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The Roles of a Soil Pedologist in Agro - Technology Transfer

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Abstract: A soil pedologist is a soil scientist who specializes in a branch of soil science that is concerned with identification, formation, and distribution of soils, which covers soil classification, soil genesis and survey as well as land evaluation. He interprets the results of his work in a simple, non-technical language in diagrammatic forms (maps) called interpretive soil maps. Examples are, land capability maps, soil suitability maps and soil fertility capability maps. They serve as visual aids for extension education in training the trainer or training of farmers. Literate farmers can use it without an aid. The maps should be able to assist a potential land user to solve soil – related problem or sets of problems such as soil fertility, erosion and drainage, in an area covered in the map with less difficulty. The interpretive maps should be able to provide information on the nature and distribution of a particular soil problem or sets of problems and enhance a potential user to predict soil attributes in an area covered by the map. Based on the maps, decisions on land use planning, dissemination and adoption of agricultural innovations can be effective within a recommendation domain.
Keywords: Agro-technology transfer; Extension; Recommendation domain; Soil pedologist.

1. Introduction

Soil is a component of land but the most valuable input and possession of the rural farmer for crop and animal production. In totality, it provides the basis for food, feed, fuel and fiber production, clean water availability, nutrient cycling, organic carbon stocks, one quarter of global biodiversity, and serves as a platform for construction and construction material. Godfray, *et al.* [1] projected that the need to feed 9 billion people by 2050 can partly be met by closing the yield gap and increasing the production limits of agriculture. A simplified good knowledge about any track of land, in terms of its potentialities and limitations, will guide appropriate land use and management to increase productivity and close the yield gap. This makes the availability of a good quality soil data imperative. Ability to interpret the soil data correctly will guarantee good land use planning and judicious application of other inputs to achieve sustainable soil management decisions, to enhance agro - technology transfer, and overall agricultural development. As a consequence, soils have been the object of close study and investigation for a successful and sustained agriculture. The knowledge of soil physical, morphological and chemical characteristics in association with environmental features would enable proper delineation of a track of land into mapping units, in relation to their potentialities and limitations, for an intended use or uses. Access to good quality soil combined with soil conservation, the knowledge for best management and adoption of technologies [2] should contribute to maximizing the yield potential [3]. This will guide potential users of the land to evaluate the usefulness of the soils, in terms of appropriate management to achieve food security and improve overall livelihood of the farm families. Despite the consciousness of the importance of soils in agriculture, there is a widespread apathy for soil, even by soil scientists. How many soil scientists freely discuss soils by name as farmers discuss their crops and their animals by name? Chukwu [4] attributed this mostly to lack of passion for soil, absence of soil evangelization/awareness campaign and the scale of mapping of Nigerian soils (1:1,000,000) displayed at a scale of 1: 650,000. Such large scale soil maps mask information about soil resources of rural communities in Nigeria where agricultural production actually take place.

2. Improving Soil Resource Literacy

The international community has focussed attention on soils. On December 20, 2013, the 68th UN General Assembly recognized December 5, 2014 as World Soil Day and 2015 as International Year of Soil. The Soil Science Society of Nigeria [5] decried increasing soil resource illiteracy in Nigeria and raised an alarm on its consequences. These include:

i. Non - involvement of soil scientists in erosion control and environmental programmes
ii. Lack of use of soil information by farmers, etc

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iii. Absence of land use policy, etc
iv. Decreasing lack of interest in agriculture by the youths as agric science is deleted as a compulsory subject in Senior Secondary School Certificate Examination and National Examination Council exams.
v. Increase in land and environmental degradation; marginal micro ecologies are over exploited

This challenge is being addressed in various ways. For instance, SSSN makes it compulsory for soil samples to be geo-referenced in all soil – related projects .Concerted efforts are being made to register Soil Science as a profession. Efforts are being made by governmental and non-governmental institutions to acquire advanced equipment is encouraged for soil studies. Capacity building through training in advanced countries with modern equipment. Nevertheless, the above approaches are not pragmatic enough to enhance agro – technology transfer. That is why Chukwu [6]; Chukwu, *et al.* [7] have proposed a pedo - extension model (an integration of pedological science and extension education) as a novel approach to strengthen the weakening gap between agricultural research and farmers, to enhance agro-technology transfer and fully realize the benefits of the Federal Government's Agricultural Transformation Agenda. The earlier a wider audience understands the proposed model and applies it, the earlier we enjoy synergy in agricultural research and extension to achieve food security.

3. Objective

The objective of this paper is to present the interrelationships between pedological science and extension education, to buttress the need for a paradigm shift to pedo – extension model, to effectively bridge the gap between agricultural research and farmers, to enhance adoption of improved agronomic technologies within a recommendation domain.

4. Who is a Soil Pedologist?

A soil pedologist is a soil scientist who specializes in a branch of soil science that is concerned with identification, formation, and distribution of soils, which covers soil classification, soil genesis and survey as well as land evaluation. According to Chukwu, *et al.* [7] pedologists can make enormous contributions to land use planning, site selection for specific practices, the design of land husbandry projects, the assessment of production potentials, the determination of the level of inputs for agricultural intensification, the evaluation of land for alternative uses and the solution to environmental problems. Pedology has the fundamental task of identifying and characterizing the soil body, determining its distribution, establishing relationships, facilitating international communication and guiding the development of new technologies and their applications [8].

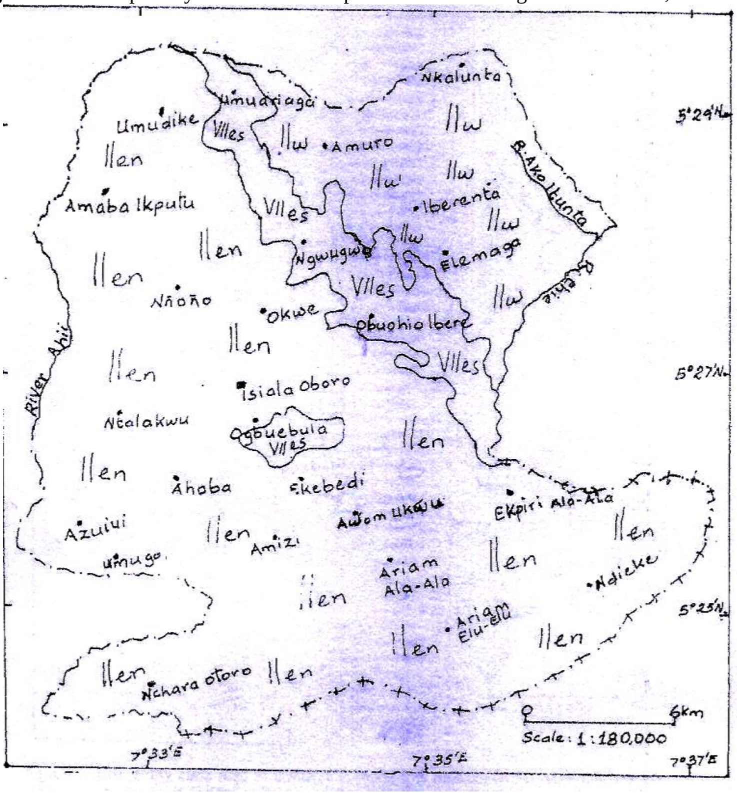
5. Pedologists' Approach to Agro-Technology Transfer

Agricultural development is limited by a weak link between agricultural research and farmers [9]. Although extension is an informal education, Christoplos [10] described it as communication. Visual aids are communication channels and important tools to facilitate the transfer of information from a source to a receiver. Chukwu [6] explained that interpretive soil maps could be excellent visual aids for extension education. Such maps apart from showing land use options can also guide resource use such as quantity of fertilizer to apply and land management options such as erosion control. The authors enumerated the following qualities of good interpretive soil maps.

i. It should have a purpose.
ii. It should be able to provide information about an area in a simplified manner.
iii. It should be able to assist a potential land user to solve soil –related problem or sets of problems in an area with less difficulty.
iv. It should be able to guide input procurement and site selection in relation to a particular land use or an agricultural project.
v. It should provide information on the nature and distribution of a particular soil problem or sets of problems.
vi. It should enhance the predictability of soil attributes in an area covered by the map by a potential user. It should therefore facilitate the dissemination and adoption of agricultural innovation within a recommendation.

Chukwu, *et al.* [7] proposed a pedo-extension model to show how pedological science and extension education can be linked as an emerging trend to enhance judicious land use, improved advisory services, dissemination and adoption of integrate soil fertility management technologies to improve agricultural productivity and sustain soil health. Synthesizing soil survey and soil fertility maps into simplified non technical language and diagrams (maps) is a pragmatic approach to achieving the proposed pedo – extension model as novel approach approach to enhance dissemination of innovative agro - technologies. Chukwu [6], [7] illustrated this in Ikwuano Local Government Area (LGA) of Abia State, Nigeria, by presenting a land capability classification map (Figure 1) and a soil fertility classification map (Figure 2) as examples of interpretive soil maps .

Figure-1. Land capability classification map of Ikwuano Local government Area, Abia State.



Source: Chukwu, *et al.* [11].

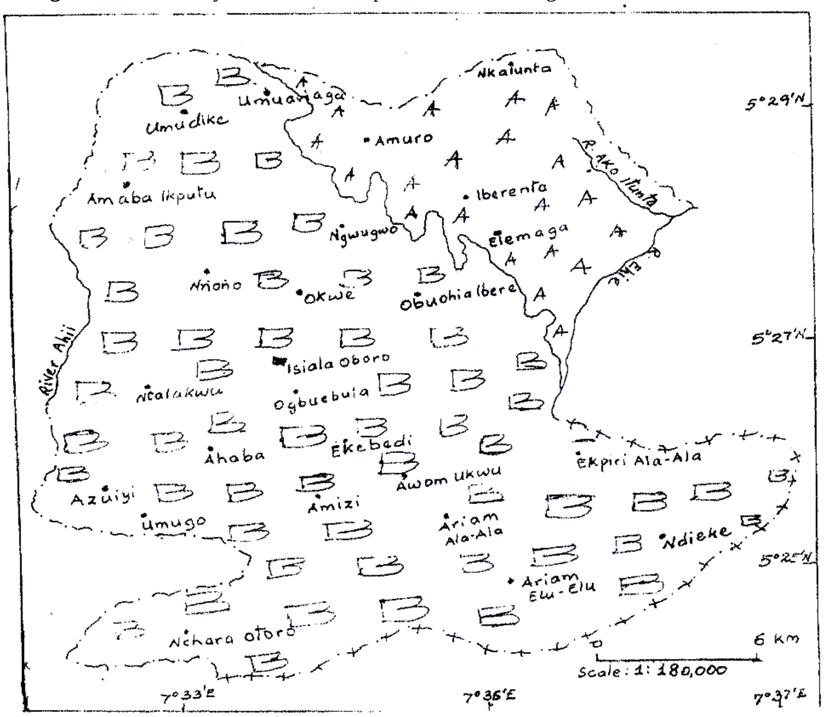
Where: II w = poorly drained medium to fine loamy to clayey soils on a nearly level arable land (4,650 ha).

VIIes = well drained coarse textured non-arable soils prone to landslides and gully erosion (morpho-erosion) (31000 ha).

IIen = well drained loamy to sandy soils, occupying nearly level to concave plain and deficient in primary treatments (23,500 ha).

The SPFS (Special Programme for Food Security) [12] recommended 500 to 600 kg/ha NPK fertilizer 15 15 15 for sustainable cassava and yam production based on soil test values. With reference to cassava and yam production, the usefulness of Figure 2 is shown.

Figure-2. Soil fertility classification map of Ikwuano Local government Area, Abia State.



Source: Chukwu, *et al.* [11]

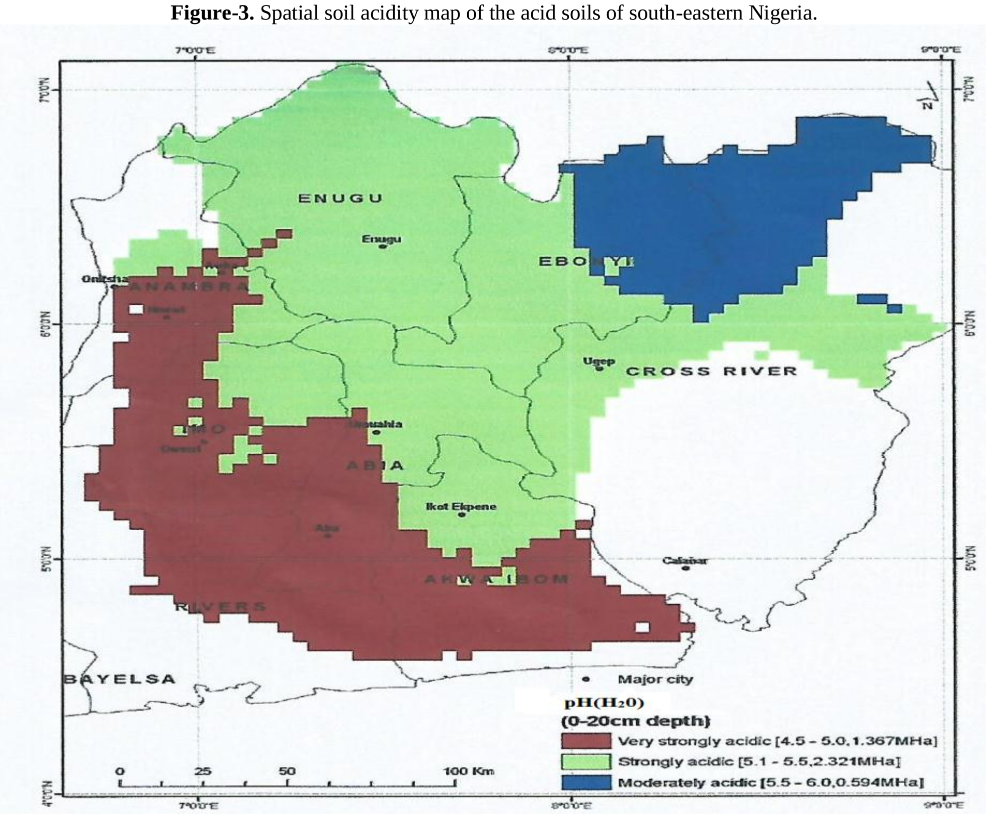
Where A = Soils of medium fertility (low to medium in N and K but low in P) where one should apply about 1/3 to 1/2 (200 to 300 kg/ha or 4 to 6 bags) of the fertilizer is recommended for optimum production of cassava and yam.

B = Soils of low fertility (low in N and K but medium to high in P) requires full recommended fertilizer requirement (500 to 600 kg/ha of the fertilizer or 10 to 12 bags) as economic fertilizer rate to optimize production of cassava and yam.

These maps will enable land users in Ikwuano LGA to appreciate the potentialities and challenges of the soil resources base for broad based uses (arable crop production, forestry, tree crop production, etc) or for specific uses (aquaculture, cocoa plantation, oil palm plantation, gully erosion control, etc) within a recommendation domain. Similarly, Chukwu and Ifenkwe [13] carried out a participatory soil survey of Ikwuano LGA, in relation to biodiversity conservation. They delineated the area into four mapping units: *Ibe*, *Ibeobo, Obollo* and *Ariolo* coined to reflect the communities where each soil predominates. For instance, *Ibe* refers to soils that are predominantly found in Ibere communities. They recommended that adaptable plant and animal species should be introduced in the areas through on-farm research. Indiscriminate logging which is common in mapping unit *Ibe* should be discouraged. Extension agents should liaise with the local government authorities, to educate the villagers on the adverse effect of uncontrolled logging on the environment and influence them through village heads, age grades, women groups and town unions to formulate and implement graduated sanctions against defaulters. They suggested that villagers should be motivated and mobilized to participate effectively in soil conservation measures such as tree plantings, and that they should adopt sloping agricultural land technology to check land sliding, gullying and roadside erosion on mapping unit *Ibeobo*.

Poor knowledge of soil resources is a major reason why many farmers in sub-Sahara Africa, which includes Nigeria, suffer from chronically low crop yields [14, 15]. The present economic meltdown and the renewed interest in agriculture have heightened focus on using soil data to answer practical questions that relate to food insecurity by an increasing array of stakeholders. Consequently, Sanginga [14] suggested that soil management techniques in sub-Saharan Africa should improve to reduce poverty, feed growing population and cope with the problem of climate change in Africa. Interaction between soil scientists and stakeholders (farmers, policy makers, researchers, environmentalists and planners) relating to agronomic research negotiations, in which problem are defined, in terms of research chains to be evaluated by a cost / benefit analysis [16], is hampered by lack of quantitative information about spatial distribution of a soil problem or sets of problems. In Nigeria, despite the large expanse of land devoted to food crop production, the huge amount of resources of labour, capital and management, outputs still remain low [17] due, probably, to inefficient use of resource inputs [18], weak link between research and farmers. All these justify the project on Africa Soil Information Service. In southeast Nigeria, Chukwu, *et al.* [19] produced a soil map showing spatial distribution of soil acidity (Figure 3) showing the magnitude and the extent of the area covered by each acidity class. The map can guide extension specialists, agronomists, farmers, extension agents and policy makers on the rate and type of soil amendment that should be applied to ameliorate the challenges of soil acidity, improve soil health to sustain increased crop production.

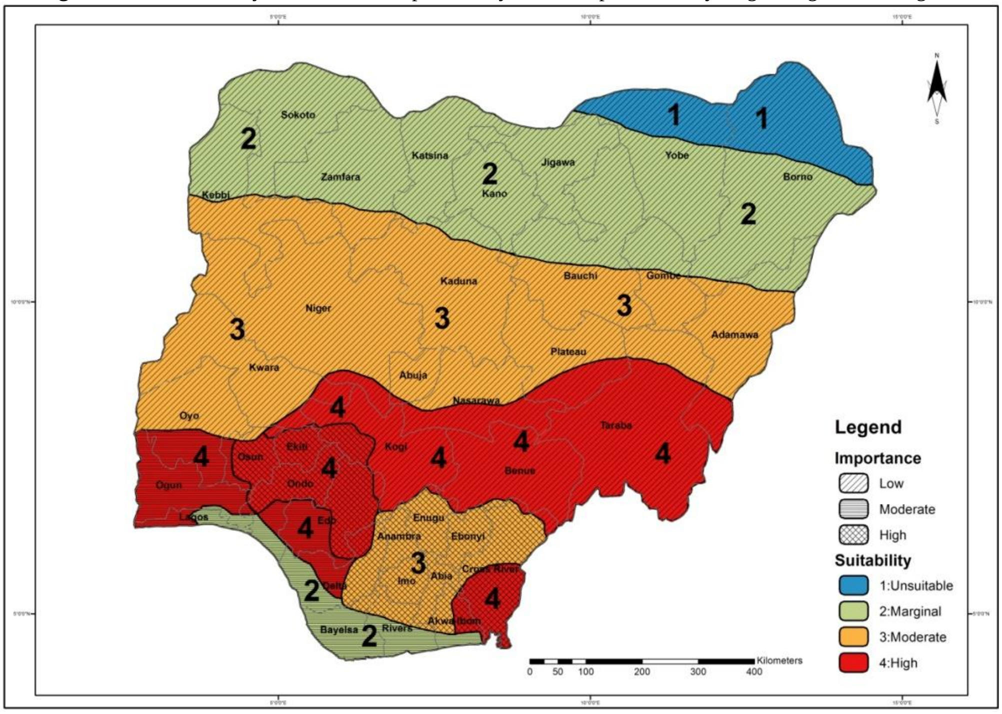
Figure-3. Spatial soil acidity map of the acid soils of south-eastern Nigeria.



Source: Chukwu, *et al*. [19].

Chukwu, *et al.* [20] evaluated land resource zones of Nigeria qualitatively for sustainable cocoyam production (Figure 4). The map could not serve as a good tool for lack of estimation of the extent of the important and unimportant cocoyam growing areas, irrespective of their suitability or otherwise for sustainable cocoyam production.

Figure-4. Land suitability classification map for cocoyam and important cocoyam growing areas in Nigeria.



Adapted from: Chukwu, *et al.* [20].

Suitability rating, where:

1 = Unsuitable: Land having significant limitations production would be at a loss.

2 = Marginal: Land having limitations, which in aggregate are severe to preclude profitable and sustained cocoyam production. A farmer can manage to break even.

3 = Moderate: Land having limitations that are moderately severe for sustained cocoyam production.

4 = High: Land having no significant limitation for sustained cocoyam production.

Area of importance, based on percentage cropland under cocoyam, thus:

Low = ≤ 9 % of cropland, moderate = 10 – 29 % of cropland and high = ≥ 30 % of cropland.

Chukwu [21] improved on the map (Figure 4) as a visual aid for effective agro-technology transfer by defining in quantitative terms the extent of each of the land suitability classes for cocoyam (Table 1) as a basis for judicious project costing.

Table-1. Extent of land suitability classes for cocoyam in Nigeria.

Suitability class	Extent (ha)	Percentage of total suitable land
Highly suitable	23,449,877.210	27.2
Moderately suitable	34,619,669.099	40.1
Marginally suitable	28,204,497.573	32.7
Non suitable	4,785,072.458	-
Total suitable area	86,274,043.882	100
Total land area	91,059,116.34	

Source: Chukwu [21]

He went further to explain how cocoyam re-birth initiative can be applied in the delineated land suitability classes to enhance agro-technology transfer of cocoyam–based technologies as in (Table 2) by expressing in hectares (ha) the suitable and unsuitable land area for cocoyam production in Nigeria earlier delineated by Chukwu, *et al.* [20]. He also disaggregated the suitable area into highly, moderately, and marginally suitable and defined the extent of each suitability class. Finally, he related cocoyam re-birth campaign to the delineated land suitability classes by recommending appropriate aspect of the cocoyam re-birth initiative that should be applied to each land suitability class to promote cocoyam research, production, processing, marketing and consumption in the area. He advised that Table 2 should be used in companion with Figure 4 in order to realize the full benefits of the map to promote cocoyam cultivation by increasing land area under cocoyam in Nigeria.

6. Conclusion

Many agricultural extension specialists and extension agents scarcely realize the need to collaborate with pedologists in order to facilitate agro-technology transfer. The adoption of the proposed pedo-extension model will enhance synergy of both disciplines to strenghten the weak link between agricultural research and farmers, to improve and sustain high agricultural productivity and the livelihood of the farm families.

Table-2. Land suitability classes, extent, and relative importance for cocoyam: implications for dissemination of cocoyam – based technologies through cocoyam re-birth initiative.

Suitability Classes	Extent of Area (ha)	(%)	Relative Importance of Cocoyam in the Area			Application of Cocoyam Re-birth for Agro-technology Transfer
Highly + Moderately	37,823,594.22**	65.1**	Relatively Unimportant	-	CRM Ad Extra	-
Highly + Moderately	20,245952.09**	34.9**	-	Very Important	-	CRM Ad Intra
Marginally	28,204,497.57*	32.7*	Relatively unimportant	-	CRM Ad Extra	-

Source: Chukwu [21]

** = Extent of combined highly and moderately suitable land.
* = Extent of marginally suitablity land, relative to total suitable land.
- = Not applicable.

Where: CRM *AD Extra* = Cocoyam re-birth mission *ad extra* (introduce cocoyam as a new crop to an area where it is relatively unimportant or unknown, provided the ecology is marginally to highly suitable for its production.

CRM *Ad Intra* = Cocoyam re-birth mission *ad intra* (increase and sustain the popularity of cocoyam in an area where it is already a popular and important crop).

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