planted at 20000 plants/ha.

Various crops components were significantly influenced by Agrolyser.

Results

Table 16. Fresh root yield (t/ha) of cassava as influenced by Agrolyser under intercrop with maize

NPK (kg /ha)	Agro-lyser (g)	Okigwe	Orlu	Owerri	Mean	% change due to agrolyser
300	300	12.15	14.73	10.02	12.30	+ 8.85
300	150	13.61	14.38	10.10	12.47	+ 10.35
300	0	12.07	12.42	9.42	11.30	–
Mean		12.56	13.84	9.85	**11.52**	
% Change		8.20	17.19	6.79		
LSD (5%)		ns	ns	ns		

Trends are positive. This is to say that Agrolyser does help in more cases than not. The relative yield increase of *6 to 18 percent* from the application of Agrolyser would be worthwhile; though not a statistically significant change.

Discussion

The type of NPK used in the trial was not stated. But be that as it may, there is a tendency for the better balance in the cationic milieu of the soil to favor better growth of the cassava crop For that reason, this finding should be considered in tandem with other similar trials to reach a general guidance for use of Agrolyser.

Even in a recent work on 0, 400, 600, and 100N, 100P, 45K kilograms [illegible] PK fertilizer with four levels of agrolyser;

averaged over all levels of NPK, the Agrolyser effect on another root crop, Eke-Okoro et al. (2007) showed that Agrolyser enhances the attributes of potato yield (Table 17).

Table 17. Mean yield attributes of potato as affected by fertilizer and agrolyser application in 2006 at Umidike, Abia State.

	Agrolyser rate (kg/ha)				
	0	10	15	20	LSD (5%)
Fresh yield (t/ha)	6.00	8.00	7.00	7.43	1.31
Ware yield (t/ha)	4.27	5.00	4.05	4.42	0.74
Seed yield (t/ha)	2.00	3.04	3.02	2.87	0.67
Number of ware	6125	7756	4858	6088	307
Number of seed	7775	7049	7076	7078	279

Source: Eke-Okoro, et al. 2007.

Beyond 10 kg/ha rate of application, Agrolyser did not increase any attribute of potato yield. This indicates that the small amount of Agrolyser applied is effective. There is need for more detailed studies to narrow the gap between the 4 kg for cassava to a little less so as to reduce the cost of application through lower doses. A 33 percent increase in fresh yield of potato was realised by applying 10 kg of Agrolyser.

Chapter 5

Multilocational testing of agrolyser in IITA cassava fields

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IITA grew 18 varieties of cassava in six locations: Ibadan, Mokwa, Ubiaja, Lanlate, Onne, and Obudu representing moist, high rainfall, and subhumid cassava growing areas of Nigeria.

The Objective was to evaluate the effect of Agrolyser on cassava at three different agroecologies in Nigeria.

Plot size harvested was for 16 stands from 4 m x 4 m. The quantity of fertilizer per plot was 30 g/stand (30 g x 16 stands), that is, 480 g per harvest plot area. The quantity of Agrolyser applied to plot was 2 bottles [300 g x 2] pre-mixed with 50 kg of NPK [15-15-15]. The field had three weeding operations and no herbicide was applied.

Results and Discussion

The results show that the application of Agrolyser is evident if the ratios of NPK are appropriately balanced for the cassava crop. This is with regard to the amount of nutrient elements removed from soil by cassava plants.

Table 18. Amount of nutrients applied fields of cassava at the three trial locations in Nigeria.

Nutrient Applied (kg/ha)	NPK+Ag	Cotonou	NPK
	Kg of fertilizer applied		
N	44.47	39.0	45.0
P	44.47	27.0	45.0
K	44.47	81.0	45.0
S	0	15.0	0
Ca	0	12.0	0
All applied nutrients	**133.41**	**174.0**	**135.0**

It is important to note that the level of applied nutrients in the fertilizers were not same. The Cotonou fertilizer was 29.7 percent higher in nutrients than the NPK fertilizers. Consequently, their differential responses are to be expected.

Results are still preliminary until the second year trials are concluded. However, this first year results showed that at Ibadan and Obudu root yields were compareable between NPK+Ag and NPK. At Lanlate, and Onne, plots with agrolyser gave higher yields (12.5%, 19.3%). In all the locations, yields in plots with fertilizer applications were comparable for NPK with and without Agrolyser as regards root and top shoot. Overall performance across the four sites showed that root yield increased by 7.3% and top yield increased by 10.9% in plots with Agrolyser.

Table 19. Mean cassava fresh top and root yield [t/ha] in IITA Agrolyser field trials at three sites in Nigeria, 2006.

Locations	Yield (t/ha)	NPK +Ag	Cotonou	No fert	NPK only	Mean	SE
Ibadan	Top	14.16	13.45	12.54	14.19	13.58	0.87
	SE	0.66	0.73	0.82	0.91		
	Root	19.66	19.74	18.35	21.13	19.72	1.62
	SE	1.14	1.47	1.64	2.05		
Mokwa	Top	26.14	25.01	20.59	–	23.91	2.90
	SE	1.01	1.69	1.03	–		
	Root	29.45	27.99	24.30	–	27.25	2.13
	SE	0.93	1.02	1.04	–		
Ubiaja	Top	7.93	11.02	7.31	–	8.75	1.70
	SE	0.54	0.53	0.82	–		
	Root	17.93	21.32	16.01	–	18.42	2.49
	SE	1.23	0.95	1.35	–		
Lanlate	Top	15.25	13.45	11.80	14.06	13.64	0.72
	SE	0.55	0.38	0.50	0.30		
	Root	20.32	17.75	10.61	18.06	16.69	2.10
	SE	1.23	0.80	0.70	0.93		
Onne	Top	8.72	12.49	10.59	6.19	9.50	1.34
	SE	0.60	0.87	0.62	0.49		
	Root	13.68	17.03	14.98	11.47	14.29	1.17
	SE	0.83	0.99	0.71	0.76		
Obudu	Top	15.45	14.78	12.68	18.23	15.29	1.15
	SE	0.67	0.65	0.55	0.88		
	Root	29.11	24.92	24.25	30.20	27.12	1.49
	SE	1.25	1.26	0.88	1.41		
Mean of six sites for 18 improved varieties							
	Top	14.61	15.03	12.59	13.17	13.85	0.58
	SE	2.67	2.06	1.79	2.52		
	Root	21.69	21.46	18.08	20.22	20.36	0.83
	SE	2.58	1.74	2.21	3.89		

SE: standard error

Table 20. **Coefficient of variation** of fresh root yield, dry root yield, top yield, and harvest index combined for 18 elite cassava genotypes in six sites, 2005/06 trials.

	t/ha	NPK+Ag	Cotonou	Control	NPK only
Ibadan					
Fresh	Mean	19.66	19.74	18.35	21.13
root	SE	1.14	1.47	1.64	2.05
yield	CV (%)	24.63	31.58	37.84	41.25
Dry root	Mean	6.37	6.58	6.31	6.92
yield	SE	0.35	0.52	0.57	0.64
	CV (%)	23.46	33.22	37.98	39.25
Top	Mean	14.16	13.45	12.54	14.19
Yield	SE	0.66	0.73	0.82	0.91
	CV (%)	19.81	23.01	27.73	27.05
Harvest	Mean	0.56	0.57	0.58	0.56
Index	SE	0.02	0.02	0.02	0.02
	CV (%)	13.78	11.94	12.88	18.05
Mokwa					
Fresh	Mean	29.45	27.99	24.3	–
root	SE	0.93	1.02	1.04	–
yield	CV (%)	13.38	15.49	18.1	–
Dry root	Mean	10.97	10.82	9.2	–
yield	SE	0.42	0.5	0.51	–
	CV (%)	16.27	19.76	23.34	–
Top	Mean	26.14	25.01	20.59	–
yield	SE	1.01	1.69	1.03	–
	CV (%)	16.31	28.74	21.15	–
Harvest	Mean	0.54	0.55	0.55	–
Index	SE	0.01	0.01	0.01	–
	CV (%)	9.81	11.11	8.99	–

Table 20. **continued**

	t/ha	NPK+Ag	Cotonou	Control	NPK only
Ubiaja					
Fresh	Mean	17.93	21.32	16.01	–
root	SE	1.23	0.95	1.35	–
yield	CV (%)	29.13	18.96	35.69	–
Dry root	Mean	7.15	7.77	5.99	–
yield	SE	0.54	0.37	0.54	–
	CV (%)	32.06	19.99	38.39	–
Top	Mean	7.93	11.02	7.31	–
yield	SE	0.54	0.53	0.82	–
	CV (%)	28.75	20.6	47.34	–
Harvest	Mean	0.69	0.66	0.7	–
Index	SE	0.01	0.01	0.01	–
	CV (%)	8.11	5.67	7.4	–
Lanlate					
Fresh	Mean	20.32	17.75	10.61	18.06
root	SE	1.23	0.8	0.7	0.93
yield	CV (%)	25.68	19.12	27.99	21.85
Dry root	Mean	8.04	6.96	4.25	7.35
yield	SE	0.49	0.33	0.3	0.4
	CV (%)	26.06	20.26	30.13	22.98
Top	Mean	15.25	13.45	11.8	14.06
Yield	SE	0.55	0.38	0.5	0.3
	CV (%)	15.3	11.99	17.98	9.05
Harvest	Mean	0.56	0.56	0.46	0.54
Index	SE	0.01	0.01	0.02	0.01
	CV (%)	9.65	11.19	14.9	10.7

Table 20. **continued**

	t/ha	NPK+Ag	Cotonou	Control	NPK only
Onne					
Fresh	Mean	13.68	17.03	14.98	11.47
root	SE	0.83	0.99	0.71	0.76
yield	CV (%)	25.74	24.66	20.11	28.11
Dry root	Mean	3.32	4.3	3.66	2.5
yield	SE	0.24	0.31	0.23	0.2
	CV (%)	30.67	30.59	26.66	33.94
Top	Mean	8.72	12.49	10.59	6.19
Yield	SE	0.6	0.87	0.62	0.49
	CV (%)	29.19	29.55	24.84	33.58
Harvest	Mean	0.61	0.58	0.59	0.67
Index	SE	0.01	0.01	0.01	0.02
	CV (%)	6.96	7.31	7.19	12.66
Obudu					
Fresh	Mean	29.11	24.92	24.25	30.2
root	SE	1.25	1.26	0.88	1.41
yield	CV (%)	18.22	21.45	15.4	19.81
Dry root	Mean	11.18	9.21	9.06	11.26
yield	SE	0.51	0.47	0.34	0.53
	CV (%)	19.35	21.65	15.92	19.97
Top	Mean	15.45	14.78	12.68	18.23
Yield	SE	0.67	0.65	0.55	0.88
	CV (%)	18.4	18.66	18.4	20.48
Harvest	Mean	0.65	0.62	0.66	0.62
Index	SE	0.01	0.01	0.01	0.01
	CV (%)	6.53	6.84	6.43	6.84

At Mokwa, Lanlate, and Obudu, Agrolyser application was beneficial. Comparing Cotonou and NPK+Ag show that a slightly better root and stem yield is realised at these three locations. However, the 1.5-4.1 tonne increase in root yield as a result of Agrolyser in these sites have to be shown to produce more value than the cost expended in applying it.

Coefficient of variation indicates how variable the 18 genotypes were under the fertilizer applied to them. On that basis, the control had the higher values than those that were fertilized with NPK with and without agrolyser for Ibadan, Ubiaja, Lanlate (root and top yields), and Mokwa for root yield only. Agrolyser reduced the variation in Ibadan, Mokwa (root and top yields), and Obudu for top yield only but not in Ubiaja, Lanlate, Onne, and Obudu (root yield). The Cotonou fertilizer reduced the variation among genotypes in Ubiaja and Lanlate (root yields). Clearly, better crop nutrition give better and more stable yields.

Chapter 6

Effect of Agrolyser on cassava productivity

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Integrated Cassava Project [CMD], IITA Onne

Introduction.

In developed countries, fertilizers have become an integral part of the agricultural economy, but in developing countries, their use is a comparatively recent occurrence. Various studies show that there is a close relationship between fertilizer consumption levels and agricultural productivity. Crop yield levels are generally higher where fertilizer consumption levels are also high. It has been estimated that about 50% of the increase in agricultural production is attributed to fertilizer use. Agrolyser, which is a balanced micronutrient element formulation, consisting of ten micronutrients and secondary elements like Cu, Mn, Mg, Fe, Na, Ca, S, B, Zn, and Mo were also used to increase the yield of some crops such as maize, rice, and soybean. Several studies on Agrolyser in some locations in Nigeria revealed that in a soybean trial, agrolysed plots were more lush in appearance and agrolysed plants had less

disease infection than non-agrolysed plants. Also in a rice trial, agrolysed plants produced more tillers than non-agrolysed plants. Cassava is a very important staple food for millions of people in sub-Sahara Africa and is gradually being transformed from a famine-reserve commodity and rural food staple to a cash crop for urban consumption, livestock feed and industrial raw material for various products, so there is a need to improve its productivity. Apart from fertilizers, Agrolyser can also be used to increase cassava yield. But currently not much is known about the effect of the Agrolyser on cassava since it can be grown for its roots, forage, and stems. Agrolyser tested on cassava productivity in one location in Nigeria revealed that the dry root yields of agrolysed plots were significantly higher than those without Agrolyser.

Objectives

The objectives of this work were to evaluate the effect of agrolyser on growth components (roots, stem, and foliage) of 43 improved pest-disease resistant and high yielding IITA cassava varieties in two locations in Nigeria; and specifically:

- To evaluate the effect of Agrolyser on growth components (roots, stem, and foliage) of the 43 improved IITA cassava varieties by location.
- To construct cost-benefit analysis of the use of Agrolyser in order to make an appropriate recommendation.
- To evaluate the performance of Agrolyser containing fertilizers as compared to that of other fertilizers such as NPK and Cotonou fertilizer without Agrolyser on cassava components yield.

Materials and Methods

A trial was set up in two locations: RIART, Onne Rivers State and Ferdinand Farms, Ogurugu, Enugu State.

RIART Onne, River State. The first plot located at the RIART was ploughed and harrowed without ridges between 30 May 2005 and 7 June 2005. Planting materials were cut from IITA's field on 7 June 2005, and cut into planting size (3 to 5 nodes) on 8 June 2005. These cuttings were pre-sprouted in a warm room for one week (9–17 June 2005). Sprouted materials were removed from the warm room on 17 June 2005 and the planting started the same day. Due to the weather condition (heavy rain everyday), the planting was extended for 5 days (17–21 June 2005).

Planting materials (varieties) used were:

- 5 CMD varieties: TMS 98/0505; TMS 97/2205; TME 419; TMS 98/0581; and TMS 98/0510
- 1 national check variety: TMS 30572
- 1 NRCRI Umudike resistant variety: NR8082

Ferdinand Farms, Ogurugu, Enugu State. At Ugurugu, the plot was ploughed and double harrowed without ridges between 28 October 2005 and 1 November 2005. Planting materials were cut from IITA fields at Onne Station on 30/10/06, cut into 25 cm stakes and planted in an inclined direction. Between 1 to 12 cuttings were planted in each of the 3 rows considered

by variety. Thirteen spacing combinations were considered. The experiment was repeated 4 times. Factorial: 12 cuttings x 3 rows x 13 treatment combinations x 4 replicates = 1872 stem cuttings [stakes].

Row–row (cm)	Plant–plant (cm)			
	0.5	0.6	0.7	0.8
0.6	1	2		
0.7	3	4	5	
0.8	6	7	8	9
0.9	10	11	12	13

Two months after planting (16 August 2005) at the RIART plot, different types of fertilizer treatments were applied at the rate of 400 kg/ha.

Table 21. Types of fertilizer or Agrolyser [AG] applied, their composition and percentage nutrients in added matter.

Fertilizer type applied	Composition ratio/weights	% nutrients in added matter
NPK + AG (pre-mixed)	N16:P27:K10	52.93
NPK = 15:15:15	6.5kg/10 kg	
DAP = 21%N + 53%P	3.2kg/10kg	
Agrolyser	0.3kg/10kg	
NPK	15:15:15	45.00
Cotonou fertilizer (N:P:K:S:MgO)	13:9:27:5:4	58.00
No Fertilizer	-	0

Data Collection

At 12 MAP, the standard stakes yield, forage yield, and the root yield were assessed. At RIART, data was collected per plant. Each plant available in each row for all the 3 rows per plot and per variety was harvested.

While at Ogurugu, four plants per treatment and per variety were considered for the assessment. Each stem was cut into stake units [main stem, primary, secondary, tertiary, and other branches] up to the green-brown point [point of separation between the mature part of the plant and the immature part or the forage]. The total length of the plantable stem was

measured [in cm] using a tape rule; the diameter was estimated [in cm] using a venier calliper, a 1 kg spring balance was used to measure the stem weight [in gram] while the forage and root weight was measured [in gram] using a 50 kg spring balance.

Varieties used were:

- 5 CMD varieties: TMS 98/0505; TMS 97/2205; TME 419; TMS 98/0581; TMS 98/0510
- 1 national check: TMS 30572
- 1 NRCRI Umudike resistant variety: NR 8082

In each of the 3 rows considered by variety, 12 cuttings were planted. A total of 13 spacing combinations were considered. The experiment was repeated 4 times. Factorial: 12 cuttings x 3 rows x 13 combinations x 4 rep = 1872 cuttings.
One month after planting (15/12/05) different types of fertilizers was applied at the rate of 400kg/ha. Table 21 shows the types of fertilizer or agrolyser applied, their composition and percentage nutrient in added matter.

Results
Tables 22–27 show the relative standard stakes yield, root and forage yields obtained at the two locations at 3 different spacing combinations (0.9 x 0.8m, 0.9 x 0.7m, and 0.8 x 0.8m) with three different types of fertilizer.

RIART Onne

Table 22. Relative standard stake yield with NPK + Agrolyser [16:27:10], NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:9:27:5:4) to no-fertilizer (NF) at RIART, Onne.

Fertilizer	0.9 x 0.8 = 0.72m^2	0.8 x 0.8 = 0.64m^2	0.9 x 0.7 = 0.63m^2	Fertilizer Total	Relative to NF
Ag+NPK	1.89	2.74	1.25	5.88	1.96
NPK	2.09	1.93	1.35	5.37	1.79
COT	2.70	1.32	1.83	5.85	1.95
NF	1.00	1.00	1.00	3.00	1.00
Spacing total	7.68	6.99	5.43		
% of 0.64 m2	0.91	1.00	0.78		

Original values are in Appendix 1.

Table 23. Relative forage yield with NPK + Agrolyser [16:27:10], NPK 15:15:15 and Cotonou fertilizer to no-fertilizer (NF) at RIART, Onne.

Fertilizer	0.9 x 0.8 = 0.72m^2	0.8 x 0.8 = 0.64m^2	0.9 x 0.7 = 0.63m^2	Fertilizer Total	Relative to NF
Ag+NPK	2.04	3.78	1.01	6.83	2.14
NPK	3.11	4.57	1.00	8.68	2.72
COT	3.07	2.84	1.25	7.16	2.24
NF	1.00	1.00	1.19	3.19	1.00
Spacing total	9.22	12.19	4.45		
% of 0.64 m2	0.76	1.00	0.37		

Original values are in Appendix 1.

Table 24. Relative roots yield with NPK + Agrolyser [16:27:10], NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:09:27:5:4) at RIART, Onne.

Fertilizer	0.9 x 0.8 = 0.72m^2	0.8 x 0.8 = 0.64m^2	0.9 x 0.7 = 0.63m^2	Fertilizer Total	Relative to NF
Ag+NPK	1.37	1.50	1.13	4.00	1.22
NPK	2.34	2.10	1.00	5.44	1.65
COT	2.35	1.41	1.29	5.05	1.53
NF	1.00	1.00	1.29	3.29	1.00
SP total	7.06	6.01	4.71		
% of 0.64 m^2	0.85	1.00	0.78		

Original values are in Appendix 1

Ogurugu, Enugu State

Table 25. Relative standard stake yield with NPK + Agrolyser [16:27:10], NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:9:27:5:4) at Ogurugu, Enugu State.

Fertilizer	0.9 x 0.8 = 0.72m^2	0.8 x 0.8 = 0.64m^2	0.9 x 0.7 = 0.63m^2	0.8 x 0.7 =0.56m^2	Fertilizer Total	Relative to 1.00
Ag+NPK	1.14	1.13	1.23	1.01	4.51	1.13
NPK	1.08	1.03	1.55	1.13	4.79	1.20
COT	1.21	1.18	1.51	1.04	4.94	1.24
O	1.00	1.00	1.00	1.00	4.00	1.00
SP total	4.43	4.34	5.29	4.18	18.24	
% of 0.64m^2	0.98	1.00	0.82	0.96		

Original values are in Appendix 2.

Table 26. Relative forage yield with NPK [16:27:10] + Agrolyser, NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:9:27:5:4) at Ogurugu, Enugu State.

Fertilizer	0.9 x 0.8 = 0.72m^2	0.8 x 0.8 = 0.64m^2	0.9 x 0.7 = 0.63m^2	0.8 x 0.7 =0.56m^2	Fertilizer Total	Relative to 1.00
Ag+NPK	1.01	1.00	1.30	1.40	4.71	1.01
NPK	1.00	1.40	1.31	1.74	5.45	1.16
COT	1.25	1.63	1.46	1.66	6.00	1.28
O	1.19	1.49	1.00	1.00	4.68	1.00
Spacing total	4.45	5.52	5.07	5.80	20.84	
% of 0.64m^2	0.81	1.00	0.92	0.95		

Original values are in Appendix 2.

Table 27. Relative roots yield with NPK + Agrolyser [16:27:10], NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:9:27:5:4) at Ogurugu, Enugu State.

Fertilizer	0.9 x 0.8 = 0.72m^2	0.8 x 0.8 = 0.64m^2	0.9 x 0.7 = 0.63m^2	0.8 x 0.7 =0.56m^2	Fertilizer Total	Relative to 1.00
Ag+NPK	1.00	1.08	1.10	1.02	4.20	1.02
NPK	1.46	1.51	1.19	1.56	5.72	1.39
COT	1.37	1.39	1.59	1.51	5.86	1.42
O	1.12	1.00	1.00	1.00	4.12	1.00
Spacing total	4.95	4.98	4.88	5.09	19.90	
% of 0.64 m^2	0.99	1.00	0.98	0.98		

Original values are in Appendix 2.

Discussion

RIART Onne, Rivers State

Tables 22, 23, and 24 show that standard stakes yield, root and forage yields can be improved with the use of fertilizer. Considering all components of the cassava plant excluding stumps (roots, stem, and forage), NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:9:27:5:4) had a good effect of their yields. The relative standard stakes yield with the use of the mixture of Agrolyser and NPK, Cotonou fertilizer and NPK 15:15:15 are 1.96, 1.95 and 1.79, respectively. The relative forage and root yields with the use of the mixture Agrolyser and NPK 15:15:15 are 2.14 and 1.22, respectively. This is less than that of the one with the use of NPK 15:15:15 (2.72, 1.65) and Cotonou fertilizer (2.24, 1.53).

A question can be asked. Why does the Agrolyser mix with about 53% give less yields compared to just NPK 15.15.15? It seems this is due to the nutrient ratio. There is low K in the Agrolyser mix that is needed for starch deposition in roots. The ratio is more favourable in the Cotonou fertilizer. A suggested ratio for Onne soils may be 10N-10P-25-30K. This study suggests that if the ratios of the major elements are wrong or inappropriate, the effect of Agrolyser would be masked in root and forage production. This does not seem to be the case for stem production. In all, this preliminary trial at one site for one season is only indicative but not yet representative.

Ugurugu, Enugu State

Tables 25, 26, and 27 show that standard stakes yield, root, and forage yields can be improved with the use of fertilizer. Considering all components of the cassava plant excluding stumps (roots, stem and forage), NPK 15:15:15 and Cotonou fertilizer (N:P:K:S:MgO 13:9:27:5:4) had a good effect on their yields. The relative standard stakes yield with the use of the mixture of Agrolyser and NPK, Cotonou fertilizer and NPK 15:15:15 are 1.13, 1.24, and 1.20, respectively. The relative forage and root yields with the use of the mixture of Agrolyser and NPK 15:15:15 are 1.01 and 1.02, respectively. This is less than that of the one with the use of NPK 15:15:15 (1.16, 1.39) and Cotonou fertilizer (1.28, 1.42).

These results show that Cotonou fertilizer is better than that of NPK 15:15:15 which is also better than the mixture Agrolyser and fertilizer, ready made fertilizer. Similar observations were also made at Onne where the relative standard stakes, forage and roots yields with the use of Cotonou fertilizer (1.95, 1.53, 2.74) and NPK 15:15:15 (1.79, 1.65, 2.24) were better than that with the use of Agrolyser and NPK 15:15:15 (1.96, 1.22, 2.14). These observations bring us to look at the composition of each of these fertilizers. Knowing that root crops require more potassium for tuberization, we found that Agrolyser-NPK had a very low percentage of potassium (0.975).

We can now conclude that the Agrolyser mix with about 53% gave lesser yields compared to just NPK 15.15.15 because of the nutrient ratio. Agrolyser mix has a low K ratio, which is needed for starch deposition in roots. The K ratio is more

favorable in the Cotonou fertilizer. A suggested ratio both for Onne and Ogurugu soils may be 10N-10P- with 25-30K. This study suggests that if the ratios of the major elements are wrong or inappropriate, the effect of Agrolyser would be masked in root and forage production.

Overall, the application of agrolyser is beneficial to varying extents for stem production depending on the conditions of soil, weather, and cassava variety planted.

Appendices

Appendix 1. Original values of field measurements from Onne trial of spacing and fertilizers.

Standard stake yield = no of stake/stand

Fertilizer applied	0.72 m²	0.64 m²	0.63 m²	Treatment Average
A+F	8.67	14.40	10.71	11.26
NPK	9.54	10.18	11.58	10.43
COT	12.35	6.96	15.71	11.67
0	4.58	5.26	8.59	6.14
Spacing Average	8.78	9.20	11.65	

Forage yield = gram/stand

Fertilizer applied	0.72 m²	0.64 m²	0.63 m²	Treatment Average
A+F	421.97	436.13	357.16	405.08
NPK	642.86	527.18	353.95	508.00
COT	635.75	328.13	441.26	468.38
0	241.32	161.33	421.73	274.79
Spacing Average	485.47	363.19	393.52	

Fresh root yield at 12 months = gram/stand

Fertilizer applied	0.72 m²	0.64 m²	0.63 m²	Treatment Average
A+F	2812.26	3533.52	2937.55	3094.44
NPK	4785.46	4945.76	2608.25	4113.16
COT	4822.98	3332.04	3353.42	3836.15
0	2048.84	2356.60	3354.59	2586.68
Spacing Average	3617.39	3541.98	3063.45	

Appendix 2. Original values of field measurements from Ogurugu trial of spacing and fertilizers.

Standard stake yield = no of stake/stand

Fertilizer	0.72 m²	0.64 m²	0.63 m²	0.56 m²	Fertilizer mean
A+F	14.78	14.2752	11.00	14.84	**13.72**
NPK	14.10	13.0929	13.81	16.67	**14.42**
COT	15.69	14.99108	13.49	15.25	**14.86**
0	13.00	12.65135	8.92	14.72	**12.32**
Spacing Average	**14.39**	**13.75**	**11.81**	**15.37**	

Forage yield = gram/stand

Fertilizer	0.72 m²	0.64 m²	0.63 m²	0.56 m²	Fertilizer mean
A+F	190.32	215.9048	241.43	261.93	**227.39**
NPK	237.48	301.4603	243.57	325.55	**277.02**
COT	305.01	351.2698	270.36	309.72	**309.09**
0	294.90	321.3571	185.71	186.57	**247.13**
Spacing Average	**256.93**	**297.50**	**235.27**	**270.94**	

Fresh root yield at 12 months = gram/stand

Fertilizer	0.72 m²	0.64 m²	0.63 m²	0.56 m²	Fertilizer mean
A+F	1596.43	1840.375	1717.86	1946.95	**1775.40**
NPK	2337.10	2575.873	1852.08	2979.82	**2436.22**
COT	2193.33	2378.373	2471.43	2887.38	**2482.63**
0	1782.02	1709.877	1555.36	1914.96	**1740.55**
Spacing Average	1977.22	2126.12	1899.18	2432.28	

Chapter 7

General Discussion and Recommendations

The six cases considered in this book show that there is benefit to be derived from applying Agrolyser along with manures and inorganic fertilizers in cassava cultivation. However, the amount of change in the produced yields of roots or of stems that can be used as planting materials and forage is of the order of 6 to 20 percent. That is good considering that the active ingredients are micronutrients and thus their influences should not be expected to be as large as is the case with NP and K in crop nutrition and production.

The current price of N300 per 300 g equivalent to N1 per gram and with the current "likely" recommended dose of about 4 kg per hectare; this would amount to N1 x 4000 g or about N4000/ha. Its use is fully indicated, if the value of the induced output at the end of harvest exceeds the cost for its use. The economics of these are not to be assumed but are to be checked for each locality so as to make its use as financially rewarding to all cassava producers.

Relative yields show that the 6 to 20 percent increases in fresh and dry output of produce of cassava are likely. These are expected to give a combined higher value of stem, forage, and roots than the cost of using agrolyser when used along with NPK or manures.

We have learnt that:

1. Agrolyser contains ten cations that provide essential nutrient elements to cassava plants during growth and is helpful for raising the level of yield for root, stem, stump, as well as shoot forage. The degrees of change in such yields of these plant parts are not the same. Stem and stump matter respond better to Agrolyser application. This would then assist in the production of stems as cassava planting materials.
2. The dose of Agrolyser is about 4 kg per hectare. The exact amount could be slightly more or less depending on the soil of the site where the farm is located.
3. Agrolyser alone cannot and should not be applied without being mixed with a fertilizer material or manures. It is only in this supplementary role that its best effect is realised.
4. The cationic balance of the fertilizer affects the overall influence of Agrolyser. If the fertilizer is much higher in a cation compared to the other two major ones for the cassava crop, then the effect of Agrolyser is cancelled.
5. The price of fertilizer, Agrolyser, and products are to be considered together before judgement is made as to the use of Agrolyser. The call for reduced prices for fertilizer and Agrolyser and a higher price for roots and stems and forage from cassava are right and due.
6. The soil and rainfall characteristics of the season are to be considered as we investigate the effect of Agrolyser. Under some conditions the effect is larger in magnitude than in others. Thus, a general use is recommended even if the current and prevailing conditions seem poor for plant growth.

7. The optimum dose of Agrolyser is definitely less than 10 kg/ha. To precisely ascertain this dose multilocational trials are best using factorial combinations of fertilizer, manure, and agrolyser at different levels.

The role of trace elements in the nutrition of the plant and in the diet of humans has been emphasized as a new way to improve food and nutrition. It is not just the quantity but also the quality of the food we take. "*We are what we eat*" says the old German Proverb.

The participatory field trials in Lagos State show that the involvement of all levels of stakeholders makes the lessons more appreciated. Research fully controlled by scientists and on-farm trials in farmers field and handled by them is helpful in assessing the worst-case scenarios of the influence of Agrolyser. We have evidence from wet humid areas of Lagos, Onne in Rivers State; forest-savanna transition areas such as Ibadan, and Lanlate in Oyo State, Ubiaja in Edo State, and Mokwa in Niger State, Okigwe, Orlu, and Owerri in Imo State, and Ugurugu in Enugu States; and subhumid areas such as Obudu. These locations and sites altogether cover much of the cassava growing areas of Nigeria. It would suggest that the data as a whole could help us make a fair judgement on the performance and benefits of the use of Agrolyser in Nigeria to supplement fertilizers and manures for growing nutritionally balanced cassava roots and stems as well as shoots for livestock feed.

The quality of the roots and the leafy shoots that livestock will consume will be improved as a result of ensuring that adequate

levels of micronutrients are contained in them.

In all, the higher stem and shoot yields and better nutrition for the roots are pluses that should be the basis of routine application of micronutrients in normal cassava field cultivation systems under soil fertility status in Nigeria. Further research to advance our knowledge and utilization of this naturally occurring resource in Nigeria will require funding from all stakeholders.

Annex

Recommendations from the Federal Ministry of Agriculture and Rural Development on Agrolyser, July 2005.

FEDERAL MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

DEPARTMENT OF AGRICULTURAL SCIENCES

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FMA/ASD/AGROLYSER/001/T.1
Ref. NO._____
Date: 8th July 2005

The Director General,
RMRDC,
Maitama - Abuja

AGROLYSER APPLICATION IN NIGERIA

Please refer to your request on the position of the Federal Ministry of Agriculture and Rural Development on the research, utilization and application of Agrolizer in the country

2. Agrolyser is a micronutrient fertilizer that contains the essential micronutrients, which are required for healthy plant growth and development. It also contains secondary elements (Ca, Mg, Zn, Mn, Cu, Fe, Na, S, Bo and Mo) that help produce healthy plants. Agrolyser fertilizers have extensively been tested by several research institutes in the different soil types of the country and have been found to enhance crop productivity in all aspects. It was also not found to have any adverse effect on the microfauna of soils on which they were applied. These research findings have been confirmed and approved by the National Fertilizer Technical Committee (NFTC) and the National Council on Agriculture (NCA)

3. The fact that the application of agrolyser is beneficial to the farmers, however does not mean it can be used as a sole fertilizer. The application of agrolyser fertilizer alone can not increase crop yields. Agrolyser is a supplementary additive to macro-nutrient fertilizers. It only boosts the performance of the conventional, macro-nutrient fertilizers ion common use. Moreover, considering the literacy level of most our peasant farmers who produce the bulk of the food we consume in this country, blindly recommending agrolyser fertilizer as a good fertiliser can be mistaken to be a substitute to inorganic fertilizers.

4. In view of its supplementary nature, agrolyser should be component of the common inorganic fertilizers applied by farmers. It should be like the recommendation of government to add iodine to table salt in order to reduce cases of goiter. Agrolyser should not be promoted as an independent and sole fertilizer because it can not increase crop yields alone without the application of adequate quantities of the macro-nutrient inorganic or organic fertilizers. The recommendation of agrolyser should therefore pay off better if fertilizer blending

plants could be mandated to incorporate the micro-nutrient elements of agrolyser into their products

5 The stand of the Ministry on the adoption of agrolyser by Nigerian farmers would thus be as follows:

i) agrolyser fertilizer has been proved to be good for our crops because it boosts the performance of the conventional macro-nutrient fertilizers commonly used by our farmers

ii) Agrolyser or the micro-nutrients in agrolyser should form part of the inorganic fertilizers sold to our farmers for direct application;

iii) The federal government should make the incorporation of these micro-nutrient contents of agrolysers mandatory into inorganic fertilizers and henceforth ban all brands of fertilizers that are not fortified with these micro-nutrients

iv) The federal government should recommend the agrolyser companies to link up with fertilizer blending plants in the country to buy the agrolyser for incorporation into the inorganic fertilizers the produce

v) The federal government should embark on awareness/ enlightenment programme to educate farmers on the importance and application of agrolyser

Mohammed Magaji Ibrahim
Director, Agric. Sciences Dept.
for Honourable Minister

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About IITA

The International Institute of Tropical Agriculture (IITA, www.iita.org) is an Africa-based international research-for-development organization, established in 1967, and governed by a board of trustees. Our vision is to be Africa's leading research partner in finding solutions for hunger and poverty. We have more than 100 international scientists based in various IITA stations across Africa. This network of scientists is dedicated to the development of technologies that reduce producer and consumer risk, increase local production, and generate wealth. We are supported primarily by the Consultative Group for International Agricultural Research (CGIAR, www.cgiar.org).

About Cybernetics Nigeria Limited

Cybernetics Nigeria Limited, an indigenous company was incorporated in 1985 to focus national attention on the adverse effects of micronutrient deficiency on agricultural productivity, and proffer a solution through the use of Agrolyser Micronutrient Fertilizer (AMF).

From a humble beginning of total importation from the United States in 1985, Cybernetics commenced packaging of AMF in Nigeria in 1987. With the assistance of the Federal Ministry of Science and Technology through the Raw Materials Research and Development Council RMRDC, and the National Research Institute for Chemical Technology, Agrolyser is now a **patented, totally indigenous product** and acquired technology with **zero** import. The apex policy advisory body in Nigerian agriculture, the National Council on Agriculture, approved AMF in 1992. Continental use of AMF has been endorsed by the African Union/Scientific Technical and Research Commission.