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PAPER PRESENTED AT THE WORKSHOP ON

EXPERIMENTAL DESIGNS FOR PREDICTING CROP PRODUCTIVITY

WITH ENVIRONMENTAL AND ECONOMIC INPUTS

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TITLE: EXPERIMENTAL DESIGN FOR PREDICTING CROP PRODUCTIVITY WITH ENVIRONMENTAL AND ECONOMIC INPUTS

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Purpose: It is the purpose of this proposal to test the hypothesis that agricultural technology manifested through crop productivity can be exchanged between diverse geographical tropical regions provided the technology developed at one site is transferred and practiced on soil of the same or similar family at the other site.

To test the validity of the hypothesis, an experimental design is suggested which could serve as a preliminary effort requiring minimum expenditures of AID resources for maximum gains.

The design implicitly tests the suitability of the soil family (U.S. Soil Taxonomy) to serve as a vehicle for the transfer of agri-technology among tropical regions.

Rationale for Experimental Design: The preliminary effort should not seek to isolate and measure those specific soil properties which could strongly influence crop responses. Rather, the research design should view the soil family as a pedological unit operating on crop responses. The same consideration should be extended to the environment external to the soil. The separate factors of climate, plant physiology, biotic population, etc. and their interactions have varying effects on plant responses and testing these parameters becomes an awsome and unmanageable task. Taken as a whole, the influence of the normal external environment at a site can be considered as constant in the experimental design. It is proposed therefore, that a soil management innovation become the independent variable which will operate on crop productivity through the design described below.

A tropical agronomic crop is selected as an indicator plant from several crops important to the economy of the agricultural sector in LDC's. The crop might be cultured at four different geographical testing sites (the replicates) on similar benchmark soils employing practices which are unique for each site and presently reliable enough to produce satisfactory yields under normal environmental conditions.

The relative crop responses (dependent variables) to a soil management innovation (the independent variable) are compared between sites. A soil innovation would include those factors of the soil which strongly influence yields on upland soils of the tropics; as for example, the levels of soil nitrogen and phosphorus which are serious constraints to crop production in the tropics.

If a statistical variance of response between treatments is detected and an interaction between site and treatment is not, the null hypothesis is accepted and the influence of treatment on identical soil family among diverse sites is manifest. In essence, by measuring plant responses to a soil innovation at all sites, the experiment will test the "predictability" of a relative response to a soil management innovation. If the transfer of agro-technology can be accomplished with reliability, then the economics of the innovation can be ascertained.

Assumptions and Restrictions Inherent in the Design

1. The benchmark soil at each site is correctly classified at the family level.
2. A comparable soil family is available at each site.

3. The varieties of the indicator crop used at a specific site are responsive to soil treatments.
4. The normal external environment of the benchmark soils prevails during the test period, or abnormal situations can be assessed.
5. The technical innovation is soil-oriented or an operation on the physical and chemical properties of the soil.

Experimental Design: Four sites will be selected within the tropical world at different locations. In each case the site should be associated with an agricultural institution.

To test the interaction of the site and treatment on crop productivity, a factorial experiment is suggested. As an example, the following treatments are advanced.

At each site, a soil management innovation is introduced which involves the preplant addition of a slow-release nitrogen compound and P from rock phosphate applied to groundnut at three rates respectively. The design is a randomized block of treatments replicated three times. Yield data will be plotted as a function against level of treatments for each site. Divergence of the plotted paralleled lines between sites is indicative of a site or soil interaction with the innovation. If it is subsequently determined that the divergence is a soil related condition then the hypothesis that agri-technical transfer is feasible at the soil family level is weakened and the soil property(s) contributing to the divergence should be ascertained.

Table 1. AOV of yield at each site for a single family:

Source of Variation	Degrees of Freedom
Total	26
Block (Replications)	2
Treatments	8
N	2
P	2
N X P	4
Error	16

Table 2. AOV of yield between diverse sites and treatment for a single family

Source of Variation	Degrees of Freedom
Total	107
Block/Sites	8
Treatments	35
Sites (diverse locale (S))	3
N	2
P	2
N X P	4
S X N	6
S X P	6
S X N X P	12
Error	64

The statistics employing the same treatment per site and between sites for 2 families are depicted in Tables 3 and 4.

Table 3. AOV of yield at each site for two families

Source of Variation	Degrees of Freedom
Total	53
Replicates/soils	4
Treatments	17
Soils (So)	1
N	2
P	2
N X P	4
So X N	2
So X P	2
So X N X P	4
Error	31

Table 4. AOV of yield between diverse sites and treatment for two families.

Source of Variation	Degrees of Freedom
Total	215
Reps/soil/sites	16
Sites	3
Soils	1
Treatments	71
N	2
S X N	6
So X N	2
S X So X N	6
P	2
P X S	6

Table 4. cont's

Source of Variation	Degrees of Freedom
P X So	2
P X S X So	6
P X N	4
P X S X N	12
P X So X N	4
P X S X So X N	12