FERARI
FERTILIZER RESEARCH & RESPONSIBLE IMPLEMENTATION

IFDC
Developing Agriculture from the Ground Up

8TH QUARTER – JANUARY 2022

QUARTERLY newsletter

FERARI FOCUS

USE EFFICIENCY OF FERTILIZERS

FERARI has conducted researcher-managed fertilizer trials in research stations of local institutions and on farmers' fields. Farmer surveys were also conducted to pinpoint their views about fertilizer impact on crop yield. Findings revealed significant challenges for the fertilizer industry, the government, farmers, and researchers that must be addressed collectively, and extensive discussions among these actors were facilitated through the Fertilizer Platform Ghana.

The survey targeted regions supplied with fertilizers and found 80% of farmers use fertilizer at a rate of 150-300 kilograms per hectare (kg/ha), equivalent to about 80-170 kg/ha of nutrients. This is much higher than the average value for Ghana of around 22 kg/ha, which suggests many other farmers in the country use virtually no fertilizer. However, low yield response to these high application rates is problematic. The average maize yield of non-fertilizers users is 1.1 metric tons per hectare (mt/ha) of maize grain and increases to only 1.5 mt/ha for fertilizer users. This implies a very low nitrogen use efficiency of around 5 kg of maize grains per kg of nitrogen applied. Many farmers even record negative use efficiency. The nitrogen use efficiency found in on-station trials ranges from almost zero (under drought) to 20 kg of grain per kg of nitrogen applied, which is still well below the achievable 40-50 kg/kg.

With fertilizers prices quadrupling over the past few months from around U.S. $200-300 to U.S. $1000 per metric ton, nutrient use efficiency must be improved to ensure the economic viability of fertilizer use. FERARI will prioritize identifying the reasons for this meager result and seek to determine practical solutions. ■

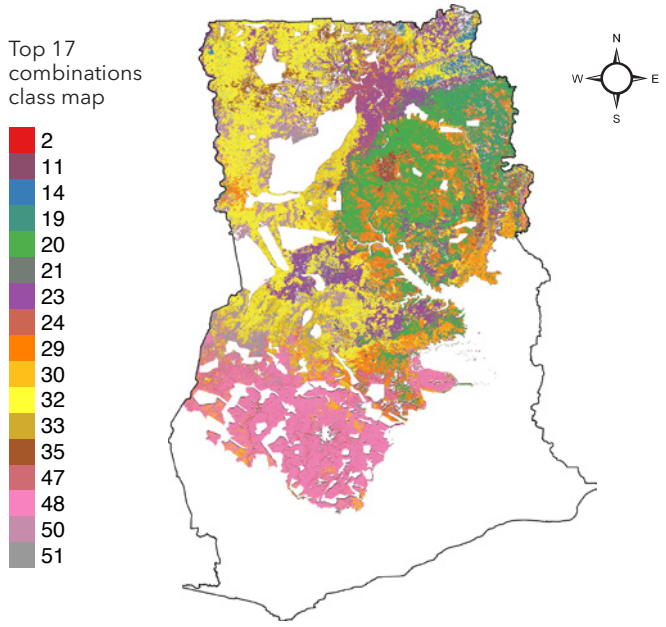
FERARI FEATURE

MODELING AND MAPPING: FERARI PROMOTES STATE-OF-THE-ART TECHNOLOGY AND TRAINING

During the first two years of the FERARI program, much data from Ghana has been analyzed, and captivating reports and policy briefs have been produced to explain important areas of food security, such as crop yield response to fertilizers, factors influencing crop yield variability, and fertilizer cost components and their effect on fertilizer prices. FERARI's annual operations are informed by the results of the previous year's analyses, and the variety and volume of data continue to gradually increase.

FERARI is introducing a new mode of analysis, known as crop and soil modeling, to its existing statistical, geostatistical, and machine learning modes of analysis. Crop and soil modeling will be utilized to study the effect

Figure 1. *Spatial analysis revealing the variability in soil types based on soil organic matter, soil depth, pH, and slope, classified for field trial sites selections. The numbers represent the 17 most common classes, covering 94% of the agricultural area in the program area.*



of climate on crop physiology, as this has not received much research attention in Ghana. In effect, potential (water- and nutrient-limited) yields can be estimated, as agriculture in Ghana is predominantly rainfed and nutrient deficiency has been noted in the soils. FERARI will rely on field observations (weather station data, soil properties, crop agronomic characteristics, and yields) and satellite data and will also introduce drones for timely data collection toward precision agriculture. Given that underpinnings of the analysis are highly technical, the team delivers the results through easy-to-understand maps. The sample map shown (Fig. 1) demonstrates a recent spatial analysis to reveal the variability in soil layers, which are classified into codes to inform FERARI field trial site selection.

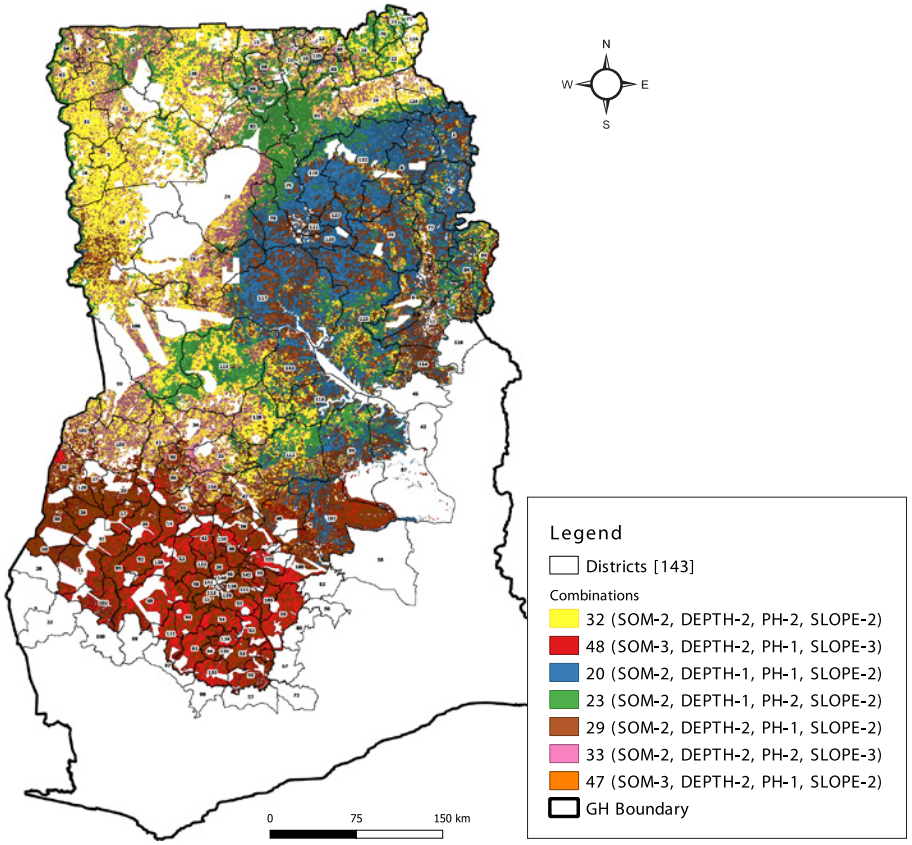
FERARI plans to extend its expertise in modeling and mapping in the coming years and to train university staff and students using hands-on practicals. ■

FERARI STUDENTS CONDUCT NUTRIENT USE EFFICIENCY TRIALS IN 2022

Soil organic matter, soil depth (relevant to soil water storage), pH, and slope (pertinent to runoff) have been found to be important determinants of yield response to fertilization. For optimal distribution and alignment of our agronomic trials and socioeconomics surveys, the spatial variability of these soil properties was analyzed. They were classified into groups (three for soil organic matter, two for soil depth, three for pH, and three for slope), resulting in 54 combinations (Fig. 2). After excluding protected areas, 17 of the top combinations, covering 94% of the agricultural lands, comprise the most important range of soil properties. FERARI will conduct 35 N-response trials on these 17 soil combinations to unveil the great spatial variability in the important factors driving crop productivity. Other trials, including the testing of briquettes and the impact of sulfur and zinc, will be conducted on the top seven combinations, representing over 75% of the agricultural soils. The insights generated could help explain the low nutrient use efficiency and reveal the need to vary the recommended amounts of fertilizers across the soil types.

Our Ph.D. students will conduct detailed trials on the impact of soil organic matter, crop residues, mulching, planting density, and different varieties to further identify practices to enhance water and nutrient use efficiency. In addition to on-station and on-farm trials, around 56 farmer-managed maize trials will be conducted in the top seven combinations to identify associated socioeconomic factors that affect nutrient use efficiency and yield. These trials will be conducted in cooperation with FERARI partner institutions across Ghana. ■

Figure 2. *Top 7 soil types for FERARI site selection in Ghana*



DISTRICT ID	DISTRICT	REGION
1	CHEREPONI	NORTHERN EAST
2	WA EAST	UPPER WEST
3	WA MUNICIPAL	UPPER WEST
4	SABOBA	NORTHERN
5	JIRAPA	UPPER WEST
6	GUSHEGU	NORTHERN
7	SISSALA WEST	UPPER WEST
8	NANUMBA NORTH	NORTHERN
9	LAMBUSSIE-KARNI	UPPER WEST
10	BOLGATANGA MUNICIPAL	UPPER EAST
11	NANUMBA SOUTH	NORTHERN
12	WENCHI MUNICIPAL	BONO
13	BONGO	UPPER EAST
14	TANO SOUTH MUNICIPAL	AHAFO
15	KASENA NANKANA WEST	UPPER EAST
16	WA WEST	UPPER WEST
17	SUNYANI MUNICIPAL	BONO
18	SAWLA-TUNA-KALBA	SAVANNAH
19	ASANTE AKIM SOUTH	ASHANTI
20	SISSALA EAST	UPPER WEST
21	KASENA NANKANA EAST	UPPER EAST
22	BUNKPURUGU NAKPANDURI	NORTHERN EAST
23	GARU	UPPER EAST
24	EAST MAMPRUSI	NORTHERN EAST
25	BAWKU WEST	UPPER EAST
26	DORMAA EAST	BONO
27	BEREKUM EAST MUNICIPAL	BONO
28	BIA EAST	WESTERN NORTH
29	JAMAN SOUTH MUNICIPAL	BONO
30	SUNYANI WEST	BONO
31	ASUNAFO NORTH MUNICIPAL	AHAFO
32	JUABOSO	WESTERN NORTH
33	NKORANZA NORTH	BONO EAST
34	KINTAMPO SOUTH	BONO EAST
35	TANO NORTH MUNICIPAL	AHAFO
36	AFIGYA KWABRE SOUTH	ASHANTI
37	ATWIMA KWANWOMA	ASHANTI

▲ *Aerial view from a drone-mounted camera of an experiment at Nyankpala shows heterogeneity in the cultivation plots, revealing the huge variabilities in fertilizer use efficiency within the plots.*

DRONES IN AGRICULTURE: FERARI STUDENTS GET A BIRDS-EYE VIEW OF CROPS TO GAIN INSIGHT INTO NUTRIENT USE EFFICIENCY

A drone is an unmanned aerial system that can include sensors, software, and other components for use in a wide range of applications in agriculture. Drones will be used in a FERARI program subproject in several applications to unravel the drivers of the observed low crop response to fertilization. The variability in farmers' fields can be identified through aerial crop monitoring for issues, such as nutrient deficiencies, pests, and diseases, to determine site-specific agronomic practices for improvement. Mapping and delineating agricultural plots and monitoring crop water and nutrient stresses through the normalized difference water index (NDWI), green normalized difference vegetation index (GNDVI), normal difference vegetation index (NDVI), and normalized difference red edge (NDRE; for measuring chlorophyll content) can assist in modulation and recommendation of water management practices and fertilization strategies.

This collection of multispectral images can be obtained at a lower cost through drones and used to speed up the laborious process of inventorying crops and estimating crop yields through statistical (machine and deep learning) and systems modeling (LINTUL, QUEFTS, WOFOST, etc.) for enhanced agricultural intelligence. ■

▲ *Aerial view of fields.*

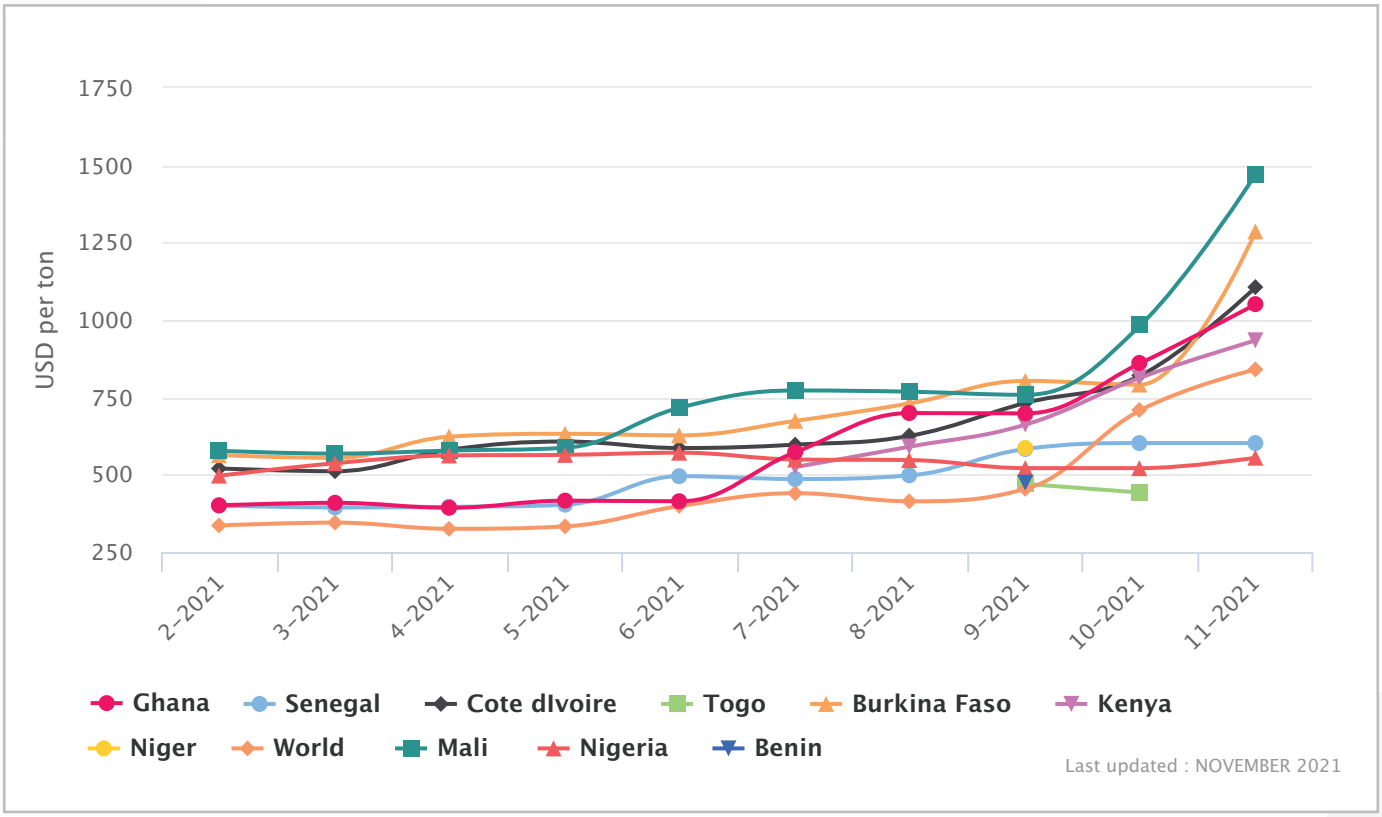
▲ *FERARI partner UDS pose with drones.*

IMPACTS OF RISING FERTILIZER PRICES ON GHANA'S FOOD SECURITY

The COVID-19 pandemic has not spared the global fertilizer industry. Its impacts have been most severe on developing economies, such as Ghana, which source their fertilizer supply externally. The recent rise in international fertilizer prices has negatively affected the supply of fertilizer to local Ghanaian farmers. The fertilizer shortage began in the third quarter of 2021, coinciding with peak fertilizer demand, and has affected access to fertilizer, especially urea, in the northern part of the country. As a stopgap measure, the government immediately adjusted its subsidized fertilizer list to include ammonium sulfate.

In many parts of sub-Saharan Africa, providing sufficient food for the rising population requires the application of adequate quantities of appropriate fertilizers. Over the years, progress has been made in the rate of fertilizer use in Ghana. However, rising fertilizer prices may lead to lower fertilizer use, depressing yields and consequently raising food prices. This will have dire consequences on the rising food demand in the country.

In 2022, the Ghanaian government indicated that it will reduce the subsidy on fertilizers, as it gradually begins to exit the program. Together with fertilizer price hikes, this will negatively affect fertilizer demand and food security. Concerted efforts by both public and private stakeholders must immediately be made to counteract these repercussions. Thus, agricultural and fertilizer stakeholders have the opportunity to pull back on the promotion of increased fertilizer use and instead understand and improve their use efficiency. This could offer sustainable improvement in crop yields in the country and provide the best economic, social, and environmental outcomes from fertilizer usage. ■



▲ *Ten-month average commercial price of urea. Source: https://africafertilizer.org/national/*

TRAINING ON MOBILE SOCIOECONOMIC DATA COLLECTION

FERARI has engaged an external consultant for the design of computerized data collection for its surveys over the past years. However, in order to build the capacity of its staff and to offset the challenges associated with this arrangement, two staff members, Soua Jeannette Mamy and Geoffrey Amaniampong, underwent training on the subject. This one-week training provided them with adequate experience to design and manage computerized data collection, adding to the expertise of the FERARI program. Going forward, FERARI will be able to manage computerized data collection internally. This will also prevent third parties from accessing farmers' private information.

According to Jeannette, "This training has been a success and a new skill for me. I am looking forward to build[ing] questionnaires for FERARI's next survey." Geoffrey noted, "The training has enlightened my understanding and skills about Excel and the steps in designing a questionnaire and using ODK converter and the KoBo Toolbox. This skill will help FERARI in effectively conducting its surveys." ■

FERTILIZER PLATFORM GHANA IS ESTABLISHED

▲ *The Third Fertilizer Stakeholder Roundtable in session at the Capital View Hotel in Koforidua, Ghana, November 2021.*

The Third Fertilizer Stakeholder Roundtable (RT3), organized by the Ministry of Food and Agriculture (MoFA) Ghana Fertilizer Expansion Programme (GFEP), with support from IFDC's FERARI program, resulted in the formal establishment of a multi-stakeholder fertilizer sector dialogue platform, the Fertilizer Platform Ghana (FPG). The RT3, held at Capital View Hotel at Koforidua, November 10-11, 2021, witnessed the finalization of discussions from the previous two Fertilizer Stakeholder Roundtables (RT1 And RT2), which had produced stakeholder resolutions and a roadmap toward a legally registered FPG.

RT3 participants included more than 45 fertilizer stakeholders from the public sector, private sector, non-governmental and civil society organizations, development partners, knowledge partners (research/academia), and farmer organizations and associations. The meeting culminated in the effective realization of a formally established dialogue platform to address fertilizer sector-related issues, harness potentials, and provide solutions to challenges.

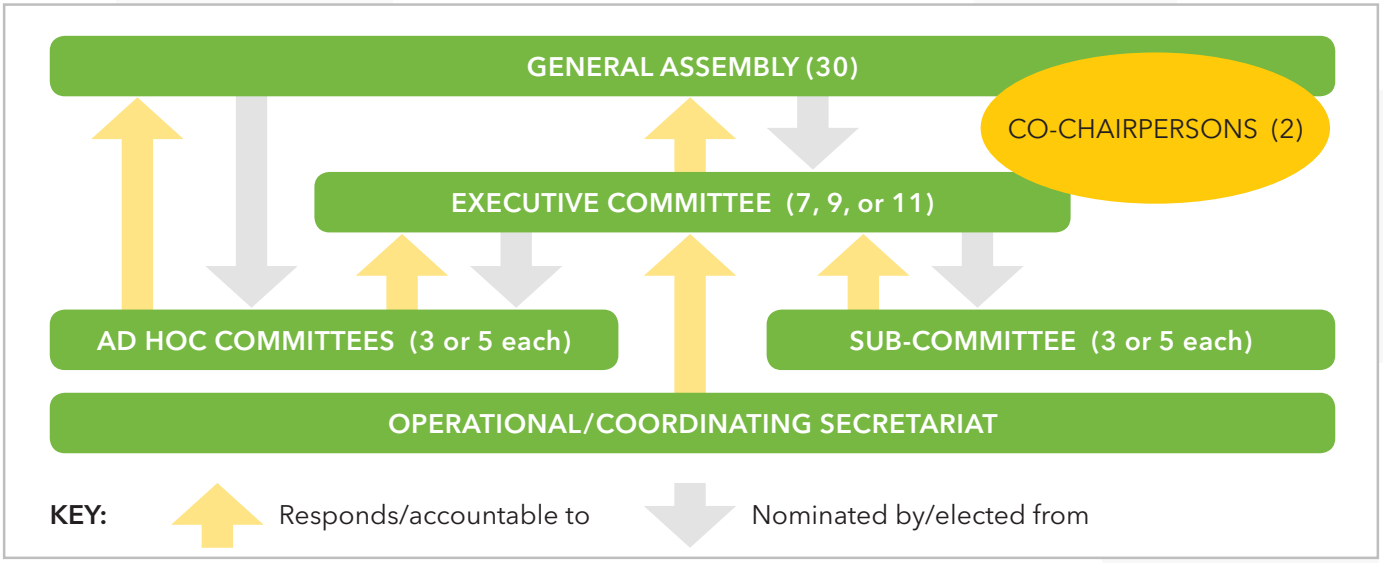
MAJOR OUTCOMES OF THE MEETING

- ✓ Adoption of the FPG Constitution (vision, mission, goals and objectives, organizational structure, membership and sustainability measures) and logo, paving the way for the platform's formal installation.
- ✓ Election of the Executive Committee, comprising two co-chairs (one each from the public and private sector) and five members, and creation of four subcommittees for effective coordination, operationalization, and institutionalization of the FPG.
- ✓ Unanimous acceptance of the Council for Scientific and Industrial Research – Soil Research Institute (CSIR-SRI) contribution of office space to host the FPG Secretariat.

FERTILIZER PLATFORM Ghana FPG.GH

Promoting dialogue for food security

▼ *FPG organizational structure*



FPG'S NEXT STEPS

Regarding the way forward in consolidating FPG operationalization and sustainability, the following actions were agreed upon at the RT3 meeting:

- ✓ Hire a full-time executive secretary and a part-time treasurer to complete the nine-member Executive Committee and equip the office space for the FPG Secretariat.
- ✓ Develop a workplan and terms of reference for the FPG committees.
- ✓ Work toward the effective launching of the platform in May/June 2022.

COMMITTEE MEMBERS ELECTED

Members of all FPG stakeholder organizations were eligible for election to the several committees set up to manage the platform. FERARI's key role in developing the FPG and its staff insights into FPG issues were acknowledged by the election of 3 FERARI staff to committee seats.

The full-time Executive Committee elected from the General Assembly are as follows:

EXECUTIVE COMMITTEE

(elected for a two-year term)

#	NAME	ORGANIZATION
1.	Ernest Osei-Assibey (Co-Chair, Public Sector Representative)	PPRSD-MoFA, Pokase
2.	Richmond Dogbe (Co-Chair, Private Sector Representative)	OCP-Ghana, Accra
3.	Bismark O. Nortey (Member)	PFAG, Kotobabi-Accra
4.	Dr. Edward Yeboah (Member)	CSIR-SRI, Kumasi
5.	Dr. Williams Atakora (Member)	IFDC-FERARI, East Legon
6.	Nana Aisha Mohammed (Member)	AFAP, West Legon-Accra
7.	Stephen Tour (Member)	LDC, Tema

▲ *The FPG Secretariat will be sharing office space with the CSIR-SRI headquarters located in Accra, Ghana.*

The four FPG subcommittees and members are:

FUNDRAISING COMMITTEE

#	NAME	ORGANIZATION
1.	Nana Aisha Mohammed	AFAP, West Legon, Accra
2.	Stephen Tour	LDC, Tema
3.	Isaac Berchie Opoku	AMG, Dzorwulu, Accra
4.	Seth Ansah	ACARP, Adjen Kotoku
5.	Fred Gyasi	IFDC-EnGRAIS/AFO, E. Legon

ORGANIZING COMMITTEE

#	NAME	ORGANIZATION
1.	Bismark Owusu Nortey	PFAG, Kotobabi, Accra
2.	Dr. Williams K Atakora	IFDC-FERARI, East Legon
3.	Dominic Donkoh	Omnifert, Labone, Accra
4.	Asare Bediako	GGC, Dzorwulu, Accra
5.	Michael Owusu	DCS-MoFA, Accra

COMMUNICATION COMMITTEE

#	NAME	ORGANIZATION
1.	Joseph Kugbe	OCP-Ghana, Accra
2.	Christiana Yakubu	CDF/4R, Tamale
4.	Yakubu Iddrisu	IFDC-FERARI, E. Legon, Accra
4.	Adiza Iddrisu	PPRSD-MoFA, Pokuase, Accra
5.	Bismark O. Nortey	PFAG, Kotobabi, Accra

RESEARCH COMMITTEE

#	NAME	ORGANIZATION
1.	Dr. Edward Yeboah	CSIR-SRI, Kumasi
2.	Comfort Freeman	UG, Legon, Accra
3.	Theophilus	Yara-Ghana, Airport West, Accra
4.	Simon Sakyi	Safi Sana, Adjei-Kojo, Ashaiman
5.	Dr. William Adzawla	IFDC-FERARI, E. Legon, Accra

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