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LIST OF ACRONYMS

ANOVA	-	Analysis of Variance
CEC	-	Cation Exchange Capacity
CSIR	-	Council for Scientific and Industrial Research
CSIR-CRI	-	CSIR - Crops Research Institute
CSIR-FORIG	-	CSIR - Forestry Research Institute of Ghana
CSIR-SARI	-	CSIR - Savanna Agricultural Research Institute
CSIR-SRI	-	CSIR - Soil Research Institute
EDIF	-	Export Development Investment Fund
IFDC	-	International Centre for Soil fertility and Agricultural Development
INM	-	Integrated Nutrient Management
JIRCAS	-	Japan International Research Centre for Agricultural Sciences
KNUST	-	Kwame Nkrumah University of Science and Technology
MoFA	-	Ministry of Food and Agriculture
NUE	-	Nutrient Use Efficiency
PRA	-	Participatory Rural Appraisal
QUEFTS	-	Quantitative Evaluation of the Fertility of Tropical Soils
RTIMP	-	Root and Tubers Improvement and Marketing Programme
UDS	-	University of Development Studies

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EXECUTIVE SUMMARY

The CSIR-Soil Research Institute continued to focus Research and Development (R&D) activities on the generation of information and technologies for the sustainable management of Ghana's soil resources as captured under the following three main research programmes during the year under review:

i. Soil Classification and Land Evaluation Programme

This programme focused on studies on the characterization and suitability evaluation of the various soil resources for land-use planning purposes during the year. The West African Agricultural Productivity Project (WAAPP) funded analogue soil maps digitization programme and associated establishment of a Geodatabase at the SRI was continued. Other soil characterization and land evaluation studies were undertaken for various clients of the institute including the Goldfields Ghana Ltd and the Bui Irrigation Project.

ii. Soil Fertility Management Programme

The Soil Fertility Management Programme undertook studies on integrated soil fertility management, plant nutrition and general cropland productivity enhancement practices for the production of the various crops on the different soil series in Ghana. The nstitute's New "Sawah" Project continued its field experimentation and data collection activities with project farmers obtaining rice yields of 6.0 - 8.0 t ha^{-1}. In addition the New "Sawah" Project organized an international workshop on "the SAWAH Eco-technology for Rice Farming in Africa" which attracted participants from Togo, Benin, Japan, Ghana, Nigeria, South Africa and Indonesia. Several other studies were undertaken to develop sustainable cropland productivity improvement protocols for the production of rice, yam, maize and sweet potatoes.

iii. Environmental Management and Climate Change Programme

Under the environmental management and climate change programme, the ClimAfrica's project was initiated in collaboration with the CSIR-CRI and CSIR-FORIG. The main objective was to better understand and predict climate change in SSA for the next 10-20 years and analyse the expected impacts on ecosystems and population as well as developing adaptation strategies tailored to the African context. Another study on planning climate change adaptation and poverty reduction project was initiated to manage water resource in Daka catchment of northern Ghana. It focuses on planning and implementation of procedures on harvesting water to mitigate the effects of flooding and drought for developing the Daka River valley.

iv. Research commercialization

The Institute's research commercialization activities led to the generation of GHC35,055.65 mainly from laboratory analytical services and land evaluation consultancy services.

v. Human resource development

The Institute's staff strength stood at 294, made up of 33 senior members, 85 senior staff and 176 junior staff. In all 5 staff were enrolled in various foreign and local institutions for studies in relevant soil management fields.

vi. Finance

Total receipts of Ghana Government funds for the year was GHC 3.7 million constituting about 70% of the approved budget.

vii. Information management

Scientists from the Institute continued to produce refereed journal, conference and technical publications in 2011 and also participated in a number of local and international conferences and workshops to promote the advancements in soil science and technology. The Institute also participated in numerous exhibitions and fairs to promote sustainable soil management technologies.

viii. Major constraints

Inadequate funding as well as delays in the release of approved funds for research and development activities continued to be the major constraints faced by the Institute. Some of the important equipment being used in the laboratories are obsolete and need to be replaced urgently.

1.0 INTRODUCTION

The Soil Research Institute (SRI) of Ghana's Council for Scientific and Industrial Research (CSIR) continued to pursue the following research and development objectives during the year under review:

* Develop knowledge for efficient management of the soil resources of Ghana.
* Strengthen the Institute's delivery capacity for increased agricultural production.
* Establish and strengthen linkages with local and international organizations
* Develop and promote sound and safe environmental practices.
* Commercialize soil resources research findings and services.

In line with the Institute's mandate of generating scientific information and technologies for effective planning, utilization and management of the soil resources of Ghana for sustainable agriculture, industry and environment, research activities during the year consisted of the following programmes:

- Land Evaluation Programme
- Soil Fertility Management Programme
- Soil and Water Management Programme
- Environmental Management and Climate Change Programme
- Laboratory Analytical Services Programme
- Training/Technology Transfer.

This report, however, only highlights some research activities of the Land Evaluation, Soil Fertility Management and the Environmental Management and Climate Change Programmes undertaken in 2011.

2.0 RESEARCH PROGRAMMES

2.1 SOIL CLASSIFICATION AND LAND EVALUATION PROGRAMME

2.1.1 Study Title: Soil map digitization and report production for soil survey regions and districts in Ghana. **(**Research contract NCRG NO. 017-CSIR/WAAPP)

Research Team: J. K. Senayah, K. A. Nketia, E. Amoakwa, J. Awoonor
Source of Funding: WAAPP
Duration of Project: 2010-2013

Introduction

The project started in October 2010 to establish and develop a geodatabase as a tool for mapping as well as analyzing geospatial data for CSIR-Soil Research Institute. Principally, the project seeks to re-package, update and store existing soil information at SRI and also change over from analogue to digital map production with the use of Arc-GIS software. Major activities include soil mapping and soil resource reporting / documentation at the District level and updating of Regional Detailed reconnaissance soil survey regions of Ghana. The base information is provided by the Detailed Reconnaissance soil surveys available at a scale of 1:250,000. This exercise, it is recognized, would span several years far beyond the duration of the WAAPP Project.

Objectives

The objectives of this project therefore are to:

1. Create a catalogue of all maps and reports available in CSIR-Soil Research Institute
2. Upgrade our traditional (analogue) map making to digital formats
3. Update some of the soil maps of the Detailed Reconnaissance soil surveys of Ghana and produce soil maps at the district level to facilitate access to information for the districts.
4. Produce digitize maps so as to facilitate precision, accuracy and spatial data handling as well as storage.
5. Establish a Geodatabase for easy accessibility and compatibility.

Implementation

Objective 1 is completed.
Objective 2, 3, 4 and 5 are on-going

As part of the updating programme, soil resources updates and mapping have been started at the district level as well as soil map digitization and updates for the detailed reconnaissance soil survey regions.

The implementation is being facilitated by (i) The use of the Regional soil survey reports (1:250,000) as base information / soil map (ii) Topographical maps (1:50,000) of the Survey Department of Ghana (iii) Field check on available soil units and the superimposition of digital elevation model (DEM) to separate uplands from the lowlands (iv) Profile description, classification and suitability assessment of the major soils for crop production.

Work so far done

1. District soil maps and reports completed on Afigya-Kwabre, Tain and Wenchi Municipality

2. Digitized soil maps have been completed on the following survey regions
   - Afram basin
   - Ayensu- Densu
   - Nasia basin
   - Ochi – Nakwa basin
   - Pawnpawn basin
   - Pra basin
   - Pru basin
   - Yapei – Sawla basin
   - Kumasi Region
   - Ankobra basin
   - Lawra – Wa
   - Ho – Keta Plains

Plan for 2012

- To digitize soil maps of the following survey regions
- Bole – Bamboi Region
- Bia basin
- Dayi – Asukawkaw basin
- Accra Plains
- Navrongo – Bawku Region
- Cape Coast Region
- Birim basin
- Lower Tano basin
- Upper Tano basin
- Lower Oti basin
- Upper Oti basin

1. Other works

To generate descriptive legend for Lower Tano, Upper Tano, Lower Oti, Upper Oti soil maps

Challenges

The implementation of the project has been of immense benefit to the Institute but there are quite a number of challenges. Below are some of the challenges;

1. Lack of Remote Sensing component in spatial data analysis.
2. Adequate facilities (equipment) in handling data storage
3. Adequate facilities (equipment) for field data capture.

Conclusion

The project so far has been of immense benefit to Soil Research Institute and its entire clientele. The benefits include,

i. Quick search and easy access to available information
ii. Improved skills of staff and
iii. Opportunity for information updates.

2.1.2 Study Title: Soils of selected compartments in the Afram Headwaters Forest Reserve

Research Team: J. K. Senayah, E. Amoakwa, K. A. Nketia, J. Awoonor & Julius Badu

Source of Funding: Mere Plantations Ltd

Duration of Project: 2012

Introduction

This was a reconnaissance study carried out for Mere Plantation in selected compartments of the Afram Headwaters Forest Reserve near Ofinso in the Ashanti Region of Ghana. The purpose of the study was to determine the soils prevalent in the selected compartments so as to provide basic soil physico-chemical information needed for the selection of suitable compartments for teak plantation development.

The Afram Headwaters Forest Reserve is located in the moist semi-deciduous forest agro-ecological zone. The zone is characterized by relatively high rainfall (1400 mm per annum) with a bimodal pattern. The major season rains occur between March and mid-July, with peak in May/June. There is a short dry spell from mid-July to mid August. The minor rainy season starts from mid August to about the end of October with a peak in September. A long dry period is experienced from November to February with possibilities of occasional rains.

Objectives

The objectives of the study were to describe the morphological characteristics of major soils in the Afram Head Water Forest Reserve, and to assess their suitability for teak production

Methodology

The study involved the examination of soils in selected compartments in the forest reserve. Two sites (A and B) were examined (Figure 1). Five compartments within site A were studied, and six compartments in site B were also studied.

The total area of site A was 1829 hectares and comprised of 17 compartments. Out of these compartments 12, 17, 29, 31 and 114. Similarly, site B had 17 compartments in all, with a total area of 2249 hectares. Compartments examined here were 43, 45, 47, 82, 83 and 100.

Generally, three observation points were sampled in a compartment. At each observation point, an auger bore was dug and the soil described for depth, texture, drainage and coarse-fragment content. Soil samples were then taken at pre-determined depths of 0-20cm, 20-40cm and 40-60cm for laboratory analysis.

Results

The soils of the forest reserve

Site A

At site A, the soils are weathered from Voltaian sandstone and granite. Soil associations covering the site are Bediesi-Sutawa-Bejua Association weathered from sandstone and Kumasi-Ofin Compound Association from granite (Adu and Mensah Ansah, 1995). The former is the dominant soil in site A and constitute the soils occurring in the selected compartments.

Bediesi-Sutawa-Bejua Soil Association which predominantly occurs at site A consists of individual soils comprising *Yaya, Pimpimso, Bedieso, Sutawa, Kaple* and *Bejua series*. However, the dominant soils occurring in the selected compartments are Bediesi and Sutawa series whose profiles and description are shown in figures 1 and 2.

Bediesi series *(Haplic Nitisol)*

Hor.	*Depth (cm)*	*Description*
Ap	0 – 9	Dk reddish brown; sandy loam; weak fine granular; friable
BA	9 -28	Yellowish red; sandy loam; weak medium granular; friable
Bt1	28 – 74	Dusky red; sandy clay loam; moderate medium sub-angular blocky; firm
Bt2	74- 132	Dark red; sandy clay loam; moderate medium sub-angular blocky; firm

Figure 1. Bediesi series: *Haplic Nitisol*

Sutawa series *(Gleyic Lixisol)*

Hor.	*Depth (cm)*	*Description*
Ap	0 – 8	Dark brown; loam; weak fine granular ; friable
BA	8 – 30	Brown; loam; moderate medium Sub-angular blocky; friable
Bt	30 – 65	Strong brown; clay loam; moderate medium subangular blocky; firm
Btv1	65 – 100	Strong brown; few faint yellowish red/ brown mottles; clay loam; moderate medium subangular blocky

Figure 2. Sutawa series: *Gleyic Lixisol,*

Observations in the selected compartments in 'A'

The compartments observed at site A were 12, 17, 29, 31 and 114. A summary of the observations are presented in Table 1.

Table 1. Soil characteristics and location of observed points at Site A

Compartment	Characteristics of observed points				Remarks	General Assessment
	Texture		Gravel content	Soil series		
	Top	*Sub*				
12 (a) (b) (c)	S L S L S L	C L S L S L	Few NIL NIL	Bediesi Sutawa Sutawa	Deep soils with good drainage. Very good for tree production	These soils may be considered highly suitable for teak in terms of morphological characteristics such as depth, drainage, texture and structure. Morphologically, there is no root restriction to depth, >1 metre for Bediesi and about 70 cm for Sutawa due to drainage as shown in profile pictures on the two soils in figures Fig. 1 and Fig 2
17 (a) (b) (c)	S L S L S L	S L S L S L	Few NIL Many	Bediesi Beidesi Pimpimso	Largely deep well drained soils. The Compartment is good	
29 (a) (b) (c)	S L S L S L	S C L S C L S L	NIL NIL Common	Bediesi Sutawa Pimpimso	Largely deep well drained soils. The Compartment is good	
31 (a) (b) (c)	S L S L S L	L S S C L S C L	Many NIL NIL	Pimpimso Sutawa Sutawa	Largely deep well drained soils. The Compartment is good	
114 (a) (b) (c)	S L S L S L	S C L S C L SL	NIL NIL NIL	Sutawa Sutawa Bediesi	Deep soils with good drainage. Very good for tree production	

Notes: *Texture – SL-sandy loam, SCL-sandy clay loam, CL-clay loam; (a), (b), (c) - observation points within compartments*

Site B

Site B is largely covered by Yaya-Pimpimso-Bejua Association which is weathered from the Voltaian sandstone. The major soils of this association are *Yaya* and *Pimpimso series*. *Yaya series* is shallow (<30cm) and also occur as rock exposures at several locations. The soil normally occurs on summits and upper slopes of scarps and hills. *Yaya series* is normally associated with moderately shallow (>30cm) soil that consists of reddish brown loamy sands with ironstone concretions overlying ironpan or sandstone rock, *Pimpimso series*. However, within the Yaya-Pimpimso-Bejua soil association, pockets of deep, well drained, non-gravelly soils, *Bediesi* and *Sutawa series* are common. The specific compartments examined in site B were 43, 45, 47, 82, 83 and 100. Observations in the compartments are presented in Table 2.

Table 2. Soil characteristics and location of observed points at Site B

Compartment	Characteristics of observed points				Remarks	General Assessment
	Texture		Gravel content	Soil series		
	Top	*Sub*				
43 (a) (b) (c)	S L S L S L	C L S C L S L	NIL Few Many	Sutawa Pimpimso Pimpimso	Iron pan boulders around points (a) & (c). Generally shallow	Most of the compartments are marginal for teak production and would not be recommended for economic / commercial teak production. Plant growth would be slow and stunted due to shallow depth and skeletal subsoil giving rise to low moisture retention. Among the observed compartments, only 47 and 100 are moderately good for economic / commercial teak production.
45 (a) (b) (c)	S L S L S L	S L S L C L	Few Fe Many NIL	Pimpimso Pimpimso Sutawa	Dominantly shallow with few areas of deep soils	
47 (a) (b) (c)	S L S L S L	S C L S C L S L	Few NIL Few	Bediesi -sh Sutawa-sh Bediesi-sh	Moderately good compartment with moderately deep (>60cm) soils	
82 (a) (b) (c)	S L S L S L	S L S L S L	Many Many Many	Pimpimso Pimpimso Pimpimso	Generally shallow with soils marginal for tree production	
83 (a) (b) (c)	S L S L S L	S L S L	NIL Many NIL	Bediesi Pimpimso Wenchi (pan @20cm)	Combination of deep and shallow soils. Marginal for commercial production	
100 (a) (b) (c) (d)	S L S L S L S L	S C L S L S C L S L	Few NIL Few	Sutawa Sutawa Sutawa Bediesi -sh	Moderately deep soils, modeately good for tree production	

Notes: *Texture – SL-sandy loam, SCL-sandy clay loam, CL-clay loam Bediesi -sh – shallow phase of Bediesi series with depth between 60 and 100cm (a), (b), (c) - observation points within compartments*

4.0 Conclusion and recommendations

Site A falls within a good soil unit Bediesi-Sutawa-Bejua Association. All the compartments observed have soils that are suitable for teak development. The soils are generally deep, well drained, sandy loam to sandy clay loam textures with moderate moisture retention capacity.

Site B falls within a soil unit Yaya-Pimpimso-Bejua that is generally shallow and skeletal. Most of the compartments observed are marginal for teak development except compartment 47 and 100 that are considered moderately good.

All the soils have sandy loam topsoil which is susceptible to erosion. Erosion prevention measures are important on all the soils.

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2.1.3 Study Title: Soil Investigation on the Farmlands of Goldfields Ltd in the concession near Awodua, Tarkwa

Research Team: J. K. Senayah, J. Awoonor and E. Asamoah
Source of Funding: Goldfields Ghana Limited, Tarkwa
Duration of Project: 2011

Introduction

This was a soil investigation carried out within the concession of Goldfields Ltd at Awodua near Prestea in the Western Region. It was aimed at providing information to enhance land management practices in the production of oil palm, pepper and other potentially suitable crops. The farmland is located near Awodua (Figure 1).

The objectives were to assess the suitability and management of the soils for large-scale production of oil palm, pepper and other crops deemed to be potentially viable for commercial agriculture. To achieve this, specific objectives were set as follows:

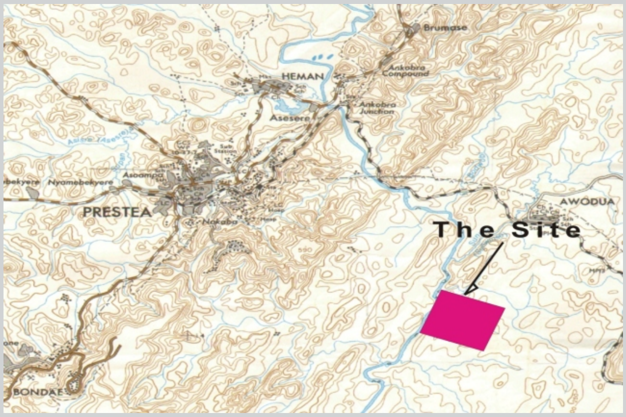


Figure 3: Location of the farmland

Method of investigation

The farmland was divided into three land management units following the nature of the topography. They are,

- Hilly Terrain
- Rolling and undulating terrain and
- Lowland

The soils were examined in each of the units by means of inspection holes, which were dug out to a depth of 60 cm or more with the aid of a chisel and supported with an auger where necessary. Parameters observed were depth, top and sub-soil textures, content of coarse fragments and drainage. Observations were made at the summits, middle and lower slopes and the valley bottoms. GPS co-ordinates of each observed point were recorded.

Results

Soils of the area

The soils of the farmland are developed over the weathered products of the Tarkwaian rocks. The soils vary from the summit, down the slope to the valley bottom. The group of soils normally occurring on the Tarkwaian geology belongs to Juaso – Mawso / Asuboa – Pamasua Compound Association (Adu, 1992). The entire farmland is occupied by this Association. However, based on relief differences it has been divided into three management units namely, the hilly terrain, the rolling to undulating terrain and the Lowand.

I. Hilly Terrain

The unit comprises an enlongated steep hill on the western part of the farmland (Fig. 2a). The soils belong to the Juaso – Mawso Upland Association. Juaso series normally occurs on summits and upper slopes while Mawso series occurs on middle slopes but sometimes displaces Juaso series to occupy the summit and upper slopes. The two soils have similar morphological characteristics except for colour where Juaso series is red and Mawso yellowish brown. The soils are deep (> 150cm) and well drained. The topsoil is sandy loam and the subsoil sandy clay loam to clay loam. The subsoil contains moderate amounts of ironstone concretions and quartz gravel.The middle to lower slope is occupied by Asuboa series, which is developed in colluvial material from upslope. The soil is deep, moderately well to imperfectly drained and free of gravel. The topsoil is sandy loam and the underlying subsoil is sandy clay loam .

ii. Rolling to Undulating Terrain

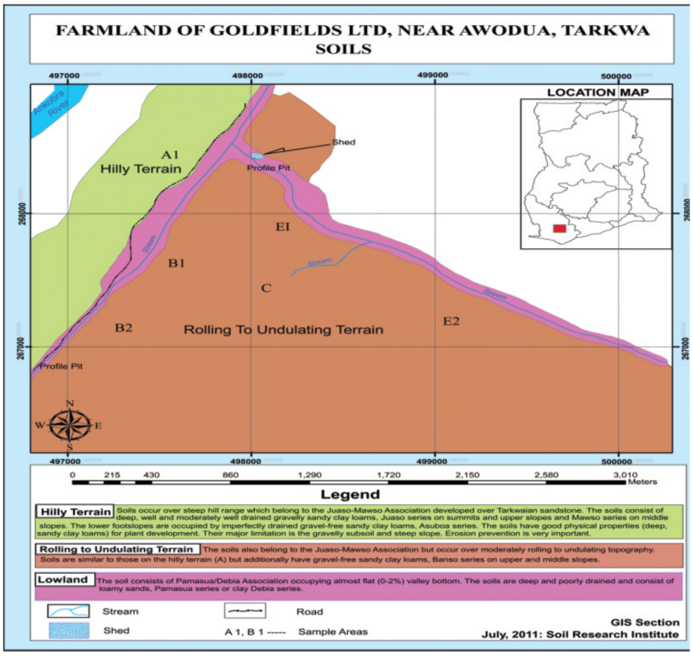
Slopes of this unit are moderate as compared to the hilly terrain (Fig. 2b). The unit is also occupied by the *Juaso-Mawso Association.* The individual soils are Juaso, Mawso and Asuboa series as described on the hilly terrain. However, farm practices are easier as a result of the moderately steep to gentle slopes.

iii. Lowland

The lowland is occupied by the Pamasua - Debia Association. The soils occupy nearly flat (0 – 2%) valley bottoms. They are poorly drained sandy *(Pamasua series)* or clayey *(Debia series)* soils, which get flooded during the wet season.

Figure 4. A view of the hilly terrain with steep slope

Figure 5. Rolling to undulating terrain with moderately steep to gentle slopes



Map 1: Soils of the Farmland

Table 3: Ratings for landscape and soil characteristics of the land units for oil palm and pepper

			Texture						
Land unit /crop	**Soil series**	**Effective depth (cm)**	**Topsoil**	**Subsoil**	**Drainage**	**Coarse fragments %**	**Topography/ Slope(%)**	**Limitations To crop**	**Suitability Rating**
Hilly terrain	Juaso, Mawso, Asuboa	>120	SL	SCL	Moderate	15 -30	>20		
Oil palm		S1	S1	S1	S1	S2	S3	Slope	S3t
Pepper		S1	S1	S1	S1	S2	S3	Slope	S3t
Rolling to undulating topography	Juaso, Mawso, Asuboa	>120	SL	SCL	Moderate	15 -30	8 - 16		
Oil palm		S1	S1	S1	S1	S2	S2	Slope	S2tc
Pepper		S1	S1	S1	S1	S2	S2	Slope	S2tc
Lowland	Pamasua Debia	>120	SL	LS/SCL	Poor	NIL	0 - 2		
Oil palm		S1	S1	S2 /S1	N1	S1	S1	Drainage	N1w
Pepper		S1	S1	S1	N1	S1	S1	Drainage	N1w

Adapted from Sys et al., (1993)

SUITABILITY CLASSES: *S1- Highly suitable; S2- Moderately suitable; S3 – Marginally suitable; N1- Currently Not suitable*

LIMITATIONS: *t – topography; w – drainage; c – coarse fragment (gravel)*

TEXTURE: *LS –loamy sand; SL – sandy loam; SCL – sandy clay loam;*

Discussion on the evaluation

Hilly Terrain

The hilly terrain generally is evaluated **marginally suitable** for both oil palm and pepper production, even though the soil quality is good. The major limitation is the steep slopes. It makes working highly inconvenient and also susceptible to severe erosion. Erosion prevention should be paramount in the management of this land unit. Surface cover should be present at all times. In this regard, planting pepper would require clean weeding to expose the bare ground and thus inducing erosion. *Therefore, it is better to avoid the cultivation of pepper on this land unit.* Oil palm could be grown but weeding should be by slashing so as to maintain some vegetative cover.

Rolling and Undulating Terrain

On the basis of soil quality and topography, this land unit is evaluated **moderately suitable** for both oil palm and pepper. The limitation here is also steep slope, but this is moderate as compared to the hilly terrain (Table 1). Working on this unit is more convenient but erosion prevention is again very important.

Lowland

The lowland is **currently not suitable** for both oil palm and pepper production due to the very poor drainage conditions. However, the unit can only be used for crop production if the drainage system could be improved for effective water control.

Conclusions

The soils encountered on the farmland are suitable for both oil palm and pepper. However, the limiting factor determining the level of suitability is topography or slope and drainage.

The steep slope makes movement and working on the land difficult. Erosion hazard is also severe as a result. Erosion prevention is very important. Measures that could be considered include the maintenance of vegetative cover to prevent erosion. The vegetative cover will reduce the impact of rain drops, serve as barrier to run-off and the roots and other plant remains bind the soil, as well as add organic matter to improve soil structure.

The cultivation of pepper should be confined to gentle slopes so as to prevent severe erosion when the land is weeded bare as part of the crop husbandry.

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2.1.4. Study Title: Soil suitability assessment for oil palm cultivation at Dodo Pepesu near Kajebi in the Volta region, for SG Sustainable Oil, Ghana Ltd.

Research Team: E. Boateng, P.M. Gyekye jnr. and E. Akuffo
Source of Funding: SG Sustainable Oil, Ghana Ltd
Duration of Project: 2011

Introduction
This report is the result of a request made by SG Sustainable Oil to the Soil Research Institute to investigate the soils on a parcel of land (approximately 524 hectares) which lies about 3 km North of Dodo Pepesu in the Volta Region, for oil palm production. A detailed soil survey was carried out to obtain optimal data.

Methodology
Some base information was gathered on climate, topography, vegetation, geology and soils of the area from secondary data, reports, maps, soil surveys etc. A site map was prepared based on a Ghana Soil Association map (scale 1:50 000), and topomap (scale 1: 25 000) and a digital outline of the site. Consultations were also made with the Chief at Dodo Pepesu for the necessary protocols.

Field studies involved field inspection, semi-detailed soil survey and sampling of soils. A total of 7 profile pits, approximately 100 x 200 cm and 100 – 200 cm deep, were dug on major soil types over the entire land, and described based on the FAO (FAO/ISRIC, 1990) soil profile description. Soil samples were taken at each genetic horizon for chemical and physical analysis. The soils were identified using physical characteristics such as physiographic position, soil colour, texture, relative amounts of coarse fragments, and depth to gravelly layer.
Laboratory analyses to assess fertility status of the soil was carried out. The soil chemical properties were rated according to classes described in FAO (1984) for soil reaction, exchangeable Mg, soil pH and electrical conductivity, total nitrogen, organic carbon, available phosphorus and potassium, exchangeable cations, exchangeable acidity (Al+H) and soil texture.

The FAO land suitability classification method was adopted for evaluating soil suitability assessment (FAO, 1976), while the two-step approach was used for the land evaluation.

Results

The soils found at the site fall within the Salom-Mate / Banda-Chaiso Complex. The complex is made up of two Associations; Salom-Mate Compound Association and Banda-Chaiso-Simple Association. The former Association consists of an upland Association of well to moderately well-drained soils and a lowland association of imperfectly to poorly drained soils. The latter occurs on upper to lower slopes and the component soils are Banda, Papase and Chiaso series.

The pH of the soils range from neutral to moderately alkaline. Organic carbon content range from medium to very high. Total nitrogen is also generally medium to very high. Available potassium (K) is generally low to very low whereas available phosphorus (P) is generally medium. Exchangeable K levels are very low to low whereas exchangeable Na is medium. Exchangeable Ca and Mg are generally medium to high except in Banda series which has low Ca.

The results of the soil suitability assessment showed that Ayoma and Banda series are moderately suitable for oil palm cultivation with some limitation of soil depth and fertility. Salom, Mate and Chaiso series are marginally suitable with some limitations of soil depth.

Moderately suitable soils occupy approximately 50% of the area, whiles marginally suitable soils occupy 47% of the area with 3% of area being not suitable for oil palm cultivation.

The fertility of the soil is generally low to moderate and will require adequate fertilizer application for effective growth and good yield.

Conclusion

Fertilizer application rate for the first three years should be 200g/plant of nitrogen, potassium and phosphorus. From the third to the seventh year, fertilizer application rate should be increased to between 500-1000g/plant of N.P and K and 500g/plant of magnesium. Above the 7th year, fertilizer application should be between 1000-1500g/plant of N, P and k and about 1000g/plant of magnesium.

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2.1.5. Study Title: Bui Irrigation Project – Phases I & II

Research Team: E. Boateng, P.M. Gyekye Junior, J. Oppong, E. Akuffo and K.A. Forson
Source of Funding: Haskoning Nederlands B.V
Duration of Project: 2011

Introduction

The Bui Power Authority of Ghana, through the consulting company, Haskoning Nederland B.V., sub-contracted the Soil Research Institute to conduct Soils and Land suitability Assessment as part of a feasibility study, which is in line with one of the cardinal principles of the Government of Ghana of ensuring increased and sustainable agricultural growth towards food availability and food security for the people of Ghana.

The study was carried out to assess the suitability of the soils for irrigated agriculture based on specified land utilization types (LUT's). The project area is at the downstream of the Bui Hydroelectric Dam (under construction) and on the left bank of the Black Volta within the Bole-Bamboi District in the Northern region. The study area is located North of Bamboi and also 3.5 Km north of Chibrinyoa (Krompo) village. The study is in two phases. Phase 1 lies within longitudes 1° 53'W and 2° 03'W, and latitudes 8° 15' N and 8° 32'N, with a total area of approximately 30,000 hectares. Phase II site, selected out of that of Phase 1, lies within longitudes 1° 53'W and 1° 57'W, and latitudes 8° 20' N and 8° 27'N, covering an area of 5,000 ha.

Whilst the main objective of Phase I was to conduct a semi-detailed/reconnaissance soil survey to cover the 30,000 ha, Phase II was set to conduct a detailed soil survey to cover the selected 5,000 ha.

Methodology

In both phases, the field survey relied on information provided by existing studies: Bole-Bamboi Report, a survey report by the Soil Research Institute between 1965 and 1966 (Adu, S.V, 1995), the Vol. III report on Land and Water Surveys (FAO, 1967) and a preliminary soil studies along the left banks of the White and Black Volta rivers in the Northern, Upper East and West regions (Boateng, E. 1991). Base information was extracted from these survey reports. Information provided by the Phase 1 studies was also used as the basis for the Phase 2 study.

The soil association map produced by the Bole Bamboi report was clipped with the boundary of the study site and geo-referenced. A base topographic map (scale 1:50,000) covering the site was overlaid unto the soil association map to form one seamless map, which was used for trekking the area to identify and validate the existing soil mapping

units. Soil identification and characterization were carried out along the map routes at every 1 km or less to identify soil types with a locally made chisel. Short transects were also made perpendicularly to the main route towards the river to establish the toposequence of the soils. A hand held GPS was used to record the coordinates (latitude and longitude) and the altitude. Soils were identified by their series names on the basis of baseline information on hand. Data recorded on the soil includes parent material, presence of surface materials, color, texture, structure, presence of concretions, stones or gravel content, drainage class, root density and position of soil on the toposequence.
Five profile pits were dug during the Phase 1 and 12 in Phase 2 and described according to 'Field book for describing and sampling soils' (NSSC, 2002). On the basis of additional information obtained from the field the soil boundaries were redrawn and a soil association map was produced at a scale of 1:250,000.

For the assessment of the fertility status of the soils, certain chemical and physical properties were determined. The parameters assessed in the laboratory include soil pH and electrical conductivity, total nitrogen, organic carbon, available phosphorus and potassium, exchangeable cations, Exchangeable acidity (Al+H) and soil texture.

Additionally in Phase 2, Infiltration rate analysis using the double ring method and biophysical land evaluation using the FAO Framework for Land Evaluation (FAO, 1976) and Guidelines for Land Evaluation for Irrigated Agriculture (FAO, 1985) were adopted.

Results

In Phase 1, the soils of the site are developed over the weathering products of Voltaian sandstone, mudstone and shales, and river alluvium. The soils are grouped into 7 mapping units: Vs1-Kpelesawgu-Chagnalili/Lima-Volta association, Vs2-Mimi-Techiman association , G1-Kolingu association, AL1-Pani-Kupela association, Al2- Siare-Dagare association, Al3-Sirru-Lapliki association), and AL4-Nterso-Zaw association).Soils developed over Voltaian mudstone and shales have been grouped into Kpwelesawgu-Changnalili/Lima-Volta and Damongo-Murugu Associations, and this group forms approximately 68 % of total soil coverage.
In Phase 2, the soils/land types were evaluated for mechanized irrigated crop production up to the first level (Order) of suitability assessment. 86% of the area is suitable, 5% marginally suitable and 9% not suitable for mechanized farming. For irrigated farming, 91% is suitable whiles 9% is not suitable. The major limiting factors were inadequate soil depth for root development and quantity of gravel and stones present in the surface and sub soils respectively. Infiltration analysis shows that the soils on the average have low hydraulic conductivities.

Conclusion

In Phase 1 the chemical analyses of the soils indicate that the levels of nutrient elements in the top 50-88 cm of five soil types are generally low to medium. Soil mapping Units G1 and AL4 have severe limitations of depth and coarse fragments and should be removed from any selected area for the detailed suitability assessment.

Phase 2 study shows that on basis of the selected soil fertility parameters the soils have low to moderate fertility levels. The soils are generally medium to heavy texture with saturated conductivity ranging from low to high. About 86% of the soils are suitable for mechanized farming whiles 91% percent of the area could be put under irrigation.

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2.1.6. Study Title: Soil characterization for irrigation

Research Team: B.O. Antwi, J.K. Senaya, E. Gaisie, R. Anim, and J. Awoonor

Collaborating Institutions: CSIR-CRI,
Source of Funding: AGRA
Duration of Project: 2011

Introduction

CSIR-Crops Research Institute (CSIR-CRI) develops crop varieties and carries out research on different types of crops. Unfortunately, research relies heavily on rainfed agriculture with supplementary irrigation provided to crops close to two dams at the site.

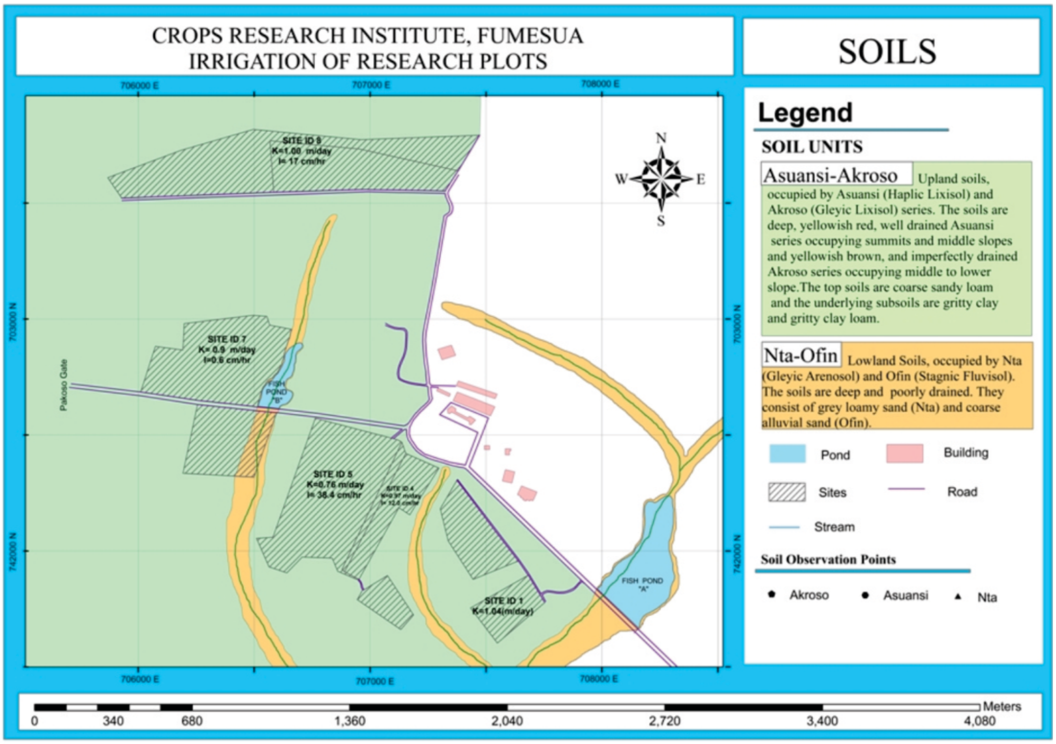

Figure 6. Layout of research blocks at Crops Research Institute, Fumesua

Alliance for Green Revolution in Africa (AGRA) was to support CSIR-Crops Research Institute to establish irrigation facilities on research plots at Fumesua The purpose of this study was to provide supplementary information for irrigation design and to determine the volume of water in two dams at the site.

Methodology

The team assessed the total volume of water in the two dams and demarcated the research plots using Geographical Information System (GIS) tools. The hydraulic properties determined were infiltration rate (double ring method), bulk density, soil water content (pressure plate method) and hydraulic conductivity (augerhole method). The water quality data in the dams were obtained from the results of CSIR-Water Research Institute, Accra.

Results

The assessment of the two dams shows a total of 43, 800 m^3 of irrigation water with capacities of 36,896 $m^3$and 6,869 m^3. The water quality was suitable for irrigation. The soils identified were *Lixisols*. Bulk density of the soils ranges from 1.32 g/cm^3 to1.52 g/cm^3 and contains 430 mm to 500 mm of soil water at saturation. Available moisture ranges from 122 mm/m to 140 mm/m. Basic infiltration rates ranged from 0.6 cm/hr to

38.4 cm/hr while hydraulic conductivity values ranged from 0.76 m/day to 1.0 m/day. It is recommended that the institute selects the best irrigation management options to provide high irrigation efficiency and optimum use of the equipment.

2.2. SOIL FERTILITY MANAGEMENT PROGRAMME

2.2.1 Study Title: CSIR-Soil Research Institute / Kinki University joint study (New "Sawah") Project

Research Team: Buri M. M, Issaka R. N. and Wakatsuki T
Collaborating Institutions: Kinki University, Japan; CSIR-CRI, MoFA
Source of Funding: Kinki University, Japan
Duration of Project: 2011

Introduction

The CSIR-Soil Research Institute (SRI)/Kinki University New "Sawah" Project is a collaborative project which is basically executed by SRI. The main goal of the project is to develop suitable technologies that will enhance, encourage and sustain rice production within the lowlands across the variable agro-ecological zones in the country. In brief, the New "Sawah" Project has come not only to encourage local rice production through the transfer of improved production techniques to local farmers, but also to monitor and design future sustainable production methods through appropriate research. Food security is a major problem which developing countries like Ghana are striving to achieve. This can only be made possible when certain interventions are put in place to ensure and encourage local production of our staple food crops. Rice is one crop whose imports takes a significant portion of Ghana foreign reserves. Consequently, any interventions that will lead to increased production on the local front is welcome, as this will not only enhance food security but will also create an avenue for rural employment and revenue generation.

The project continued with its two way approach towards achieving its objectives. Technology transfer through on-the-job-training which involves extension-farmer, research –extension/farmer and farmer-farmer training constitutes the first approach, while conduction of field experiments to generate more information that will enhance further technology transfer forms the second. Several lead farmers and extension staff of the Ministry of Food and Agriculture have been trained, to continue to assist in the scaling out of the technology. Several lead farmers have been trained to assist in farmer to farmer training. Farmers who have adopted the technology now obtain yields of 6.0 - 8.0 t ha^{-1}. Field experimentation and data collection continued during the year by both scientists and students.

Data collection was, however, hampered by the destruction of some action research sites by the IVRDP the previous year. In fact, data collection on long term experiments which were being conducted have stopped. This action of IVRDP also continued to affect production as some of the farmer-groups could not cultivate during the year due to the massive destruction of their "Sawah" rice fields. The Ph. D students sponsored by the Project continued with field data collection during the year. Field experiments for the year have been harvested and results are being analyzed.

As a way of informing the general public including the international community about the new technology, the New "Sawah" Project organized an international workshop on "the 'Sawah' Eco-technology for Rice Farming in Africa". The workshop attracted participants from Togo, Benin, Nigeria, South Africa, Indonesia, Japan and Ghana. During the workshop which was attended by policy makers, scientists, researchers and farmers from several countries, the contribution of the "Sawah" technology to increased productivity and its potential to improve, increase and sustain rice production not only in Ghana but within the sub-region were highlighted. Recommendations of the workshop have been presented to the Government of Ghana, the Ministry of Environment, Science and Technology (MEST) and the Ministry of Food and Agriculture (MoFA)

2.2.2 Study Title: On-Farm Evaluation of Burkina Rock Phosphate on Rice Production under the Sawah System

Research Team: Issaka R.N., Buri M.M. and Adjei E.O
Collaborating Institutions: JIRCAS,
Source of Funding: JIRCAS
Duration of Project: 2010-2011

Introduction
Low inherent soil fertility has been identified as a major cause for low rice yield (Abe et al., 2010; Buri et al., 2009; Buri at al., 2004; Issaka et al., 2009; Senayah, et al., 2008). Rice yield generally range from 1.0 t/ha on the upland to 2.2 t/ha in the valleys (MOFA, 2009). Phosphorus particularly is very low in most soils grown to rice. There is substantial potential for increasing production through effective soil management. An on-farm evaluation of Burkina Faso Rock phosphate (BRP) was conducted at Baniekrom and Nsutem in the AhafoAno South District in the Ashanti Region.

Objectives:
To evaluate the effect of Burkina Rock Phosphate on rice growth and yield

Summary of Results

Initial soil properties: Initial soil fertility status of farmers' field is presented in Table 1. Soil pH ranged from strongly acidic to slightly acidic. Generally all the fertility parameters are low.

Table 4. Initial soil properties of experimental site

Farmer	Soil pH	C	OM	TN	Av. P	K	Ca	Mg	EA
			(g/kg)		($mgkg^{-1}$)			(cmol(+)/kg)	
Bukari 1	4.6	13.0	22.3	0.9	4.5	0.3	5.2	2.2	0.9
Bukari 2	4.5	12.0	23.4	1.0	5.3	0.2	4.6	1.2	0.8
Kasoom	4.5	10.0	19.2	0.8	6.2	0.2	5.6	2.5	1.1
Mba	6.0	8.5	15.6	0.7	3.5	0.2	3.5	1.6	0.4
Moro	5.3	9.7	16.4	0.8	6.2	0.1	3.0	1.2	0.8
Musah	6.5	9.5	15.3	0.8	5.4	0.2	5.1	2.2	0.3
Surajzu	4.8	8.8	14.5	0.6	4.2	0.3	6.4	2.1	1.3
Yakubu	5.5	9.2	16.6	0.8	5.5	0.3	5.3	2.3	1.1

Number of panicles/plant *Grain yield*

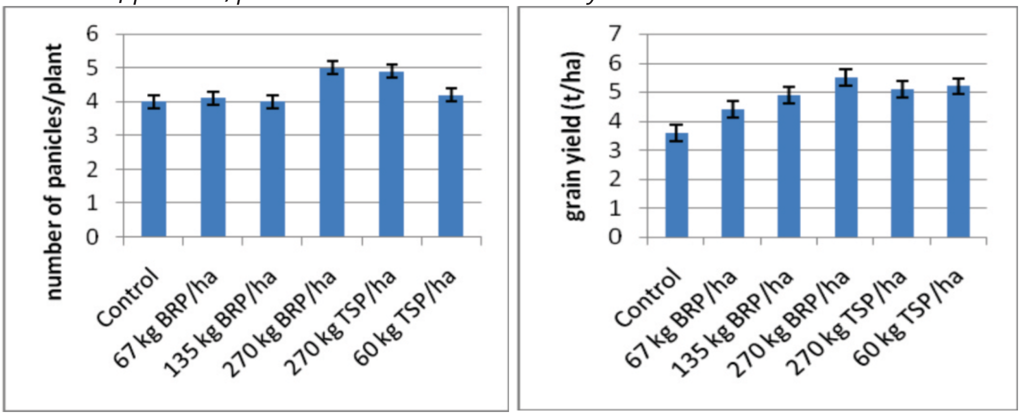

Figure 1. Effect of P-source on the number of panicles/plant and grain yield

Effect of treatments on yield: Treatment did not affect number of panicles/plant. Grain yield was significantly higher for 270 kg BRP /ha than Control and 67 kg BRP/ha. Control produced significantly lower grain yield than all the treatments except 67 kg BRP/ha. Figure 1.

Farmer influence on yield: Under similar management practice crop yield may vary depending on the attitude of the farmer. Yield from the various farms (mean of 6 treatments) are presented in Figure 2.

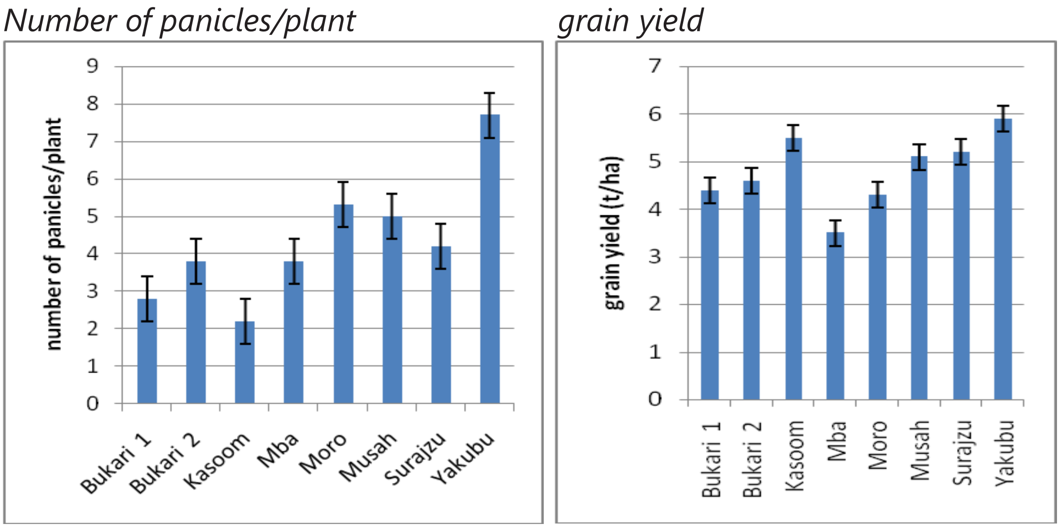

Figure 2. Number of panicles/plant and grain yield observed on farmers field

Farmers may behave differently when introduced to a new technology (Fig. 2). Yakubu obeyed all the basic rules of planting at 20 x 20 cm and general water management. His crops gave high number of panicles/plant which resulted in high grain yield. On the other hand Kasoom transplanted very closely (about 35 stands/m^2). He had the lowest number of panicles/plant but had an equally good crop yield. Mba had about 30 stands/m^2 but failed to manage his field properly. He had the lowest grain yield among all the farmers.

Conclusion

Within a year of the study it is clear that BRP has a potential of improving rice production in these valleys. Further studies will help suggest the most efficient rate of application.

2.2.3 Study Title: CSIR Yam fertilizer response to NPK fertilizer on some benchmark soils in the interior savanna zone of Ghana: calibrating the QUEFTS models for yam fertilization in Ghana

Research Team: Dr. F.M. Tetteh, G. Quansah and S. Ofosu Frempong
Collaborating Institutions: CSIR-CRI, MoFA
Source of Funding: WAAPP
Duration of Project: 20------

Introduction

Yam is important for food security in Ghana. Despite its importance, yam cultivation has been declining. Currently the increase in yam production has resulted mostly from increase in land-area under cultivation while the yields per unit area continue to decline. The increased demand for yam by consumers can only be met by an increase in yam productivity.

The advantage of the QUEFTS model is that a targeted economic yield of yam will be obtained based on the initial fertility status of the land. The usage of the model QUEFTS, (Quantitative Evaluation of the Fertility of Tropical Soils- Janssen *et al*., 1990), a decision support tool developed for the quantitative evaluation of initial fertility of tropical soils will assist to meet this objective. This will involve the determination of nutrient-use efficiency and the recovery rate of yam, the determination of the economic (marketable) yield and the total amount of nutrients absorbed by the crop and the estimation of the amount of nutrients needed to attain a given yield (targeted yield). It defines dilution limits and levels of accumulation of a given nutrient in the plant, which varies from one crop to another.

Goal and Objectives

The goal of this study is to adapt the QUEFTS model for yam fertilization in Ghana.

The specific objectives are as follows:

- To evaluate the performances of the original QUEFTS model for yam fertilization;
- To parameterize the model for yam fertilization;
- To calibrate the QUEFTS model for yam fertilization
- To establish optimum and economic fertilizer rates for yam grown on benchmark soils.

Expected Results

- Parameters for calibrating QUEFTS for yam are determined;
- QUEFTS is calibrated for yam fertilization;
- A database on yam is created.
- Optimum economic fertilizer rates established on benchmark soils

Materials and methods

The on-station experiment was carried out at **Wenchi** and **Atebubu** in the Brong-Ahafo Region on *Damongo* and *Lima* soil series respectively (Benchmark soils).

Widely grown white yam variety in Ghana (*Puna)* was used. Mineral Fertilizers used were Urea (46% N), TSP (46% P_2O_5) and KCl (60% K_2O). The QUEFTS Model (Janssen *et al*., 1990) input parameters were OC, P-available, K-exchangeable, pH-water, recovery rates of N, P and K, maximum yield (>80% of the potential yield). The output parameters were: Initial soil fertility (N, P and K content), uptake of N, P and K, and yield.

The 1st phase of the study (the calibrating phase of the QUEFTS model) primarily involved the building of a database during on-station fertilizer trials on yam for the first year.

Fertilization trials of yam
Fertilizer trials of white yam (*Puna*) were laid out on-station using completely randomized block designs (Figure 9).

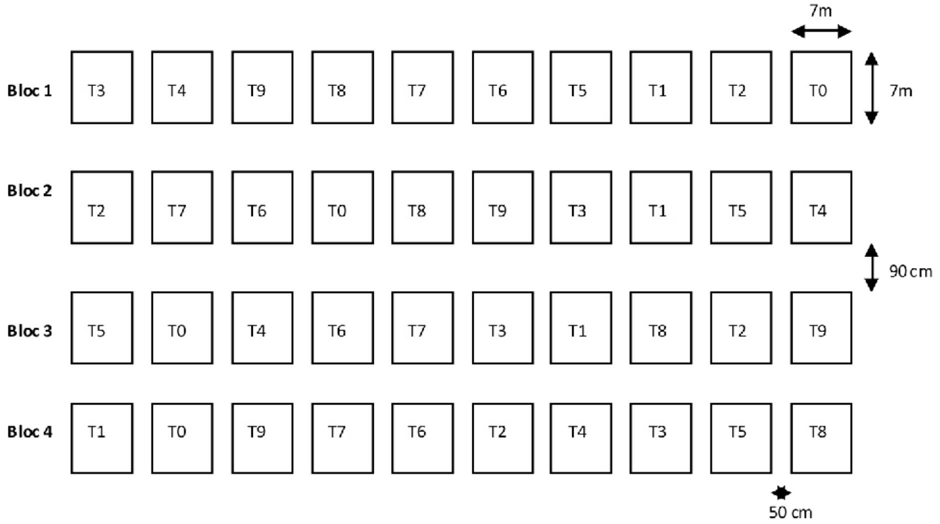

Figure 1. Experimental plots layout

The trial treatments were determined in a way to express the dilution limits and the accumulation of the nutrients and the capacity of the soil to furnish the major nutrients according to the increasing rates of the nutrients (elements). Altogether there were 10 treatments (Table 1).
All cropping practices such as planting, weeding, fertilizer applications, etc. were done on the same days on all the respective plots.

Table 1. Yam fertilization trial treatment

Treatments	Rates (kg ha^{-1})		
	N	P	K
T0	0	0	0
T1	0	40	130
T2	40	40	130
T3	80	0	130
T4	80	20	130
T5	80	40	0
T6	80	40	65
T7	80	40	130
T8	40	20	65
T9	100	50	170

Composite soil samples were taken at each site before setting up the trials. These samples were taken from 3 layers (horizons): 0-20cm, 20-40cm and >40cm for chemical analyses. The parameters to analyzed for include organic carbon content, total nitrogen, available phosphorus, exchangeable potassium, CEC, pH and the physical properties (clay, silt, sand content). A series of measurements were done throughout the trial on a number of tagged plants (4 stands / plot). These were: Date of germination of yam/water yam seeds (75% sprouting); Plant height at 2 months intervals, and leaf area index (LAI) at the time of measuring the plant height.
The daily climatic data of minimum and maximum temperatures, of solar radiations and of rainfall were also collected at Wenchi and Atebubu.

The data was subjected to analysis of variance (ANOVA) using the statistical software STATISTICA and the mean comparison was done by the statistical software Statsview. In addition, the following tools were used to evaluate the performance of the QUEFTS model:
Line 1:1 coupled with the coefficient of correlation; the acceptable precision envelope method (Mitchell, 1997); the normalized root mean square error NRMSE (Du Toit *et al.*, 2001), the mean square deviation (MSD) and its components (Kobayashi and Us Salam, 2000) and the Wilmott index of agreement (Willmott, 1981).

Results

Tables 2 and 3 show the fresh and dry matter yield of yam at Atebubu and Wenchi.

Table 2. Yield of yam tubers (fresh and dry matter weight) at Atebubu.

Treatment	Mean Tuber Yield kg/ha – Atebubu Fresh wt.	Conversion factor	Dry wt.
T_0	13687.5	0.3314	4536.04
T_1	20593.75	0.312125	6427.82
T_2	22906.25	0.299175	6852.98
T_3	18331.25	0.288	5279.4
T_4	19062.5	0.3212	6122.88
T_5	18343.75	0.30815	5652.63
T_6	13312.5	0.296425	3946.16
T_7	20156.25	0.311925	6287.24
T_8	13843.75	0.308225	4266.99
T_9	17718.75	0.303225	5372.77

Table 3. Yield of yam tubers (fresh and dry matter weight) at Wenchi

Treatment	Mean Tuber Yield kg/ha –Wenchi Fresh wt.	Conversion factor	Dry wt.
T_0	14063	0.3428	4820.8
T_1	12375	0.3072	3801.6
T_2	14687.5	0.3073	4513.47
T_3	14843.75	0.337025	5002.71
T_4	11875	0.327375	3887.58
T_5	13437.5	0.264675	3556.57
T_6	18125	0.328525	5954.52
T_7	12187.5	0.334525	4077.02
T_8	12250	0.30185	3697.66
T_9	13125	0.294925	3870.89

Table 4. Physiological Use Efficiencies of nutrient uptake by yam at Wenchi and Atebubu

	Physiolo gical Use Internal Efficiencies Wenchi N	P	K	Atebubu N	P	K
2.5 Percentile	27.8	368.3	88.6	25.9	394.4	100.6
97.5 Percentile	33.4	573.0	163.4	34.9	734.4	204.5
Mean	30.6	470.6	126.0	30.4	564.4	152.5

Table 5. Indigenous soil nutrient supply at Wenchi and Atebubu

Limiting Nutrient	Soil Nutrient Supply (kg/ha) Wenchi	Atebubu
0 – 40 – 130 (N)	136.9	188.2
80 – 0 – 130 (P)	9.3	11.3
80 – 40 – 0 (K)	36.1	27.5

Table 6 . The most limiting nutrients in soils at Wenchi and Atebubu

Treatment	Wenchi	Atebubu
0 – 0 – 0	14063	13687.5
0 – 40 – 130	12375.0(-)	20593.8
80 – 0 – 130	14843.8	18331.3
80 – 40 – 0	13437.5	18343.8
Limiting Nutrient	N	P&K

Table 4 shows the physiological use efficiency values obtained for yam at Wenchi and Atebubu. The 5 and 95% percentile values were obtained as borderlines (Fig. 2&3) The measured PhE showed that the uptake of 1 kg N produces in average 30.6 kg yam DM, corresponding to a reciprocal physiological efficiency (R-PhE) of 32.7 kg N required to produce 1Mg yam DM at Wenchi. Likewise, the uptake of 1 kg P produces 470.6 kg yam DM, corresponding to 2.1 kg P to produce 1 Mg yam DM. With 1 kg K taken up, is produced 126 kg yam DM, corresponding to 7.9 kg K for the production of 1Mg yam DM at Wenchi. Data for Atebubu are also provided in Table 4.

Estimation of balanced nutrition is based on the following equations:

1. B-PhEx = (aPhEx-bPhEx)/2
2. B-Tyx = PhEx*Ux
3. UN/UP=B-PhEP/B-PhEN

where B-PhE = physiological nutrient use efficiency (PhE) for balanced nutrition (B), x = specific nutrient (N, P or K), a = accumulation, d = dilution, B-TY = Targeted yield at balanced nutrition, U = nutrient uptake to attain B-TY

Table 5 shows that the indigenous soil N and P supply values were higher in Atebubu than in Wenchi. Wenchi soils are therefore poorer in N and P. Table 6 shows the most limiting nutrients at the Wenchi and Atebubu sites.

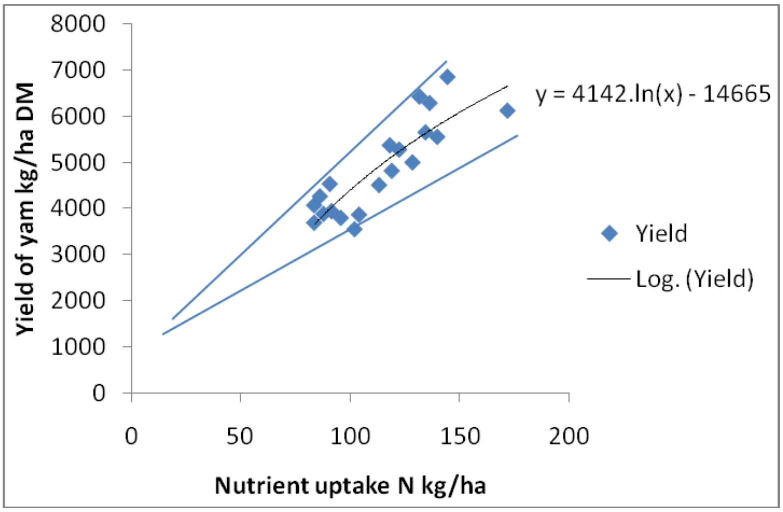

Figure 2. Physiological use efficiency of N for yam at Wenchi. (max. accumulation and max. dilution)

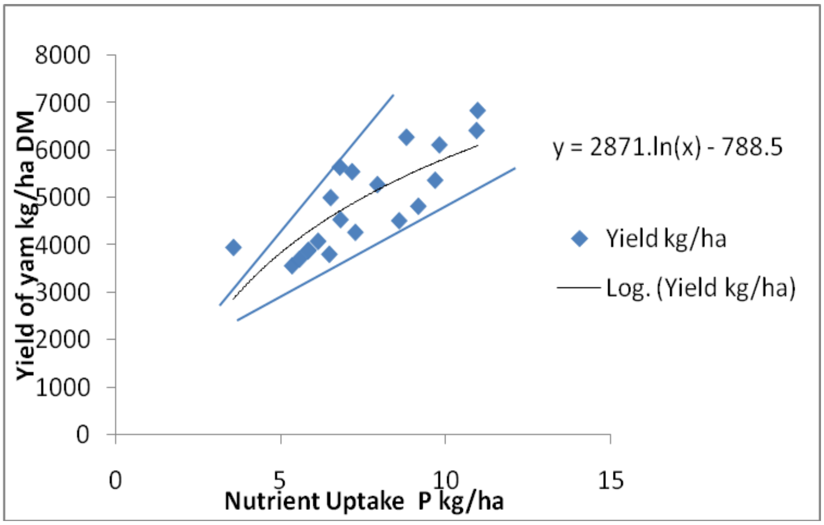

Figure 13. Physiological use efficiency of P for yam at Atebubu (maximum dilution and maximum accumulation)

Fertilizer recommendation

QUEFTS allows to determine the optimum quantity of fertilizer for a particular soil type and input and output prices, with a limited budget.

This means that fertilizer recommendations can be developed for various yield targets depending on the economic situation of the farmer, i.e. small scale resource poor, medium scale and large scale farmers (Tables 7 and 8)

Table 7. Fertilizer recommendation for the Atebubu site

Targeted Yield	N	P	K
9 t DMW	112.6	5.2	35.1
8 t DMW	79.8	3.4	28.3
7 t DMW	46.9	1.6	21.6
6 t DMW	12.4	0	15.0

Table 8. Fertilizer recommendation for the Wenchi site

Targeted Yield	N	P	K
7 t DMW	107.9	5.9	22.5
6 t DMW	73.6	3.8	14.4
5 t DMW	39.4	1.7	6.3

Conclusion

Calibrating the QUEFTS' model for yam to determine fertilizer recommendations for targeted yam yields and most yield limiting nutrients led to promising results. Further research will be conducted on other benchmark soils and results validated on farmers' fields

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2.2.4 Study Title:	Update and refine of profitable fertilizer recommendations for maize and grain legumes in northern ghana (sudan and guinea savanna zones)
SRI Research Team:	Dr. F.M. Tetteh, G. Quansah, S. Ofosu Frempong, K. Boah
Collaborating Institutions:	SARI,
Source of Funding:	AGRA
Duration of Project:	2010-2014

Introduction

Increasing crop productivity in Ghana cannot be achieved without proper targeting of the applied fertilizers. Total fertilizer use in Ghana is 250,000 metric tons against a potential of 1.0 million metric tons. Fertilizer use rate at farm level is, however, very low (less than 8 kg ha^{-1} compared to the nutrient depletion rates at farm level that range from about 40 to 60 kg of nitrogen, phosphorus, and potassium (NPK) ha^{-1} yr^{-1} (FAO, 2005).

Lack of site specific fertilizer recommendations has been identified as a major obstacle to optimizing benefits from fertilizer use. This project therefore seeks to contribute to this overall goal of increasing food production and incomes of smallholder farmers by developing site-specific fertilizer-recommendations for major cereals (Maize, Sorghum and Rice) in key ecological zones in Ghana. The following specific objectives will be pursued:

The main activities planned for implementation to realize the set objectives are:

* Identify, select and map benchmark soils
* Conduct participatory yield response trials or adaptive trials.
* Assemble relevant minimum dataset needed for crop models (DSSAT, APSIM)
* Conduct soil testing in the field

Activity 1. Identification and selection of benchmark soils

The identification and mapping of benchmark soil units will facilitate agro-technology development and transfer. The work was in three phases: phase I involved secondary data compilation and syntheses on environmental conditions and soils identified as benchmark soils in the project area of the three northern regions of Ghana. This is followed by documentation of information gaps on each benchmark soil. Phase II involved fieldwork to describe and determine the extent of the identified benchmark soils. Phase III is on-going and involved hydrological and fertility studies on benchmark soils**.** Phase IV involved laboratory analyses to establish the physico–chemical and hydrological characteristics of the benchmark soils to ensure their proper use and management.

Work done

The soil encountered at Wa West District (Nyoli) are Kolingu (Chromic Luvisol), Dondiron (Ferric Lixisol), Varempre (Ferric Luvisol) and Wenchi series. They are developed over Cape Coast Granite and belong to Varempre – Kupela Association.

The dominant soils at the site are Varempre and Kolingu series. Soils of the experimental sites were identified and sampled for laboratory analyses. Secondary data collection and synthesis of environmental conditions and soils are in progress. Fertility studies on benchmark soils through on-station and on-farm fertilizer trials is in progress.

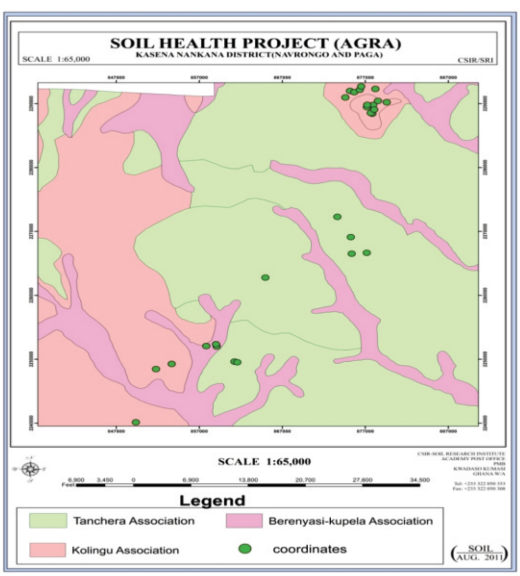

Figure 1. Distribution of soils at Kasena Nankana district showing benchmark soils

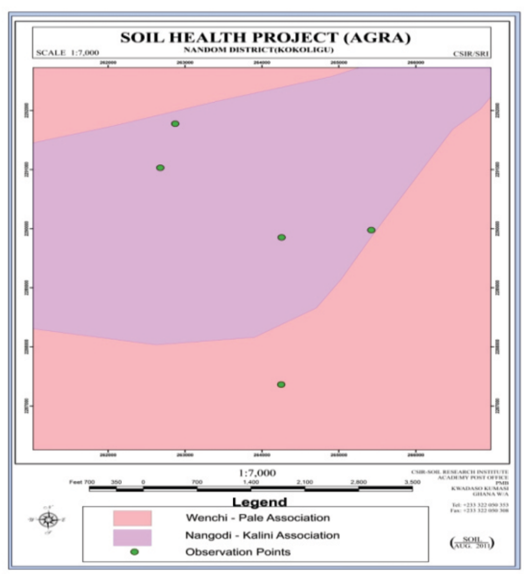

Figure 2. Distribution of benchmarksoils in the Wa area (UWR)

Activity 2: Conduct participatory yield response trials or adaptive trials

Maize fertilizer response trials were established on-station and on-farm.

I. On-station

Maize trials were set up at Tono, Nyankpala , Bimbila and Salaga.

The plots (about 0.5 ha each) were ploughed and harrowed. At Tono, ploughing was done with a tractor followed by ridging with a bullock. The rest were ploughed and harrowed by a tractor. The plots were laid in a randomized complete block design with 4 replications. The size of a plot is 6.0 m X 4.8 m. There were 10 fertilizer treatment combinations as follows:

Table 1

Treatment	N	P_2O_5	K_2O (kg/ha)
1.	0	0	0
2.	0	90	90
3.	40	90	90
4.	80	90	90
5.	120	0	90
6.	120	45	90
7.	120	90	90
8.	120	90	0
9.	120	90	45
10.	160	90	90

Planting

Maize variety, *obatanpa,* was planted at 3 seeds per hill at a spacing of 80 cm x 40 cm and later thinned to 2 plants per hill. This was done before fertilizer application.

Fertilizer application

Half of the N and all of the P and K rates were applied 2 weeks after planting in bands at both sides of the plants and buried. The second fertilizer application was done 4 weeks after the first application.

Weeding was done two weeks after planting with a hoe and when necessary.

ii. On-farm trials

Six districts (Kassena- Nankana West and East, Nanumba and West Gonja, Tolon-Kumbugu and Savelugu) were selected for the establishment of the on-farm trials to validate the DSSAT model.

A randomized complete block design with 5 fertilizer treatment combinations was used. In each district, 10 farmers were selected. Each farmer became a replicate. The plots were disc-ploughed followed by ridging with bullock. The plots were arranged in a randomized complete block design with 4 replications. Each plot size was 10 m X 5 m.

The treatments were as follows:

Table 2

Treatments	N	P_2O_5	K_2O
A	0	0	0
B	40	60	60
C	80	60	60
D	120	60	60
E	160	60	60

Data collection

Soil

In the northern region, the soils found at the selected sites belong to the *Nyankpala-Kumayilli/ Lima- Volta* compound association and are developed over mudstones and clay shales. The soil series encountered at the selected sites were *Wenchi, Nyankpala, Kumayili,* and *Kpelesawgu* series. The soils encountered at the navrongo sites in the upper east region are *Tanchera* and *Kulingu* series and belong to the pusiga association which is derived from hornblende granite.

At the Paga sites, *Kulingu* and *Kupela* series which belong to the Kulingu association were encountered. They are developed over the same hornblende granite.

The soil at the Tono on-station trial is *Tanchera* series (Adu, 1969). These are imperfectly drained soils consisting of 60-90 cm of pale gritty sandy loam usually underlain by packed iron concretions or seepage iron-pan overlying decomposing granite. Soils of the various on-farm trials were also identified and sampled for laboratory analyses. Stratified sampling of the soil profile pit was done at 0 – 10, 10-20, ... 140-150 cm. Parameters determined were bulk density, organic carbon, NH_4^+—N, NO_3^-—N , Bray's P, ECEC, and exchangeable bases, pH and texture. Moisture content was determined on volume basis.

Weather

Secondary weather data was collected from Navrongo, Salaga and Bibimbila weather stations on rainfall, minimum and maximum temperatures, relative humidity, sunshine hours and solar radiation.

Crop data

Date for 6th visible collar leaf, date for tassel initiation, days to 50% tasseling, days to 50% silking and days to maturity (black layer formation) were recorded.

Results

Maize responded well to N, P and K application (Table 3). The DSSAT simulation model was used to run the data after which the most economic rate was obtained after which the results were validated through on-station and on-farm trials.

Table 3 Maize response to fertilizer application (On -station trails -Nyankpala)

Treatment	Yield (kg/ha)	
120-90-60	2180.6	A
120-60-90	2127.8	AB
120-60-60	2125.0	AB
120-45-60	2119.4	AB
120-60-45	2011.1	BC
120-0-60	1955.6	C
150-60-60	1780.6	D
80-60-60	1702.8	D
120-60-0	1427.8	E
40-60-60	1208.3	F
0-0-0	230.5	G

In simulation studies, the treatments were developed to cover a range of management input files. These input files include experimental file which was created by inputting name and geographical position of the field, planting date, fertilizer application dates, five levels of N (0, 40, 80, 120, 160), three levels of P (0, 45, 90) and three levels of K (0, 45, 90). The soil file includes the analytical characteristics of the soil of the study field such as particle size, pH, nitrate, ammonium, total N, available phosphorus, excheangeable potassium, organic carbon, bulk density, and volumetric moisture content. The weather file which also consisted of precipitation, minimum and maximum temperatures and solar radiation of the study field from 1960 to 2010 was used. The genetic co-efficient for the maize was calibrated from the field results. These model inputs were integrated to provide a framework for simulating and analyzing outputs.

Model calibration and validation

The values for the thermal time from seedling emergence to the end of juvenile phase (P1 in degree days), photoperiod sensitivity coefficient (P2 in days), thermal time from silking to time of physiological maturity (P5 in degree days), maximum kernel number per plant (G2), potential grain filling rate (G3 in mgd^{-1}) and thermal time between successive leaf tip appearance (PHINT in degree days) were 380, 0.1, 750, 532, 8, 38.9 respectively.

The CSM-CERES model was validated by comparing the observed field data with the simulated data for the 2010 growing season. The corresponding results were as follows:

Maturity (grain yield)

The R-square value between the observed and the simulated result was 0.915 (Table 1). The model showed a good performance as the R-square value was close to 1 (*Wilmott* et

al., 1985; and *Wallach* and *Goffinet* (1987). The normalized root mean square error (NRMSE) between the observed and the simulated grain yield result was also 26.1 %. This also confirms that the model performance in simulating the yield at maturity was in the acceptable range (*Jamieson* et al., 1991; *Loague* and *Green*, 1991).
However, the model was very sensitive to the fertilizer rates as the simulation of yields for treatments with no or little fertilizer rates especially N was bad compared to treatments with high rate of fertilizer.

By-product (stover) weight
The model showed a good simulation performance with R^2 value of 0.892 between the observed and simulated results (Table 14). According to *Wilmott* et al. (1985) and Wallach and *Goffinet* (1987), any R^2 value between observed and simulated result close to 1 shows a good model simulation performance. The NRSME value between the observed and simulated result was 21.2 % which was within the acceptable range according to *Jamieson* et al. (1991) and *Loague* and *Green* (1991). The model was very sensitive to N rate as the predicted by-product weight for the treatment increased with increasing N rates. However, the model was not sensitive to P and K rates as increase in P and K rates did not increase by-product yield

Table 4 : Comparison between observed and simulated maize yield results at Navrongo in 2010.

YIELD PARAMETER (kg/ha)	[a]Obs	[b]Sim	[c]MD	[d]RMSE	[e]R-Sqaure	[f]NRMSE (%)
Maturity Yield	1940	2280	340	507.02	0.915	26.1
By-Product (Stover) Weight	7635	9075	1440	1622.41	0.892	21.2
Top weight (Total Biomass)	10487	11268	781	855.17	0.988	08.2

[a]Observed;[b]Simulted;[c]Mean Difference;[d]Root Mean Square Error;[e]Root Square;[f]Normalised Root Mean Square Error.

Top weight (total biomass)
Top weight at maturity in general, showed a very good prediction by the model between the observed and simulated result. The comparison between the observed and simulated data showed R^2 value of 0.988 (Table 2). The simulation of the top weight by model was in similar trend as the results from the observed field data. Treatment 160-90-90 had the highest top weight for both the simulated and observed results compared to the rest of the treatments. This was due to high rate of N fertilizer. The model was sensitive to N rates as increasing rate of N increased the top weight.

Seasonal analysis
The yields at maturity for the treatments for the 50 years seasonal analysis for the treatments were discussed under the following:

Biophysical analysis

The biophysical analysis determined the minimum and maximum yields for the treatments, cumulative probability and rate of variance of yields for the treatments during the 50 years.

Treatment 10 (160-90-90) gave the best yield among the treatments during the 50 years. Its minimum yield (up to the 25 % yield) was above 2200 kg/ha which was above 75 % yield of the rest of the treatments (Fig. 3). It had a maximum yield of above 3800 kg/ha. Treatment 2 (0-90-90) had the least yield with a minimum of 640 kg/ha and maximum yield of 1400 kg/ha. This showed the level of significance of N in the development and growth of maize.

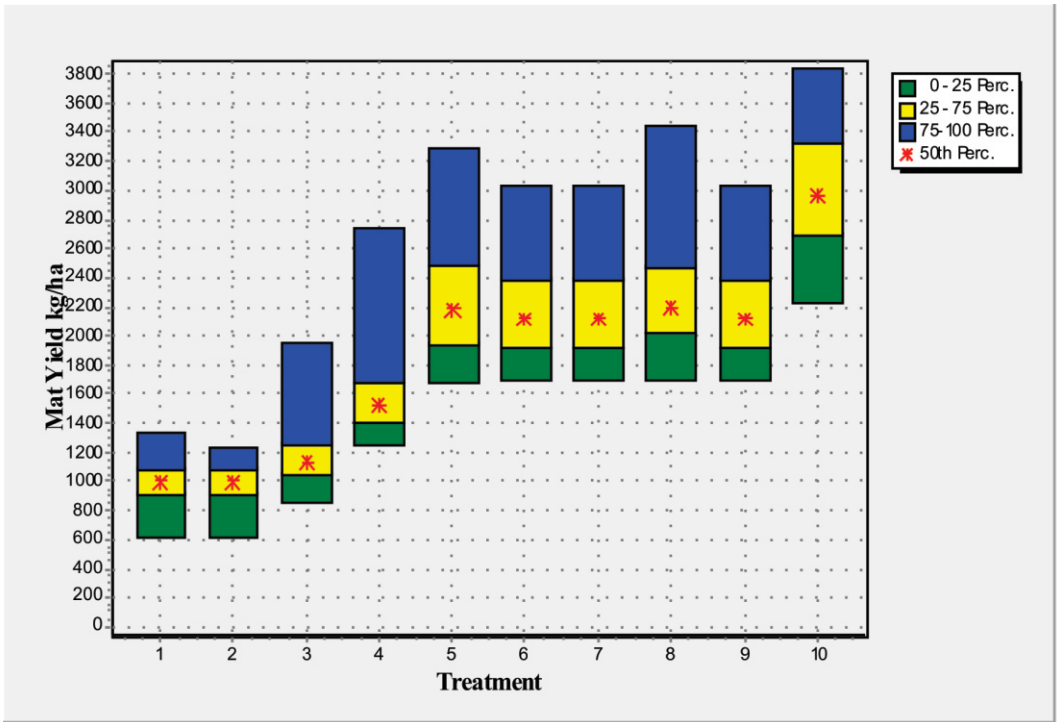

Figure 3. Maize yield as affected by different rates of NPK fertilizer for 50 years (1960-2010) biophysical analysis of seasonal analysis at Navrongo. (1 = 0-0-0; 2 = 0-90-90; 3 = 40-90-90; 4 = 80-90-90; 5 =120-0-90; 6 = 120-45-90; 7 = 120-90-90; 8 = 120-90-0; 9 = 120-90-45; 10 = 160-90-90).

The cumulative probability of the yields of all the treatments for the 50 years analysis revealed that treatment 10 (160-90-90) gave the best response compared to the rest of the treatments. At 25 % production of treatment 10, a maturity yield of 2500 kg/ha was obtained compared to the rest of the treatments which had a maturity yield of 2500 kg/ha at their 75 % and 100 % production level (Figure 4).

The risk in variability of the yield at maturity for all the treatments for the 50 years seasonal analysis showed that treatment 10 (160-90-90) had the highest mean yield with the highest variance value compared to the rest of the treatments (Figure 3). This shows that there is high inconsistency in the yield at maturity obtained from treatment 10 as it is easy getting maximum yield of above 3000 kg/ha and a minimum yield of above 2400 kg/ha in the subsequent seasons.

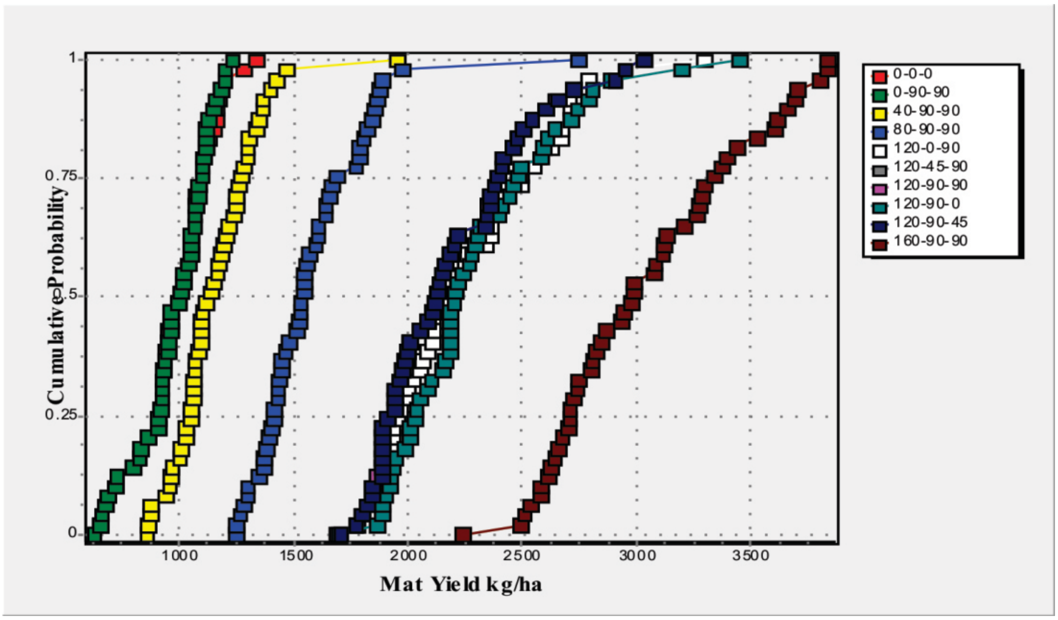

Figure 4. Cumulative probability of maize yield as affected by different rates of NPK fertilizer for 50 years (1960-2010) biophysical analysis of seasonal analysis at Navrongo.

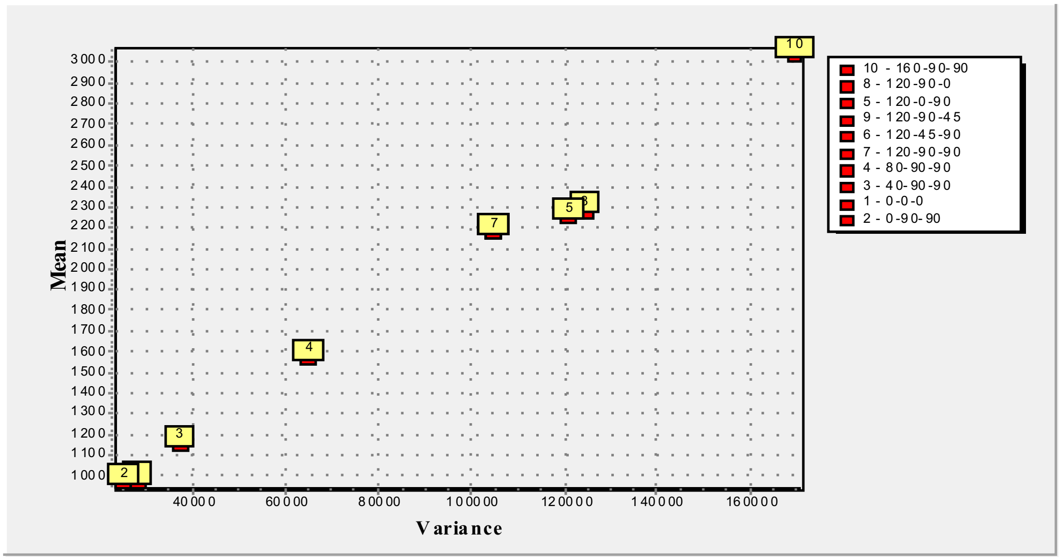

Figure 5. Maize mean yield variance as affected by different rates of NPK fertilizer for 50 years (1960-2010) biophysical analysis of seasonal analysis at Navrongo.

Economic and strategic analysis

The economic analysis option of the seasonal analysis tool calculated the net monetary return for the different treatments (Table 5). Treatment 160-90-90 had the highest mean, standard deviation minimum and maximum monetary return per hectare compared to the rest of the treatments (Table 5). This was due to the high yield obtained by the treatment (160-90-90).

However, the high value of standard deviation for treatment 160-90-90 means that, there is high risk involved in using that treatment as it is easy to get as low as the minimum monetary return and also easy get to as high as the maximum monetary return. Hence there will be very high inconsistency monetary returns per ha in using that treatment.

Table 5: Effect of NPK fertilizer rates on monetary return per hectare of maize for 50 years (1960-2010) Economic analysis of seasonal analysis at Navrongo.

Treatments	Mean (GH¢/ha)	Standard deviation (GH¢/ha)	Minimum (GH¢/ha)	Maximum (GH¢/ha)
0-0-0	618.5	191.5	218.7	1150.5
0-90-90	613.3	182.8	218.7	1049.9
40-90-90	727.4	240.0	321.7	1721.9
80-90-90	1043.0	324.2	541.7	2476.0
120-0-90	1565.2	429.0	793.0	2999.4
120-45-90	1501.5	396.8	799.2	2734.1
120-90-90	1501.5	396.9	799.2	2734.1
120-90-0	1591.2	438.3	796.7	3148.3
120-90-45	1501.9	396.9	799.2	2734.1
160-90-90	2165.2	523.6	1108.2	3513.9

(GH¢ = Ghana cedis)

Table 6: Fifty years (1960-2010) Mean-Gini dominance analysis of seasonal analysis for different rates of NPK fertilizer at Navrongo.

Treatments	E(x) Mean return (GH¢/ha)	E(x) - F(x) (GH¢/ha)	Efficient
0-0-0	738.5	509.6	No
0-90-90	733.3	508.4	No
40-90-90	865.4	600.2	No
80-90-90	1181.0	875.0	No
120-0-90	1703.2	1327.1	No
120-45-90	1639.5	1279.3	No
120-90-90	1639.5	1279.3	No
120-90-0	1729.2	1351.1	No
120-90-45	1639.9	1279.6	No
160-90-90	2303.2	1867.3	Yes

F(x) = Gini coefficient

The Mean-Gini Dominance analysis was performed to evaluate the economics of the treatments. The result showed that treatment 160-90-90 was the best fertilizer recommendation to sustain maize productivity in the Sudan savanna agro-ecological zone of Ghana (Table 6). This was due to the high mean return per hectare obtained by treatment 160-90-90. This means that, selection of treatment 160-90-90 could be the better strategy to increase the efficiency of maize production in the Sudan savanna agro-ecological zone of Ghana.

The model was helpful in making decision for refining fertilizer recommendation for the Sudan savanna agro-ecological zone. *Dzotsi* et al. (2003) and *Soler* et al. (2007) also concluded that CERES-Maize in DSSAT could successfully be used to predict the future crop yields under different management practices, and select the best one for sustainable production of maize and other crops.

Conclusion

Maize grain yield was affected by different rates of fertilizer application in the Guinea and Sudan savanna zones. Treatment 160-90-90 had the highest grain yield due to high rates of NPK fertilizer with N being the most limiting nutrient for maize production in the Sudan savanna agro-ecological zone. The model predictions were generally very good and were in the same trend as the observed field results. This suggests that the model can be used as a tool for developing site specific fertilizer recommendation for improved maize and other crops production in the country. Treatment 160-90-90 was recommended by the model as best and most efficient for maize production in the Sudan savanna agro-ecological zone of Ghana.

Treatment 160-90-90 is recommended by the model for efficient production of maize on Tanchera series soils (Ferric Lixisol, FAO 2006) in the Sudan savanna agro-ecological zone of Ghana. Testing of CSM-CERES-Maize model in DSSAT and its application in this study confirmed that, the model can be used as a research tool in various agro-ecological environments of the country for site specific fertilizer recommendation. Further studies on the effect of NPK fertilizer rates on maize production in the Sudan savanna agro-ecological zone should include other benchmark soils in order to reflect the heterogeneity in maize response.

2.2.5. Study Title: Developing Appropriate Fertilizer Management Options for Sweet-potato Production in the Central Region of Ghana

SRI Research Team: F.O. Ababio, J. O. Fening, E. Boateng, D. F. K. Allotey
Collaborating Institution: KNUST, MOFA
Source of Funding: WAAPP
Duration of Project: 2010-2014

General Objectives

- Develop appropriate fertilizer recommendations for optimum sweet-potato production.
- To enhance capacities of farmers and farmer groups to be able to use the technologies by Year 2 (40-50 % of farmers trained will be women).

Specific objectives

i. Determine the effect of soil amendments (either organic or inorganic fertilizer) on yield of sweet-potato.
ii. Determine the effect of varied rates of inorganic and organic fertilizers on Sweet-potato.
iii. Find out whether the various Sweet-potato cultivars respond differently to varied rates of mineral and organic fertilizers with regards to tuber yields.

<u>Expected outputs</u>

i. Increased sustainable soil fertility measures that are practically cost effective and attractive to Sweet-potato farmers developed
ii. More Smallholder farmers will increase acreage of sweet-potato farms
iii. Enhanced income of smallholder sweet-potato farmers

<u>Methodology</u>

The project is being conducted on farmer's fields in the Central region, at the following locations: Cape Coast (Dehia and Koforidua), Abura Asebu Kwamankesse- AAK (Miensa and Asebu Ekroful), Twifo Heman Lower Denkyira- THLD (Jukwa Zongo and Jukwa Krobo) and a municipality- Komenda Edina Eguafo Abirem- KEEA (a community each in Komenda and Antado). Eight (8) treatments namely: farmers practice, poultry manure at 5 t/ha, poultry manure at 2.5 t/ha, NPK (60-30-30), NPK (60-30-60), NPK (60-30-90), NPK (30-15-15) + poultry manure (2.5 t/ha), NPK (30-15-60) + poultry manure (2.5 t/ha) were used by the Farmers' group. Hi- Starch and Blue-Blue Santom are the cultivars of Sweetpotato being used.

A split plot design is adopted with soil amendments as main plot treatments and sweet-potato cultivars as sub-plot treatments. The experiment will be repeated in the second year. The project entails the formation of farmer groups in 8 communities within the four districts of the study sites. There will be two main treatments, farmers' practice and cultivar-fertilizer combinations. Each farmer group will implement the soil amendments- sweet-potato cultivars to be tested alongside farmer's practice. Different cultivar-fertilizer combinations will therefore be used at the different sites. Sweet-potato will be planted on ridges with 6 rows/cultivar. The vines will be planted at a spacing of 30 cm x 100 cm. At maturity, harvestable area will be the 4 middle rows. The study will also involve soil characterisation of the various location of 1.2ha/site before and after the trials. The data collected will be subjected to statistical analysis.

<u>Soil Amendments</u>

- o Nil (farmers' Practice)
- o Poultry manure at 5 t/ha
- o Poultry manure at 2.5 t/ha
- o NPK (60-30-30)
- o NPK (60-30-60)
- o NPK (60-30-90)
- o NPK (30-15-15) + poultry manure (2.5 t/ha)
- o NPK (30-15-60) + poultry manure (2.5 t/ha)

Results:

Table 1: Some physicochemical properties and Classification of some of the Study sites soils in the Central Region.

	pH (1:2.5)	N%	Av P mg/kg	Av K mg/kg	OM	Physical Analysis	Soil Series	Classification FAO (1990)
Akroful	5.4	0.12	2.96	10.27	2.23	SCL	Asuansi-Ksi	Ferralic Arenosols/
Miensa	6.1	0.09	5.21	15.18	1.92	SL	/Nta-Ofin	Ferric Acrisols
Dehia	5.7	0.08	4.41	15.41	1.63	SL	Asuansi/	Ferric Acrisols/
Koforidua	6.1	0.14	10.46	17.30	2.94	SL	Nta	
Antado	5.4	0.05	3.48	7.51	0.88	SL	Nsaba-Swedru/	Haplic Ferralsols
Komenda	6.3	0.03	5.34	7.67	0.66	SL	Nta-Ofin	
J. Zongo	6.7	0.13	28.60	17.94	2.30	SL	Asuansi	Ferric Acrisols
J. Krobo	6.0	0.09	4.53	19.09	2.04	SL		

Table 2: Means of Tuber Yields of the Two Varieties (Kg/plot) for Year 1**:**

Treatment	Variety 1 (Blue Blue)	Variety 2 (HiStarch)
Farmers' Practice	30.2b	44b
NPK (60-30-90)	51.8a	64.7a
NPK (30-15-60) + Poultry Manure (2.5t/ha)	55.5a	62.7a
Lsd (0.05)	6.48	7.40

Why Blue-Blue but not Hi-Starch?

- o Farmers rejected Hi- Starch due to some undesirable attributes when cooked (not firm and poundable and easily become soft on frying)
- o Not marketable
- o Easily Deteriorates

Table 3: Means of Tuber Yields of the Blue-Blue Variety (Kg/plot) for Year 2

Treatment	Variety 1 (Blue-Blue)
Farmers' Practice	38.4b
NPK (60 -30-90)	61.5a
NPK (30 -15-60) + Poultry Manure (2.5t/ha)	60.9a
Lsd (0.05)	8.14

Acknowledgements:

- o WAAPP Secretariat
- o MoFA

2.3 ENVIRONMENTAL MANAGEMENT AND CLIMATE CHANGE PROGRAMME

2.3.1. Study Title: CLIMAFRICA Project

SRI Research Team: B. O. Antwi
Implementing Institutions: CSIR-CRI
Collaborating Institution: CSIR-FORIG
Source of Funding: European Union
Duration of Project: 2010-2014

Sub-Saharan Africa (SSA) is the most vulnerable continent to climate change and variability, because of the combination of its low adaptive capacity with particular eco-climatic and socio-economic conditions. Climate predictions and adaptation to climate change in Africa are often limited by the use of models and strategies developed out of the African context and covering a time frame not adequate to take effective actions in time. This project is co-funded by the European Union under the 7th Framework Programme. Total budget: 4.6 M€; EU contribution 3.5 M€.

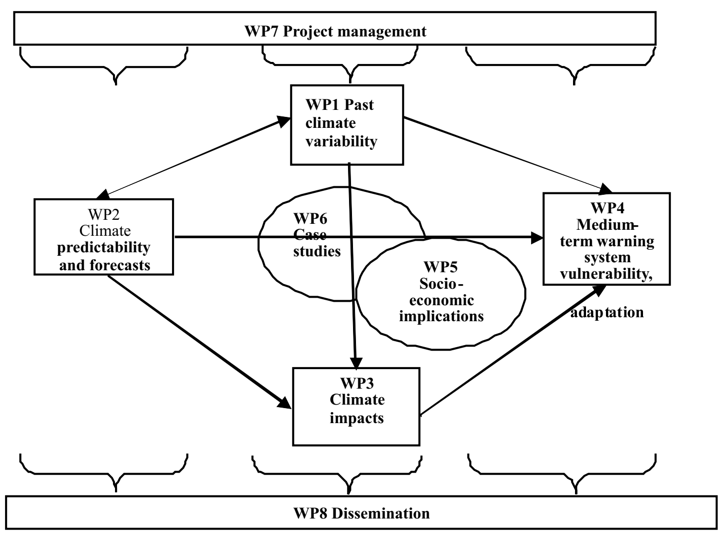

Figure 1. Project workplan

ClimAfrica's main objective is to better understand and predict climate change in SSA for the next 10-20 years, analysing the expected impacts on ecosystems and population and developing adaptation strategies tailored to the African context. The project is formulated under five specific objectives:

1. Improved climate predictions for SSA on seasonal to decadal scale developed;
2. Climate impacts in key sectors of SSA livelihood and economy, like water

resources and agriculture assessed;

3. The vulnerability of ecosystems and civil population to inter-annual variations and decadal trends in climate evaluated;
4. New adaptation strategies suited to SSA suggested and analysed;
5. New concept of medium term monitoring and forecasting warning system for food security, risk management and civil protection developed;
6. The economic impacts of climate change on agriculture and water resources in SSA and the cost-effectiveness of potential adaptation measures analysed.

Figure 1. shows the workplan to achieve the objectives. The Ghana team is in work package 6 (WP 6). The case studies and the measurements included in WP6 covers:: a) providing data for empirical model development; b) studying some particular processes that may have a strong influence on the local adaptation strategies, c) supplying parameters for mechanistic models; d) offering actual scenarios for model application and testing.

Results

Using Geographical Information System (GIS), the Ghana team selected three sites : Ankasa- Forest (Western region), Ejura GLOWA Volta site (Forest-Savannah Transition), Navrongo GLOWA site (Savanna). Due to inadequate funding for all the sites, the team together with the cases study group in WP6 decided we concentrate at Ankasa Forest site. Initial visit has been carried out and protocols for soil, vegetation and socio-economic information developed. Figure 2 shows the map of area selected for the study. The project will implement the developed protocols in the year 2012.

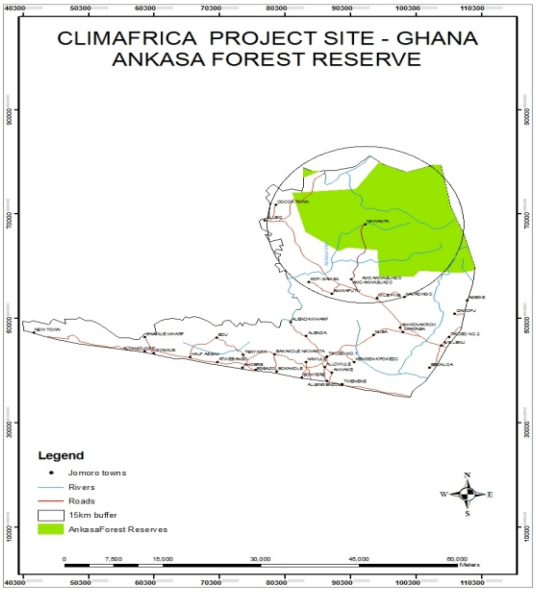

Figure 2. ClimAfrica study site

2.2.6 Study Title: Planning climate change adaptation and poverty reduction project: case study in water resource management in Daka catchment of northern Ghana

Research Team: Dr. B.O. Antwi
Collaborating Institutions: ???????
Source of Funding: Kojo Fosu
Duration of Project: 2011

Introduction

Understanding the climate-induced factors especially floods and droughts that affect rural livelihoods is a key step in reducing poverty in Northern Ghana. Unfortunately, water resources planning have been at village level through the development of small dams. These dams are not able to minimise excessive floods during the rainy season or provide adequate water during the six-month dry period. Adaptation to these extremes has resulted in degradation of top soils resulting in increased poverty, migration of the youth to cities in Southern Ghana. This study reports on planning and implementation procedures on harvesting water to mitigate the effects of flooding and drought for developing Daka River valley.

Methodology

Using an integrated approach supported by Geographical Information System (GIS) was used to define areas of the Daka River catchment that can be used to harvest enough water to meet the needs of rural people: sites for permanent housing, crop production, ranching, aquaculture, and drinking water. Soils within the sites were identified.

Results

The studies showed that:

i. Irrigation and flood control dams were required. This could release more than 200,000 ha of land for agriculture. Unfortunately, the investment is too expensive when targeted solely to food production and annual flood and drought disaster control.

ii. Food demands need to be met from increased investment in irrigation and water management. This implies that an economically viable irrigation project must incorporate an industrial crop to address the problem of sustainability, economic viability and to take care of environmental and social concerns while food production becomes an added benefit.

iii. The emerging interest in renewable energy and value-added agriculture, together with efforts to reduce global carbon emissions and the dependence on crude oil, is transforming world agriculture and energy markets. The deep soils were targeted to sugarcane for industrial fuel grade ethanol and raw sugar production. The 60,000 hectares were identified as suitable for rice, millet, sorghum and vegetable production.

Conclusion

The economic benefits to be derived from the study are numerous:

i. The output of Sugarcane industry will produce 150,000m^3 per annum of Fuel Grade Ethanol;
ii. 1,800 tons / day bagasse for power generation; 14,200 m^3 biogas / day additional fuel for boiler;
iii. Surplus electricity of 30MW (after captive consumption);
iv. 190 tons / day Press-mud for composting and 280 tons / day CO_2 for bottling. The industry will employ a minimum of 4,000 people with the local residents being the first beneficiaries.
v. The size of the workforce will demand new housing. New townships will be created as part of the project and will include clinics, schools, shops and infrastructure development (roads, electricity supply, water distribution) whose services will be available to the communities.
   The project includes research centre with a laboratory that liaises with collaborating research institutions. All production activities will be environmentally friendly and support climate change adaptation strategies for food production and poverty alleviation. The wealth creation through prudent management of Daka River resources will improve the life style of the residents and upgrade the living standards of the area.

This project is viable to meet the water requirements for the dry periods within the Daka Catchment from Salaga area to beyond Yendi. It will also solve the perennial flood disaster problems in the valley. The project has been suggested to Savanna Accelerated Development Authority to adopt the project as a starter for the development of Northern Ghana.

COMMERCIAL AND INFORMATION DIVISION (CID)

Introduction
The CID of Soil Research Institute comprises the following units**:**
1.0 Commercial Unit
2.0 Data Management Unit
3.0 Library Unit
4.0 Publication and Information Unit

1.0 Commercial Unit

1.00 Classification of Commercial Activities within the Institute

The commercial activities within the Institute are classified as follows:

1.001 Land Evaluation / Soil Survey
1.002 Laboratory Analytical Services (Soil / Plant /Water samples analyses)
1.003 Consultancy Services
1.004 Hiring of Conference Halls
1.005 Hiring of Vehicles / Tractor Services
1.006 Sale of Maps and Memoirs
1.007 Sale of Farm Produce

1.01 Internally generated funds

During the year 2011, the Institute IGF stood as depicted in table below.

Table 20. Internally generated funds

No.	Item Description	Gross Amount (GH¢)	Expenses (GH¢)	Net (GH¢)
1.001	Land Evaluation/Soil Survey	-	-	-
1.002	Lab. Analytical Services (Soil/Plant/Water Analysis)	17,638.50	11,976.85	5,662.45
1.003	Consultancy Services	21,647.63	11,578.40	10,069.23
1.004	Hiring of Conference Halls	3,806.00	200.00	3,606.00
1.005	Hiring of Vehicles/Tractors	4,534.00	976.00	3,558.00
1.006	Sale of Maps & Memoirs	7,391.00	2,270.00	5,121.00
1.007	Sale of Farm Produce	7,040.00	-	7,040.00
	TOTAL	62,057.13	27,000.45	35,055.68

2.0 Data Management Unit

The Data Management Unit of the CID executed the following activities in 2011:

1. Managed the Local Area Network of the Institute.
2. Supervised the servicing of computers by Inter-Speed Systems.
3. Analyzed experimental data for Research Scientists.

Recommendations

a. It is recommended that the service provider, UCOM is invited to explain to the Scientists on the service they are providing and how it should be used.

b. It is also recommended that a Server is purchased to enable CID monitor the internet service the Institute is getting from UCOM , the internet service provider as well as managing and controlling the use of bandwidth given to the Institute by the service provider.

c. It is also recommended that a computer hardware technician is employed to take care of computer hardware problems within the Institute.

3.0 Library Unit

The library did quite well in terms of patronage. We received students from the Agric College, KNUST, Winneba College of Education (UCEW-Kumasi campus) and Staff who came in regularly to read daily newspapers.

The library received books, periodicals, newsletters, journals, magazines and annual reports from CTA, Cocoa Research Institute of Ghana, CSIR institutes and also from various international institutes/bodies.

4.0 Publication and Information Unit

The unit dealt with a number of enquires seeking information on the country's soils, Vegetation and land use and related subjects from Government departments, organizations, and individuals, students from Senior High Schools and Tertiary Institutions as well as Foreign Students.

The unit also rendered photocopy services to all divisions within the institute, as well as binding of all the reports published within the institute.

4.0 ADMINISTRATION AND FINANCE

The Institute was managed by an eight-member Management Board chaired by Oheneba Adusei Poku, Akyempimhene, Kumasi as well as a 15 member Internal Management Committee chaired by the Director.

The Institute's staff strength stood at 294, made up of 33 senior members, 85 senior staff and 176 junior staff (Appendix 3).

Finance

Total receipts of Ghana Government funds for the year was GH Cedis 3.7 million constituting about 70% of the approved budget. The amount was spent as per the table below;

Government of Ghana funds - 2011.

Type of expenditure	Expenditure (GHC)
1. Personnel Emoluments	3 030 373.00
2. Administrative Activities	678 076.00
3. Service Activities	-
4. Investment Activities	-
TOTAL	**3,721,361.00**

APPENDIX 1

PUBLICATIONS PRODUCED IN 2011

Journal Papers:

Andoh - Mensah E., Issaka Nuhu R. and Ama Ennin S. 2011. Evaluation of growth and yield performance of coconut as influenced by cassava intercropping system. JUST Vol. 31, No. 1.

Buri M. M., Issaka R. N., Wakatsuki T and Kawano N. (2011): Improving the productivity of lowland soils for rice cultivation in Ghana: The role of the Sawah system. *Journal of Soil Sci. and Environmental Management*. Vol.2(10), pp. 304-310

Aikins, S.H.M., Afuakwa, J.J., Adjei, E O. and Kissi, G. 2011. Evaluation of different planting tools for maize stand establishment. International Journal of Science and Nature. Volume 2 (4): 890-893.

Fening, J.O., Ewusie Nana, and Safo, EY. (2011). Short- term effects of cattle manure compost and NPK application on maize grain yield and soil chemical and physical properties. Agricultural Science Research Journal. Vol. 1 (3): 69 – 83.

Obalum S. E. , Nwite J. C., Oppong J., Igwe C. A., Wakatsuki T., 2011. Comparative topsoil characterization of sawah rice fields in selected inland valleys around Bida, north-central Nigeria: textural, structural and hydrophysical properties. Paddy and Water Environment: Volume 9, Issue 3 pp.291-299

Obalum S. E. , Nwite J. C., Oppong J., Igwe C. A. and Wakatsuki T. 2011. Variations in Selected Soil Physical Properties with Landforms and Slope within an Inland Valley Ecosystem in Ashanti Region of Ghana. Soil & Water Research Volume 6, Issue.2 pp: 73–82.

Logah, N. Ewusi-Mensah and F.M. Tetteh. 2011. Soil organic carbon and crop yield under different soil amendments and cropping systems in the semi-deciduous forest zone of Ghana. *Journal of Plant Sciences* 6(4): 165-173.

Asumadu H.E.L. Omenyo and F.M. Tetteh. 2011. Physiological and economic implications of leaf harvesting on vegetative growth and cormel yield of cocoyam (Xathosoma sagittifolium). *Journal of Agronomy*. PP 6.

Tetteh F.M. Donkor O.I., and M. Bonsu. 2011. Heavy metal contents citrus fruits grown in two mining districts in Ashanti Region, Ghana. *Journal of the University of Science and*

Technology. (*In Press*)

O. I. Oladele, R. K. Bam, M. M. Buri and T. Wakatsuki (2010). Missing prerequisites for Green revolution in Africa: lessons and challenges of the "Sawah" rice eco-technology development and dissemination in Nigeria and Ghana. *Journal of Food, Agriculture & Environment.* Vol. 8 (2): 1014-1028

Buri M.M., Issaka R.N., Fujii H and Wakatsuki T (2010) Comparison of soil nutrient status of some rice growing environments in the major agro-ecological zones of Ghana. *Journal of Food, Agriculture & Environment. Vol. 8 (1):384-388*

Conference Papers

Parkes, E. Y., M. Lotsu, E. A. Akuffo and D. F. K. Allotey (2011) The yield performance of five cassava genotypes under different fertilizer rates (Abstract). Paper presented at the West Africa Root and Tuber Crops Conference, West Africa Agricultural Productivity Programme (WAAPP), 12 – 16 Sept 2011, Mensvic Grand Hotel, Accra, Ghana.

Wakatsuki T., Buri M. M. Bam R. Aemiluyi S. Y, Ozogu I. I., Oladele O. O. and Igwe C. A. (2011). Multi-Functionality of Sawah Eco-technology: Why sawah-based rice farming is critical for Africa's green revolution. Paper presented at the 1st International workshop on "Sawah" eco-technology and rice farming in sub-Saharan Africa, held at Golden Tulip hotel, Kumasi, Ghana. November 22 – 24, 2011.

Buri M. M., Issaka R. N., and Wakatsuki T. (2011): An over view of the "Sawah" Project and its implications for future rice production in Ghana. Paper presented at the 1st International workshop on "Sawah" eco-technology and rice farming in sub-Saharan Africa, held at Golden Tulip hotel, Kumasi, Ghana. November 22 – 24, 2011.

Issaka R. N., Buri M. M. and Wakatsuki T. (2011): Potential impact of the Sawah system on rice production in Ghana. . Paper presented at the 1st International workshop on "Sawah" eco-technology and rice farming in sub-Saharan Africa, held at Golden Tulip hotel, Kumasi, Ghana. November 22 – 24, 2011.

Wakatsuki T, Buri M. M., Obalum S.E., R. Bam, Oladele O. I., Ademuliyi S. e and Azogu I. I. (2011): Farmers personal irrigated sawah systems to realize the green revolution and Africa's rice potential. Paper presented at the 1st International conference on rice for food, market and development (rice-Africa), Abuja, Nigeria. March 3-5, 2011.

Buri M. M., Issaka R. N., Wakatsuki T. and Kawano N. (2011): Intensifying and sustaining rice production in inland valley ecosystems in Ghana. Paper presented at the 1st

International conference on rice for food, market and development (rice-Africa), Abuja, Nigeria. March 3-5, 2011

Issaka R. N. Buri M. M. and Wakatsuki T. (2011): Technology transfer for increasing and sustaining rice production in the Inland valleys: Adoption of the "Sawah" system. Paper presented at the 1st International conference on rice for food, market and development (rice-Africa), Abuja, Nigeria. March 3-5, 2011

Buri M. M., Imoro A. and Ahiapka E. S. (2011): The state of mechanization in Ghana with particular reference to the rice sector. Paper presented at the International workshop on "Boosting Agricultural mechanization in Rice-based systems in Sub-Saharan Africa." Held at St. Louis, Senegal. June 6-8, 2011.

Buri. M. M. (2011): Management of lowland soils for rice production in Ghana. Paper presented at the JIRCAS International workshop on Improved Infrastructure and Technologies for rice production in Africa. Ghion Hotel, Bahar Da, Ethiopia, November 4, 2011.

Obalum S.E., Oppong J., Watanabe Y., Igwe C.A., Wakatsuki T.2011. Simulation of pre-season soil hardening in West African lowlands and the effects on *sawah* rice performance under three water regimes. Poster presented at Annual Meetings of the Japanese Society of Soil Science and Plant Nutrition, 8-10th Aug.2011, Int. Conf. Centre, Tsukuba, Japan.

Logan V., F.M.K. Tetteh, E.Y. Safo, C. Quansah and I. Danso. 2011. Comparative evaluation of short term organic carbon sequestration under different nutrient management during cropping cycles on a *Ferric Acrisol* in Ghana. Proceedings of the International Conference on Environment and Industrial Innovation. June 17-19. Kuala Lumpur, Malaysia. Pp 308-312

Technical Reports

Senayah J. K., Amoakwah, E., Awoonor, J., Badu, J., Fening J. O. 2011 Soils of selected compartments in the Afram Headwaters Forest Reserve. CSIR-SRI/CR/JKS/2011/01. CSIR-Soil Research Institute, Kwadaso, Kumasi. Report submitted to Mere Plantations Limited

Senayah J. K., Awoonor, J., Asamoah, E. 2011 Report on soil investigation on the farmland of Goldfields Ltd near Awodua, Tarkwa CSIR-SRI/CR/JKS/2011/02. Soil Research Institute, Kwadaso, Kumasi

Senayah J. K., Dwomo, O.,2009 Soils of Gomoa East District, Central Region, Ghana. SRI-Miscellaneous Paper No. 303. CSIR-Soil Research Institute, Kwadaso, Kumasi

Allotey, D. F. K., E. A. Akuffo and O. Mensah (2011) Soil Test Report on Afram Plains samples for SSL sugars Limited. SRI Technical Report No. CSIR-SRI/RE/DFKA/2011/1.

Allotey, D. F. K., E. A. Akuffo and O. Mensah (2011) Soil Test Report on Afram Plains samples for SSL sugars Limited. SRI Technical Report No. CSIR-SRI/RE/DFKA/2011/2.

Buri M. M., Issaka R. N. and Bam R. K. (2011): International training on "sawah" eco-technology for rice farming in Africa for Agricultural staff from Togo and Benin. Nov. 23 – Dec. 1, 2011, Kumasi, Ghana. CSIR – SRI/CR/BMM/2011/04

Sarfo-Kantanka ,A. and Fening, J.O. (2011). Cassava marketing in some selected districts of Ghana. CSIR-SRI/PR/ASK/2011/02

Darko-Obiri B., Fening J. O., Yeboah E. and Gaisie E. (2011) Cassava production, utilization and Marketing in the Wenchi, Ejura and Sekyedumase Districts of the BrongAhafo and Ashanti Regions of Ghana. CSIR-SRI/PR/BOD/2011/03. 1- 31

Senayah, J. K., Awoonor, J., Badu, J. and Fening, J. O . (2011). Soils of selected compartments in the Afram Headwaters Forest Reserve. CSIR-SRI/CR/JKS/2011/01. 1-21.

Antwi B.O., Senayah J.K., Gaisie E, R. Anim and J awoonor. 2011. Soil characterization for irrigation: Crops Research Institute's plots. CSIR-SRI/CR/BOA/2011/03. 1-21

Nuertey, B.N. Tetteh, F.M., Andoh-Mensah, E., Danso, I. and Osei, S. 2011. Buaben Oil Palm Outgrower Project. Technical Report no. CSIR-OPRI/TR/BNN/2011/62.

Nuertey, B.N., Tetteh, F.M. Andoh-Mensah, E. Danso, I., and Osei, S. 2011. Buaben Oil Palm Out-grower Project. Technical Report no. CSIR-OPRI/TR/BNN/2011/71

Manuals

Fening J O., Yeboah E and Gaisie E. (2011). A guide for farmer field for implementation. CSIR-SRI/MA/JOF/2011/1; 12 pp

Fening J O., Yeboah E and Gaisie E. (2011). Cassava legume strip intercropping and rotation technology. A resource and reference manual. CSIR-SRI/MA/JOF/2011/2; 17 pp.

SarfoKantanka ,A. Fening, J.O. (2011). The framers guide to marketing cassava. CSIR-SRI/MA/JOF/2011/3; 8 pp

Chapters in Refereed Books

Buri M. M., Issaka R. N., Senayah J. K., Fujii H and Wakatsuki T. (2011) Lowland soils for rice cultivation in Ghana. *In* Crop production Technologies. Chapter 7. Peeyush S. and Vikas A (Ed.). ISBN: 978-953-307-787-1. Pp 137- 150

Roland Nuhu Issaka, Moro Mohammed Buri, Satoshi Tobita, Satoshi Nakamura and E. O. Adjei. 2011. Indigenous Fertilizing Materials to Enhance Soil Productivity in Ghana. ISBN 978-953-307-945-5

APPENDIX 2

Workshops and Conferences:

Dr. M.M. Buri
Development of Improved Infrastructure and Technologies for Rice Production in Africa. Bahir Dar, Ethiopia. November 2011

Dr. M.M. Buri
Sawah" Eco-technology and Rice Farming in Sub-Saharan Africa, Kumasi, Ghana. November 2011

Dr. M.M. Buri
Boosting Agricultural Mechanization in Rice-based systems in Sub-Saharan Africa, St. Louis, Senegal. June 2011

Dr. M.M. Buri
Rice for Food, Market and Development (rice-Africa), Abuja, Nigeria. March 2011

Dr. M.M. Buri.
West Africa Roots and Tuber Crops Conference. September, 2011 Mensvic Grand Hotel, Accra, Ghana.

STAFF STRENGTH

STAFF INCUMBENT	KUMASI	ACCRA	TOTAL
Senior Members	27	6	33
Senior Staff	72	13	85
Junior Staff	165	11	176
T O T A L	264	30	294

DIVISIONS/SECTIONS: MANPOWER POSITION

NO.	DIVISION	SENIOR MEMBERS	TECHNICIANS SENIOR/JUNIOR	ADMIN/ SUPPORT.	GRAND TOTAL
1.	Soil Microbiology	4	2	6	12
2.	Soil Chemistry/Mineralogy	3	5	7	15
3.	Soil Genesis & Land Evaluation	4	6		10
4.	Soil Fertility & Nutrition Div.	6	10	42	58
5.	Soil & Water Management	4	1	10	15
6.	Commercial Information	4		8	12
7.	Administration	2		15	17
	SECTIONS				
8.	Accounts & Stores			14	14
9.	Security & Watchmen			20	20
10.	SMR & Extension Farm		2	24	26
11.	Transport & Civil Workshop		1	15	16
12.	Station Maintenance		1	33	34
13.	Cartography		7	1	8
14.	Canteen			7	7
	1. KUMASI	27	35	202	264
	2. ACCRA	6	13	11	30
	GRAND TOTAL	33	48	213	294

APPOINTMENT/ENGAGEMENT

<u>Senior staff</u>

NO.	NAME	POSITION	EFFECTIVE DATE
1.	Gideon Asamoah	Laboratory Technologist	08/08/2011

<u>Junior staff</u>

NO.	NAME	POSITION	EFFECTIVE DATE
1.	Sampson Owusu	Driver Gd.1	02/05/2011
2.	Alexander Appiah	Driver Gd.1	02/05/2011
3	James Ayaaba	Labourer	1/09/2011
4.	Clara Atubiga	- do -	1/09/2011
5.	James Mensah	- do -	1/09/2011
6.	James Daabo	- do -	1/09/2011
7.	Gilbert Bonige	- do -	1/09/2011
8.	Jeff Wiafe Akenteng	- do -	1/09/2011
9	Emmanuel Boateng	- do -	1/09/2011
10.	Esther Aku-Dei	- do -	1/09/2011

DEATH

NO.	NAME	POSITION	EFFECTIVE DATE
1.	Ebenezer Aidoo	Chief Technical Officer	2/11/2011
2.	Robert Bampoe Addo	Principal Technical Officer	31/12/2011
3.	Kofi Grushie	Supervisor Headman	4/12/2011
4.	Nathaniel Bonsumah	Conservancy Labourer	16/05/2011

TRANSFERS:

Senior member

NO.	NAME	POSITION	FROM	TO	EFFECTIVE DATE
1.	Dr. B.B. Aligebam	Research Scientist	SRI -Manga Station U.E.R	SRI - Accra Centre	1/03/3011

Senior staff

NO.	NAME	POSITION	FROM	TO	EFFECTIVE DATE
1.	Doreen O.K. Sarpong	Prin. Admin. Asst.	CSIR Head Office, Superannuation Section	SRI - Kwadaso, Kumasi	04/04/2011

Junior staff

NO.	NAME	POSITION	FROM	TO	EF FECTIVE DATE
1.	Beauty A Geraldo (Mrs)	Asst. overseer	SARI	SRI -Accra Centre	1/06/2011
2.	Ramson A. Akultam	Clerk Gd. II	SRI -Kwadaso	SRI -Manga Station	1/08/2011

PROMOTIONS

Senior staff

NO.	NAME	FROM	TO	EFFECTIVE DATE
1.	Hannah Adu Nkansah	Prin. A dmin. Asst.	Chief Admin. Asst.	1/01/2011
2.	Charity Boadi	Sen. Admin. Asst.	Prin. Admin. Asst	1/01/2011
3.	Regina Opoku Agyemang	Sen. Admin. Asst.	Prin. Admin. Asst	1/01/2011
4.	Margaret Akyeampong	Sen. Acct. Assist.	Prin. Acct. Asst.	1/01/2011
5.	Johnson Osei	Sen. Acct. Assist.	Prin. Acct. Asst.	1/01/2011
6.	Samuel Joe Sam	Senior D'man	Prin. D'man	1/01/2011
7.	Margaret Mfum	Admin. Assistant	Sen. Admin. Asst.	1/01/2011
8.	Siti K. Cephas	- do -	- do -	1/01/2011
9.	George Adongo	Workshop Supt.	Sen. W orkshop Supt.	1/01/2011
10.	Robert Bampoe Addo	Sen. Lab. Technician	Prin. Lab Technician	1/01/2011
11.	Comfort Twum Barima	Admin Asst.	Sen. Admin Asst.	1/01/2011

Junior staff

NO.	NAME	FROM	TO	EFFECTIVE DATE
1.	Stephen Wiredu	Sen. Tech. Asst.	Technic al Officer	1/01/2011
2.	Daniel Wiredu	Traffic Supervisor	Asst. Transport Officer	1/01/2011
3.	P.K. Appia Adjei	Foreman	Workshop Supt.	1/01/2011
4.	John Apadu	Sen. Security Asst.	Security Officer	1/01/2011
5.	Alexander Yaw	- do -	- do -	1/01/2011
6.	Kw asi Appiah	T.A. Grade 1	Sen. Tech. Asst	1/01/2011
7.	Anim Boafo	- do -	- do -	1/01/2011
8.	Stephen Erzoah	Asst. Overseer	Overseer	1/01/2011
9.	Lucretia Agbesihe	- do -	- do -	1/01/2011
10.	Dora Antwi	- do -	- do -	1/01/2011
11.	Ibrahim Dauda	- do -	- do -	1/01/2011
12.	Daniel Anyimah	Supervisor Headman	Asst. Overseer	1/01/2011
13.	Emmanuel Amoah	Driver Gd.1	Driver Inspector	1/01/2011
14.	Roger Banzie	Security Asst. Gd1	Sen. Security Asst.	1/01/2011
15.	Gabriel Tenye	Asst Overseer	Overseer	1/01/2011
16.	Alex Borkor	Artisan	Junior Foreman	1/01/2011
17.	Kofi Attah	Artisan	Junior Foreman	1/01/2011

Labourers

NO.	NAME	FROM	TO	EFFECTIVE DATE
1.	Kwabena Gyarko	Labourer	Senior labourer	1/01/2011
2.	James Yeninga	- do -	- do -	1/01/2011
3.	Richard D arko	- do -	- do -	1/01/2011
4.	Moro Asure	- do -	- do -	1/01/2011
5.	Joseph Dakorah	- do -	- do -	1/01/2011
6.	James Kwadwo Boye	- do -	- do -	1/01/2011
7.	Kwasi Nsiah	- do -	- do -	1/01/2011
8.	Kwabena Salifu	- do -	- do -	1/01/2011

RETIREMENT

Senior staff

NO.	NAME	DATE EMPLOYED 1ST APPT.	POSITION HELD	DATE RETIRED	YEARS SERVED
1.	Kwame Boah	7/08/1974	C.T.O	20/12/2011	37 Years
2.	Edward Anarfo	2/04/1997	P.T.O	01/07/2011	14 years
3.	Kusi Boateng	01/08/1985	P.A.F Manager	05/07/2011	26 Years
4.	E.A. Badu	03/09/1985	P.A.A	24/07/2011	26 Years

Junior staff

NO.	NAME	DATE EMPLOYED 1ST APPT.	POSITION HELD	DATE RETIRED	YEARS SERVED
1.	James. K.A. Danso	01/07/1997	Traffic Supervisor	10/03/2011	14 years
2.	Daniel Kojo	09/05/1983	Overseer	23/08/ 2011	28 years
3.	Daniel Opoku	01/09/1977	Supervisor Headman	01/07/2011	34 years
4.	Ben Kakpemah	01/09/1977	- do -	15/07/2011	35 years

STUDY LEAVE

Overseas

NO.	NAME	POSITION HELD	PROGRAMME STUDIES	INSTITUTION OR SCHOOL	PERIOD
1.	Sadick Adams	Asst. Res. Scientist	M.Sc GEO Information	ICT Netherlands	3 years 2010 -2013

Local

NO.	NAME	POSITION HELD	PROGRAMME STUDIES	INSTITUTION OR SCHOOL	PERIOD
1.	Sampson Adjei	Res. Scientist	Ph.D Soil Science	KNUST, Ksi	4 years 2006 -2010
2.	Isaac Owusu Ansah	Snr. Tech. Asst.	B.Sc Agric Science	University of Cape Coast	4 years 2009 -2013
3.	Stephen Wiredu	Technical Officer	Dip. In Gen. Agric	K.A.C., Kumasi	2 years 2011 -2013
4.	Dorothy Aponye	Overseer	Cert. In Gen. Agric	K.A.C. Kumasi	2 years 2011 -2013

LIST OF STUDENTS ON INDUSTRIAL ATTACHMENTS

NO.	N A M E	INSTITUTION/COLLEGE
1.	Mavis Amofa	K.N.U.S.T
2.	Enoch Boateng	University of Cape Coast
3.	Justice Ankomah Baffoe	University of Cape Coast
4.	Isaac Owusu Ansah	University of Cape Coast
5.	Daniel Kofi Acheampong	University of Cape Coast
6.	Prince Awuah Saffoue	University of Cape Coast
7.	Bridget Agyemang -Badu	University of Cape Coast
8.	Georgina O. Bonsu	Garden City Univ. College, Kumasi
9.	Gertrude O. Mensah	Garden City Univ. College, Kumasi
10.	Enoch Asare	Univ. of Development Studies, Nyankpala
11.	Edmund Arthur	Univ. of Development Studies, Nyankpala
12.	Prince Ofori Ampong	Univ. of Development Studies, Nyankpala
13.	Madnemezia Kachimkwu	Univ. of Development Studies, Nyankpala
14.	Yahaya Yakubu Yidana	Sunyani Polytechnic
15.	Lucy Korah	Sunyani Polytechnic
16.	Michael Fudzi	University of Ghana, Legon
17.	Nancy Ansah	Ejura Agric. College
18.	Cecilia Atwiwaa	- do -
19.	Elvis Kusi	Ohawu Agric. College
20.	Sampson Awuni	- do -
21.	Priscilla Bernie	Kumasi Polytechnic
22.	Gifty Osei	- do -
23.	Kofi Owusu	- do -
24.	Maxwell Sakyi Akomeah	Univ. of Development Studies, Kumasi Campus
25.	Charlotte Baidoo	- do -
26.	Stella Owusu Dwamena	- do -
27.	Henrita Owusu	- do -
28.	Alice Norvor	Sunyani Polytechnic
29.	Frank Danso	Kwame Nkrumah University of Science & Tech.
30.	Nicholas Banahene	- do -
31.	Stephen Badu	University of Ghana, Legon
32.	Bismark Osei	Sunyani Polytechnic
33.	Kwame Asafo Boakye	Kwadaso Agric College
34.	Patrick Osei	- do -
35.	Cobbina Thomas	- do -
36.	Attefa Opoku Ware	- do -
37.	Evelyn Serwaa Kumah	Ghana Institute of Languages, Kumasi
38.	Isaac Kofi Razak	KNUST
39.	Aaron Owusu Badu	KNUST
40.	K. Gyapong Agyenim Boateng	Kwame Nkrumah University of Science & Tech
41.	Michael Boadu	Univ. of Development Studies, Kumasi Campus
42.	Naomi Aning	- do -
43.	Anastasia Anuam	Univ. of Development Studies, Tamale Campus
44.	Alfred Owusu Dua	Kumasi Polytechnic
45.	Abigail Botchway	- do -

46.	Linda Brakatu	- do -
47.	Alexander Boateng S.	K. N. U. S. T.
48.	Gladys Abiew Esihu	Univ. of Development Studies, Kumasi Campus
49.	Juliet Tiwaa Frimpong	- do -
50.	Rebecca Serwaa Tutu -Ali	- do -
51.	Rita Guanie	Kumasi Polytechnic
52.	EdithAnnan Mensah	Kumasi Polytechnic
53.	Dave Frimpong	Kumasi Polyt echnic
54.	Diana Tabi	- do -
55.	Belinda Kyerewaa	- do -
56.	Benyamin Kwaku Amo Fosu	Methodist University, Wenchi
57.	Daniel Kyereh	Methodist University, Wenchi
58.	Michael K. Anyansor	Methodist University, Wenchi
59.	Jones Kwakye	Methodist University, W enchi
60.	Simon Asamoah	Methodist University, Wenchi
61.	Eric Anin Sakyi	Univ. of Dev. Studies - Mampong Campus
62.	Ernest Adjei	Ohawu Agric College
63.	Daniel A. Awuni	Kwadaso Agric College
64.	Lambert Aliginna	- do -
65.	Francis Dwomoh	- do -
66.	Elsi e Bennet Dompreh	Univ. of Dev. Studies - Wa Campus
67.	Michael M. Adjei	Koforidua Polytechnic
68.	Michael Mensah Owusu	- do -
69.	Patricia Cudjoe Boahen	- do -
70.	Shadrack Adu -Boahen	Univ. of Dev. Studies - Wa Campus
71.	Robert Atakora	- do -
72.	Ivy Joy Kottoh	- do -

LIST OF NATIONAL SERVICE PERSONNEL

NO.	N A M E	INSTITUTION/COLLEGE	DURATION – 2 YRS
1.	Henry Osei Amankwaa	K.N.U.S.T.	Nov.2011 – Dec. 2012
2.	Abigail Akese	University of Cape Coast	- do -
3.	Vida Gyimah	- do -	- do -
4.	Rachel Cobbinah	- do -	- do -
5.	Esther Owusuaa	Wisconsin Inst. College	- do -
6.	Isaac Antwi Adjei	K.N.U.S.T	- do -
7.	Emmanuel Asafo Agyei	K.N.U.S.T	- do -
8.	Ben Amoah	K.N.U.S.T	- do -
9.	Emmanuel Akrasi (Jnr)	K.N.U.S.T	- do -
10.	Vicent Adade Mensah	K.N.U.S.T	- do -
11.	Ernest Mensah	University of Cape Coast	- do -
12.	Alexander Atia Marcuanzy	K.N.U.S.T	- do -
13.	Stephen Gerrar	K.N.U.S.T	- do -
14.	Bright Abu Brobbey	K.N.U.S.T	- do -
15.	Isaac Yeboah	K.N.U.S.T	- do -
16.	Abubakari Fariya	K.N.U.S.T	- do -
17.	Akwasi Adusei Gyamerah	K.N.U.S.T	- do -

18.	Herbert Owusu Boateng	K.N.U.S.T	- do -
19.	Sharon Abu Gyansah	K.N.U.S.T	- do -
20.	Daniel Addai	Univ. of Dev. Studies -Navrongo	- do -
21.	Patience Doku Asi	K.N.U.S.T	- do -
22.	Prosper Kyei Mensah	K.N.U.S .T	- do -
23.	Michael Akuamoah Boateng	K.N.U.S.T	- do -
24.	Edward Ansah	K.N.U.S.T	- do -
25.	Isaac Agyei Owusu	K.N.U.S.T	- do -
26.	Gideon Mensah Nyame Nyarko	University of Ghana, Legon	- do -
27.	Lovinna Yankson	University of Cape Coast	- do -
28.	Eyram Kwame Wisdom Agbeshi	K.N.U.S.T	- do -
29.	Eric Kofi Kyeremeh	K.N.U.S.T	- do -
30.	Elvis Manu	Sunyani Polytechnic	- do -
31.	Juliet Amoako Adoma	Sunyani Polytechnic	- do -
32.	Robert Adabie Laing (Jnr)	K.N.U.S.T	- do -
33.	Yaw Jackson Adjei	Kumas i Polytechnic	- do -
34.	Robert Abu	K.N.U.S.T	- do -
35.	Esther Bobie -Ansah	Kumasi Polytechnic	- do -

SOIL MICROBIOLOGY DIVISION

NO.	NAME	DESIGNATION	DATE ON PRESENT GRADE
RESEARCH SCIENTIST			
1.	Dr. Joseph Opoku Fening	Director (Prin. Res. Scientist)	1/08/2007
2.	Dr. Edward Yeboah	Research Scientist	1/01/1999
3.	Patrick Ofori	- do -	31/12/2005
4.	Adwoa Sarfo Kantanka	Asst. Res. Scientist	1/09/2007

SOIL GENESIS, SURVEY AND CLASSIFICATION DIVISION

NO	NAME	DESIGNATION	DATE ON PRESENT GRADE
RESEARCH SCIENTIST			
1.	Christian Dela Dedzoe	Senior Res. Scientist	1/01/2003
2.	Sampson Adjei	Research Scientist	1/10/1994
3.	James K. Senayah	- do -	1/06/1995

SOIL CHEMISTRY AND MINERALOGY DIVISION

NO	NAME	DESIGNATION	DATE ON PRESENT GRADE
RESEARCH SCIENTIST			
1.	Dr. F.M. Tetteh	Senior Res. Scientist	1/10/1995
2.	Gabriel Willie Quansah	Asst. Res. Scientist	1/09/1998
3.	Sadick Adams	- do -	3/06/2005

SOIL FERTILITY & PLANT NUTRITION DIVISION

NO.	NAME	DESIGNATION	DATE ON PRESENT GRADE
RESEARCH SCIENTIST			
1.	Dr. Mohammed Buri Moro	Principal Res. Scientist	01/07/2009
2.	Dr. K.O. Asubonteng	- do -	01/07/2005
3.	Dr. Roland Nuhu Issaka	- do -	01/07/2006
4.	Samuel Boadi	Research Scientist	25/06/1992
5.	Benjamin Adiyiah	- do -	01/03/2008
6.	Edward Calys Tagoe	- do -	01/03/2008
7.	B.B. Aligebam	-	

SOIL AND WATER MANAGEMENT DIVISION

NO.	NAME	DESIGNATION	DATE ON PRESENT GRADE
RESEARCH SCIENTISTS			
1.	Dr. B.O. Antwi	Sen. Research Scientist	01/10/1996
2.	James Oppong	Research Scientist	01/10/1998
3.	Emmanuel Dugan	- do -	07/01/2008
4.	Rubben Ekow Gaisie	Asst. Res. Scientist	01/06/2004

COMMERCIAL AND INFROMATION DIVISION

NO.	NAME	DESIGNATION	DATE ON PRESENT GRADE
SENIOR MEMBERS			
1.	Philip Poku-Acheampong	Scientific Officer	01/08/1990
2.	Eric Owusu Adjei	Scientific Secretary	04/01/1995
3.	Augustine A. Nyamekye	Bilingual Secretary	01/11/1995
4.	Kingsley Adusei Amponsah	Asst. Accountant	31/01/2006
5.	Adwoa Sarfo Kantanka	Marketing Officer	

ADMINISTRATION DIVISION
STAFF LIST AS AT 31ST DECEMBER, 2011

NO.	NAME	DESIGNATION	DATE ON PRESENT GRADE
SENIOR MEMBERS			
1.	Hectoria T. Harker (Mrs.)	Administrative Officer	01/10/1996
2.	Seth James Obeng	Administrative Officer	18/06/2001

ACCRA CENTRE

NO.	NAME	DESIGNATION	DATE ON PRESENT GRADE
1.	Enoch Boateng	Prin. Research Scientist	01/01/2006
2.	D.F.K. Allotey	Research Scientist	01/04/1997
3.	Felix Owusu Ababio	- do -	01/08/2002
4.	Prince Martin Gyekye (Jnr.)	Asst. Research Scientist	07/03/2008

APPENDIX 4

MEMBERSHIP OF MANAGEMENT BOARD, 2011

1.	Oheneba Adusei Poku	-	Chairman, Akempimhene, Kumasi
2.	Dr. (Mrs.) R.E.M. Entsuah-Mensah	-	Member, Deputy Director-General, CSIR Head Office, Accra.
3.	Mrs. L. Bedu Addo-Mensah	-	Member, Area Manager, Agricultural Development Bank, Kumasi
4.	Mr. T. F. Asare	-	Member, Asare Farms Limited, Kumasi
5.	Mr. George Owusu Afriyie	-	Member, Manager, Pacific Savings & Loans Limited, Kumasi.
6.	Dr. Hans Adu-Dapaa	-	Member, Director, CSIR-Crops Research Institute, Kumasi
7.	Dr. J. O. Fening	-	Member, Director, CSIR-Soil Research Institute, Kwadaso-Kumasi
8.	Mrs. Hectoria Tsaku-Harker	-	Secretary, Administrative Officer, CSIR-SRI, Kwadaso-Kumasi

APPENDIX 5.

MEMBERS OF THE INTERNAL MANAGEMENT COMMITTEE

1.	Dr. J. O. Fening	-	Director/Chairman
2.	Dr. M. M. Buri	-	Deputy Director/Head, Soil Fertility Chem.... and Plant Nutrition Division
3.	Mr. E. Boateng	-	Head, Soil Research Centre, Accra
4.	Dr. F. M. Tetteh	-	Head, Laboratory Analytical services Division
5.	Dr. B. O. Antwi	-	Head, Soil and Water management Division
6.	Mr. E. Yeboah	-	Head, Soil Microbiology Division
7.	Mr. J. K. Senayah	-	Head, Soil Genesis, Survey and Class. Div.
8.	Mrs. H. Tsaku-Harker	-	Head of Administration
9.	Mr. P. Poku Achampong	-	Head, Commercial and Information Division
10.	Mr. K. Yiadom	-	Head, Accounts and Stores Section
11.	Mr. S. B. Atiemo	-	Security and Station Maintenance Section
12.	Mr. James Oppong	-	RSA Representative
13.	Mr. G. K. Attipoe	-	SSA Representative
14.	Mr. E. Prempeh-Kessie	-	TUC Representative
15.	Mr. S. J. Obeng	-	Secretary