Plate 1: 18-month old cocoa composite trees grafted on rootstock in Owena

Plate 2: 18-month old cocoa composite trees grafted on rootstock in Ibadan

The present work will expand the scope of the project beyond Oyo and Ondo States and target all cocoa producing states using drought-tolerant cocoa genotypes already identified in Nigeria.

I. Hand Pollination of Cocoa

Hand pollination of intra-population crosses of identified drought-tolerant cocoa varieties to be used for the production of rootstocks will be carried out while fertilizing of the cocoa trees to be used as scion materials will commence. Thirteen cocoa genotypes will be used. There will be nine scions materials as follows: AMAZ 15, SCA 6, SCA 9, SCA 12, UF 676, SPEC 54, MAN 15, IMC 47, ICS 95, N 38 and MAN 15/2 while the three rootstocks materials will be N 38 * N 38, PA 7 * PA 150 and NA 32 * N32.

II. Seedlings Production, Profiling and Budding

Seedlings for rootstock would be mass produced for 6 months in the CRIN Central Nursery while cocoa profiling will be carried out in the greenhouse. Sample of all materials to be used as the rootstocks and/or scions will be extensively re-evaluated for their drought tolerant traits under a controlled environment in the greenhouse at different water regimes. Measurement will be evaluated on their morphological, anatomical and gas exchange characteristics as described by Ayegboyin (2012). Patch budding of the identified cocoa drought tolerant scions will be effected on their identified cocoa drought-tolerant rootstocks to form different composite cocoa genotypes which will be released for field evaluation across selected cocoa growing states.

III. Field Appraisal of Drought Tolerant Cocoa Genotypes

The drought tolerant cocoa genotypes will be established at Cocoa Research Institute of Nigeria (CRIN) headquarters in Ibadan and all states where CRIN substations are located (Ondo, Edo, Abia, Kogi, Taraba and Cross River states) as well as Osun, Ekiti, Ogun and Delta States.

IV. Parameters to be tested on Cocoa

A. Morphological/Agronomical parameters

For field evaluation, collection of data will be based on either the detachment of the leaves from the plants before sampling (destructive sampling) or measurement of the leaves in-situ, directly on the plants without any detachment (non-destructive sampling). While measurement of plant height, stem diameter, numbers of leaves as well as number of branches will be determined non-destructively, the leaf area will be done destructively within 24 hours of plant detachment. For greenhouse trial, leaf area will be determined the same way as for the field experiment during the growing period of the seedlings but at the harvests, the total leaf area of each of these seedlings will be determined. There will be two harvests for the greenhouse seedlings and all leaf areas determination will be done with an AM300 Portable Leaf Area Machine (ADC Bio Scientific Ltd).

B. Collection of Gas exchange parameters with Portable Infra-Red Gas Analyser

A portable infra-red gas analyser (ADC Bio Scientific, United Kingdom) will be used to measure the photosynthetic rate, stomatal conductance, transpiration conductance and water use efficiency and other gas exchange characteristics as demonstrated by Ayegboyin in Plate 3. The leaf for measurements on each plant will be between the 2^{nd} and 4^{th} fully expanded leaf on a given sun-exposed flush.

Data will be collected between 12:00 pm and 3:30 pm during each sampling day in order to obtain an accurate indication of cocoa response to environmental stress (Medrano H. *et al*., 2003). Gas exchange characteristics of the cocoa plants in all the fields as well as greenhouse will be determined. While the plants will be sampled *in-situ* for the field experiments, seedlings in the greenhouse experiment will be tested when there is ≥300µmol $m^{-2}s^{-1}$ of sunshine in order to obtain an optimum performance of the cocoa plants. The water use efficiency of all genotypes/clones will be calculated.

Plate 3: Gas exchange determination with IRGA machine on the budded plant by Ayegboyin