Research Proposal: Systems Approaches to Enhance Peanut Production under Resource Limitation

Principal Investigator

Kenneth Boote
University of Florida
P.O. Box 110500
Gainesville, FL USA 32611

Co-Project Investigator(s)

Zagre Bertin
INERA
01 BP 476
Ouagadougou
Burkina Fasso
Email: zbertin2002@yahoo.fr

John Erickson
University of Florida
Agronomy Department
PO 110500
Gainesville, FL 32111
Phone: (352) 392-1811
Email: jerickson@ufl.edu

Jim Jones
University of Florida
289 ROG, Museum Road, PO BOX 110570
Gainesville, FL 32041
Phone: (352) 3921864 x 289
Email: jimj@ifas.ufl.edu

Jessie Naab
Counsel for Scientific and Industrial Research
Savanna Agriculture Research Institute
P.O. Box 494
Wa, Ghana
Phone: 233-243-274397
Email: jessenaab@gmail.com

Philippe Sankara
University of Ouagadougou
Departement de Phytopathologie
BP 7021
Ouagadougou 03
Burkina Fasso
Phone: 226-50-36-59-12

Email: philippe.sankara@ird.fr

Geographical Locations
Burkina Faso, Ghana, Mali

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Focus
Domain - Production Values Region - West

Background

Peanut is an important crop in Ghana and Burkina Faso, both as a food crop for rural population and as a cash-generating crop that is marketed to city population. Productivity is low and is still done mostly in traditional manner with almost no inputs, despite the past activities of a limited number of host country researchers and extension officers. Past research has shown considerable potential to improve yield with use of fungicides, P fertilization, sufficient plant population, early sowing date, and improved cultivars. The goal is to further engage peanut researchers in Ghana and Burkina Faso in projects that evaluate resource limitations in farmer fields and conduct trials of new technologies to improve production. Therefore, capacity building of host country researchers is one major context and goal. We will also engage women farmers and extension specialists in the on-farm technology evaluations and demonstrations.

Technical Review

Research in the prior Peanut CRSP project with Dr. J. B. Naab showed that peanut productivity in Ghana is limited by leafspot disease, low soil phosphorus, low plant population, and water availability in some seasons. Detailed soil water measurements showed that soil water limitations were not as important as previously assumed, while leafspot disease was an always prevalent yield loss factor causing as much as 50% yield loss. On-station and on-farm trials showed nearly twofold yield increases with fungicide application, and good yield responses to phosphorus application were also obtained in on-station and on-farm trials by Dr. Naab. Studies also showed the need for sufficient plant population and showed the benefit of using improved cultivars such as F-mix or Manipinter, although farmers do not want to migrate away from the traditional short- season Chinese cultivar. Crop growth modeling was used successfully in the project as tool to evaluate yield limitations from weather, soil water, disease, and plant population. New efforts are needed to evaluate leafspot-resistant cultivars released by ICRISAT, to see whether these improve over the productivity of the Chinese cultivar, or whether fungicide use still has the same degree of benefit. Researchers in Burkina Faso have screened or evaluated peanut germplasm for leafspot resistance and yield potential over the past few years in another CRSP project. We propose to extend such evaluations into Ghana in this project because leafspot resistance is the preferable avenue to minimize yield loss from leafspot disease, if

possible. In past trials in Ghana, fungicide applications were done by the researchers, but future effort is needed to engage farmers with appropriate small scale application technology to apply not only fungicides, but also herbicides, to improve the efficiency of their production, and minimize the growing cost of labor for weed control. Future efforts are needed better integrate peanut production with cereals for N management, especially to devise harvesting strategies to return haulm residues and to improve amount of residue return via fungicide use and disease-resistant cultivars. Some areas have small dam water storage or well-water supplying abilities. For these areas with winter- season water supply, a new effort is needed to establish suitable winter-season sowing dates and efficient irrigation methods for off-season production for high value fresh-market production of peanut.

Problem Statement

Peanut production in West Africa is limited by abiotic stresses (weather, soil fertility, soil structure), biotic factors (disease, nematodes, insects), poor management, as well as insufficient use of improved cultivars. Current on-farm productivity in West Africa is about one-fourth of the climatic yield potential. There is a critical need to test use of improved, low cost, cost-effective technologies with the goal of enhancing peanut productivity and market income under these resource limitations. U.S. peanut productivity, while much higher, still encounters some of the same limitations, so study and minimization of these resource limitations should improve production in U.S. as well as West Africa.

Vision and Approach

Goals

To conduct field research on resource limitations to peanut production in Ghana and Burkina Faso, and to test new technologies (fungicides, herbicides, fertilization, crop management, improved cultivars, irrigation practices, and harvesting technologies) to improve peanut production, with the aim of being appropriate, low cost, cost-effective technology that will improve producer income and maintain good market position. To engage farmers and extension specialists in on-farm trials of these technologies.

Objectives

To evaluate improved technologies in farmer fields in Ghana with goal of increasing production and profit margin. Technologies include evaluating improved cultivars, soil-testing-fertilization, sowing dates, and especially equipment and practices of applying fungicides and herbicides to control disease and weeds.

To evaluate improved technologies in farmer fields in Burkina Faso with goal of increasing production and profit margin. Technologies include evaluating improved cultivars, soil-testing-fertilization, sowing dates, and especially equipment and practices of applying fungicides and herbicides to control

disease and weeds. To evaluate peanut cultivars for yield potential and leafspot resistance in on-station trials in Ghana, with the goal of identifying several cultivars to test in on-farm trials. To evaluate peanut cultivars for yield potential and leafspot resistance in on-station trials in Burkina Faso, with goal of identifying several cultivars to test in on-farm trials. To enhance production of high-value fresh market peanut crop in off-season in Ghana by irrigated production via determination of optimum sowing dates and irrigation practices. To enhance production of high-value fresh market peanut crop in off-season in Burkina Faso by irrigated production via determination of optimum sowing dates and irrigation practices. To use crop growth modeling as a tool to evaluate research results, to predict leafspot progression, to evaluate legume N contribution to subsequent cereal crop, and to predict peanut growth and yield response to weather, soil water, sowing date, and diseases.

Research Approach

Appropriate technology for applying fungicides and herbicides will be tested in on-station and on-farm trials. A unique push-pull sprayer mounted on a simple bicycle tire rig with a wheel- driven piston pump to create uniform spray pressure will be tested for fungicide and herbicide application and demonstrated to farmers. Benefits of herbicide and fungicide application for peanut production will be evaluated. Extension agents, women farmers, and agrichemical dealers will be encouraged to participate in the trials and demonstrations. Economic analyses of cost- benefit ratio for weed and disease control will be determined. Micro-credit agencies will be visited to discuss feasibility of lending for purchase of agrichemicals and equipment. Maximizing residue return to the land for subsequent cereal cropping will be evaluated. Soil testing for critically limiting nutrients will be evaluated in the on-farm sites and if appropriate, fertilizer applications may be tested to demonstrate yield response.

Newly released short-season cultivars will be requested from ICRISAT and Peanut CRSP breeders. Yield, pod quality, and disease score of 20 cultivars will be compared to the traditional Chinese cultivar in on-station trials, to be followed by on-farm comparisons of the two best cultivars versus the Chinese cultivar. In two years of the trials, there will be a fungicide versus non-fungicide-treated split plot for each cultivar, to determine whether improved cultivars respond well to fungicide. Ghana has not had a peanut breeder for 10 years and cultivar screening in Ghana is needed. The same strategy of testing 20 leafspot-resistant cultivars will be followed in Burkina Faso.

Off-season irrigated production of peanut to supply high value fresh market is a new idea, based on presence of small water-storage dams in the region. The climate is moderate and peanut should grow in the winter season. A test of optimum sowing dates is planned to provide a multiple set of sowing dates needed to provide a continuous supply of fresh market peanut at a time of year when peanut is not being harvested elsewhere in the country. Weather measurement and crop modeling will be used to project optimum sowing

dates to achieve given harvests and assist with irrigation scheduling. Irrigation strategies, timing and method, will be tested. Where pressure head can be achieved, we propose to test drip irrigation method, as an alternative to ditch and flood, to more efficiently apply the water, as well as timing. If there is winter-season water available at Burkina Faso site, similar trials will be implemented there.

Peanut crop growth modeling will be used as a tool to assist analyses of research results, in terms of predicting growth and yield response to weather, soil water limitation, sowing date, plant population. The model will be used to propose suitable sowing dates for fresh market production under irrigation. The crop model with its linked CENTURY soil organic matter module will be used to evaluate the N contribution of the peanut crop to subsequent cereal crops. Code development and research will be conducted at the University of Florida to enhance the current leafspot-disease simulation linked to the peanut crop growth model: improving the process of infection and polycyclic disease progression currently in the model, creating and entering components of leafspot resistance (that exist among different cultivars, i.e., latent period, lesion expansion, sporulation), and creating fungicide efficacy functions. With the CROPGRO-peanut model linked to enhanced leafspot model, we will predict leafspot disease epidemics for different weather conditions.

Training & Capacity Development Approach

The host-country scientists, Dr. Naab and Burkina Faso counterparts, will visit the U.S. about every 2 years for 1 to 2 months to observe and experience new technologies here. During this time, they will work with data previously collected to evaluate results, conduct crop model analyses, and write publishable papers of their research. At regular intervals, one or more of the U.S. investigators will travel to Ghana and Burkina Faso to visit experiments and trials in progress and to help train host country scientists in use of this appropriate technology. They will advise on how to improve capacity of their research institution. Student training would be valued, if CRSP can fund it.

Intended Benefits & Impact Responsiveness

Development Benefits

Producers and the full market chain in the host countries are expected to gain from increased peanut productivity resulting from improved technology (equipment, fungicides, herbicides, improved cultivars, fertility, management). Farmers should experience reduced labor demands and higher quality of life as this technology becomes adopted. Greater income is expected from off-season high value production of peanut under irrigation. These technologies should have good applicability to other developing country situations.

US Benefits

Benefits for U.S. peanut producers and researchers, will be our generally improved knowledge of impact of diseases, insects, poor management, low

fertility, and cultivars on peanut production. While the yield level in U.S. is higher, many of these principles still apply. In addition, if the U.S. does go for low-cost biodiesel fuel production of peanut, we will need to use the lowest level of inputs possible to maintain profitability. Thus some of the technologies may apply directly, even if applied differently. Furthermore, crop model improvements attained during this project, will be useful for applications of the crop model in the U.S., particularly those related to prediction of leafspot disease epidemics. Other world countries such as India would also benefit from peanut crop model improvement, especially from the leafspot disease prediction.

Potential Impacts

We believe that an increased percentage of farmers in Ghana and Burkina Faso will begin to use some of these practices: fungicides, herbicide, P fertilizer, equipment, irrigation, and improved cultivars. As they begin to use higher level of technology, we anticipate the impact will be increased peanut production or increased productivity on same land area, thus improving farmer income and alleviating labor shortage. This can be quantified by a survey of extent to which producers have used fungicides, herbicides, P fertilizer, some increased level of equipment, irrigation, and improved cultivars. Similarly, survey and government reports will document both acreage and productivity of the peanut crop. In all fairness, technology dissemination will take years and years, thus a 10-year cycle of evaluation is about as practical as one can evaluate it.

Equipment

Most equipment needed such as computers and portable sprayer equipment generally cost less than $5,000 and will not be listed. Weather-stations for each location (two of them = $12,000) are requested and cost about $6,000 each. A leaf area meter is also requested for Ghana and is listed for $5,500. We would like to reserve the future possibility of purchasing a small narrow-wheel tractor, as that may be very useable to apply fungicide and herbicide (cost is not known).

Project Timeline

Year 1 and 2 Conduct on-station trials of portable spray equipment to apply herbicide and fungicide, concurrently testing yield response, weed control, and disease control of treatments. These will be simple tests with one optimum herbicide, one good fungicide, as the goal is to learn how to use the equipment. UF researchers will conduct similar trials in the use of this equipment. In Ghana, conduct sowing date experiment in off-season irrigation trial, to include observations of irrigation applications (amount applied, computed ET, observed soil water status, and plant water stress). Conduct on-station trials of 20 cultivars under non-fungicide-treated conditions in both countries. HC investigators to travel to Florida to work on data and write papers.

Years 3 and 4 Conduct researcher-led on-farm trials of portable spray equipment to apply herbicide and fungicide, testing yield response, weed control, and disease control of treatments. Conduct separate hands-on trials in farmer fields involving extension and farmers, so users are trained in use of equipment. Conduct on-farm trials of best two cultivars from the year 1 and 2 on-station cultivar screening trials, compared to Chinese. Work with farmers (observe them) to do their own off-season irrigated production of peanut. Begin on-station trial of 20 cultivars under split-plot fungicide versus non-fungicide-treated conditions. HC investigators will travel to Florida to work on data and papers. UF researchers will improve the CROPGRO-peanut model and its linkage to leafspot-epidemic model.

Years 4 and 5 Continue on-farm trials, modified as necessary. Conduct best management tests of combined cultivar, herbicide, fungicide, and P fertilization. HC investigators to travel to Florida to work on data and papers.

USAID Mandate Responsiveness

MDGs

Poverty/Hunger: Improved Health: Raised Rural Incomes: Sustainable Development

Foreign Assistance Framework

Governance: Human Capacity: Economic Structure: Persistent Dire Poverty: Global Issues (HIV and Infectious Diseases, climate change, biodiversity)

IEHA

Science and Tech Applications: Increased demand for peanuts: Market Access: Increased Trade

USAID Focal Areas

Greater incomes: Greater value and market demand: Public Health: Food Security: Sustainable Value Chain: Improved Human Capacity