The Department of Agriculture (USDA) – Foreign Agricultural Service (FAS)
Office of Capacity Building and Development

Notice of Funding Opportunity (NOFO)
Borlaug Fellowship Program

A. Program Description

Program Overview, Objectives, and Priorities

The Borlaug International Agricultural Science and Technology Fellowship Program (Borlaug Fellowship Program) advances USDA's agricultural research goals of promoting collaborative programs among agricultural professionals of eligible countries, agricultural professionals of the United States, the international agricultural research system, and United States entities conducting research by providing fellowships to individuals from eligible countries who specialize or have experience in agricultural education, research, extension, or other related fields. Fellowships promote food security and economic growth in eligible countries by educating a new generation of agricultural scientists, increasing scientific knowledge and collaborative research to improve agricultural productivity, and extending that knowledge to users and intermediaries in the marketplace. The collaborative nature of the training and research programs not only benefits the Fellow, his or her home institution, and partner country; the U.S. host institution, its professors, researchers, and students; and the global agricultural sector by improving agricultural productivity, systems, and processes in partnering nations through the transfer of new science and agricultural technologies.

USDA will identify Borlaug Fellows based on country-specific topics of importance to international, agricultural trade. USDA then places Fellows with U.S. research institutions for 10-12 week, intensive programs. These programs are expected to contribute to the strategic goals and objectives of the fellow and those institutions through a hands-on experience in a "real-world" agricultural research scenario, providing opportunity for application of research agendas where they can have a direct impact on food security and economic growth in an emerging economy. It is hoped that host institutions will share the knowledge gained through the program in their classroom and extension work with their faculty, students, extension officers, and constituents; and that they will continue to maintain professional contacts with the fellows after their departure from the United States.

Borlaug fellows may be identified in any of the topics listed below:

(A) Animal health
(B) Plant health
(C) Resilient Agriculture

PLACE OF PERFORMANCE

- The applicant is expected to host fellows at a research facility on their campus in the United States.
- The mentor is expected to make a reciprocal visit of up to two weeks to the fellow's home institution, which may be in a developing country.

EXPECTATIONS:

(1) Assignment of a Principal Investigator (Training Coordinator)

The host institution will designate a contact person as the Principal Investigator (PI) responsible for coordinating all administrative and programmatic arrangements.

(2) Assignment of a Mentor

A key component of the program is matching the Fellow with a mentor. The host institution will select an appropriate mentor for one-on-one work with the Fellow for the duration of the program.

- The mentor will establish a professional relationship, providing guidance and training in the Fellow's research and studies.
- The mentor will work with the Fellow before arrival to discuss appropriate work plan, site visits, and other arrangements. A work plan should be agreed upon and finalized no later than 2 weeks after the program start date.
- The mentor will provide draft of work plan through the PI to USDA/FAS for consultation and approval approximately 2 weeks before the commencement of the program.
- The mentor agrees to commit a significant amount of time each week for one-on-one work with the Fellow during the program.
- The mentor will continue communicating with the Fellow beyond the end of the program in the U.S. through the mentor visit.
- Mentor will submit quarterly progress reports that indicate all program activities conducted (form SF-PPR).
- The mentor may assign other faculty members to assist with Fellow's training and research activities.
- Mentor may not be assigned to multiple Fellows during the same time frame.

(3) Mentor Follow-up Visit

- The mentor visit is a required component of the Borlaug Fellowship Program.
- The mentor will work with the Fellow to plan a follow-up visit to the Fellow's home country. The trip should occur within 6 months to 1 year after the program ends.
- The PI should provide USDA/FAS with an agenda for mentor's travel, including goals and objectives. The mentor's travel information must be provided for emergency contact purposes and country clearance (if required by the cognizant FAS Overseas Office).
- The mentor will provide a trip report highlighting the trip's activities and results through the PI to USDA/FAS within 30 days after the visit.
- The mentor should plan to meet with the USDA/FAS Attaché or staff from the U.S. Embassy while they are traveling, if feasible. USDA/FAS can assist with coordination prior to the trip.

(4) Visa

- USDA/FAS will provide a DS-2019 for the Fellow to request and obtain a J-1 Visa. USDA/FAS will provide instructions to the Fellow regarding the application process, the

amount of lead-time needed, and any paperwork required. The visa start and end date will be coordinated with the host institution who will be responsible for purchasing round trip plane tickets for the fellow to come to the U.S. for his or her program.

- Fellows, including those already in possession of another valid U.S. visa, must still obtain a J-1 visa to participate in the program. Fellows will be refused entry if they arrive in the United States without the appropriate category of visa.

(5) Travel and Transportation

- The host institution must comply with the Federal Travel Regulations (41 CFR 300 et seq.).
- The host institution will provide round trip, economy class, international airfare from the Fellow's home to the university.
- The host institution is responsible for arranging and purchasing all domestic travel related to the Fellow's training program.
- The host institution will provide housing for the Fellow for the duration of the training program, taking into account gender and cultural norms.
- The host institution will pay lodging fees directly. The host institution will not require the Fellow to pay for his or her lodging expenses, whether through reimbursement or advance payment.
- Lodging will include a private bedroom, private or shared bathroom, access to a laundry room, and access to a kitchen with pots, pans, and utensils.
- Basic necessities, such as sheets, towels, and cleaning supplies (if not already provided), will be provided for Fellow's use. The Fellow should not have to pay for these items.
- Lodging will be within walking distance to the campus/training location or easily accessible by public transportation.
- If public transportation is required to access campus/training location, the host institution will provide the Fellow with a bus pass or proper allowance for transportation expenses.
- When planning lodging options, the host institution should check with the Fellow and account for any special dietary restrictions or preferences.

(6) Meals and Incidentals (M&IE)

- The host institution will provide each Fellow with meal and living allowances for the duration of stay.
- Daily M&IE allowance may not exceed current GSA per diem rates.
- The host institution can determine the frequency of per diem allotments, but the Fellow must receive per diem within the first week of the Fellowship. The PI must inform the Fellow and USDA/FAS immediately if this cannot be accommodated.

(7) Emergency Health Insurance

- The host institution will purchase emergency health insurance for the Fellow for the duration of stay, as required for all J-1 Visa holders (22 CFR 62.14).
- The Fellow will not be required to purchase his or her health insurance and then be reimbursed.

- The host institution will educate the Fellow as to what is covered under health insurance policy, especially highlighting that pre-existing medical conditions are not covered.
- The host institution will alert USDA/FAS staff if any health/medical conditions arise during the Fellowship.

(8) Communication

- The host institution will initiate contact with the Fellow as soon as possible.
- The host institution will develop the training program in consultation with USDA/FAS and the Fellow.
- The host institution will keep USDA/FAS informed regarding any logistical or program planning.
- The host institution will notify USDA/FAS immediately upon Fellow's physical arrival and departure from the U.S. to comply with U.S. Department of Homeland Security requirements
- The host institution will provide USDA/FAS with the Fellow's temporary U.S. address and phone number, and emergency contact numbers for the PI, mentor, or other appropriate institution personnel. This information is required so that Fellow can be reached in the event of an emergency.

(9) Fellowship Program

- The host institution will provide educational materials and supplies to each Fellow necessary for their full participation in the fellowship.
- The host institution will pay for all fees related to the Fellow's training program, such as (but not limited to) technology fees, administrative fees, laboratory fees, etc.
- The host institution will arrange relevant field visits as applicable to the Fellow's training program.
- The host institution will ensure the Fellow submits an interim and final report (2-3 pages each) to USDA/FAS before the Fellow leaves the United States.

(10) Orientation

- The PI/Training Coordinator will communicate directly with the Fellow at least 4-8 weeks before his or her arrival in the U.S. to ensure that all pertinent information is provided, including:
    - Name and contact information of PI/Training Coordinator
    - Name and contact information of mentor
    - Institution information, weather information, and clothing needs
    - Housing and M&IE allowance
    - Program plan and anticipated site visits
    - Professional development expectations
    - Reminder to bring any necessary prescription medications
    - Explain what is and is not covered under emergency health insurance policy (e.g. no pre-existing conditions, no dental, etc.)

- Institution will provide an orientation upon the Fellow's arrival to acquaint them with campus and community resources, such as:
  - Explanation and demonstration of local bus/transportation options
  - Explanation of cultural and legal expectations
- USDA will provide a welcome and orientation packet for mentors

Issued By

Foreign Agricultural Service, Office of Capacity Building & Development, Trade & Scientific Exchanges Division, Scientific Exchanges Branch

Catalog of Federal Domestic Assistance (CFDA) Number and Title

10.777
Norman E. Borlaug International Science and Technology Fellowship Program

Notice of Funding Opportunity Title

Borlaug Fellowship Program

NOFO Numbers

USDA-FAS-10777-0700-10.-18-0031 – Fellow 3, Algeria
USDA-FAS-10777-0700-10.-18-0034 – Fellow 4, Egypt
USDA-FAS-10777-0700-10.-18-0035 – Fellow 5, Ethiopia
USDA-FAS-10777-0700-10.-18-0036 – Fellow 6, Ethiopia
USDA-FAS-10777-0700-10.-18-0037 – Fellow 7, Ghana
USDA-FAS-10777-0700-10.-18-0039 – Fellow 9, Liberia
USDA-FAS-10777-0700-10.-18-0042 – Fellow 12, Mozambique

Authorizing Authority for Program

The legislative authority for the Borlaug Fellowship Program is provided in Sec. 7139 of the Food, Conservation, and Energy Act of 2008 (PL 110-234), as incorporated in to the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended.

Appropriation Authority for Program

Consolidated Appropriations Act, 2017 (PL 115-31)

Program Type

New

B. Federal Award Information

Award Amounts, Important Dates, and Extensions

Available Funding for the NOFO: Each award (for one fellow) is up to $50,000.

Projected number of Awards: 7

Number of Project Budget Periods: 1

Projected First Budget Period: N/A

Projected Period of Performance Start Date(s): Subject to the availability of implementer and Fellows.

Projected Period of Performance End Date(s): 18 months after the start date

Extensions are allowable, please see Section H. Additional Information to see how to requests one should the need arise.

Pre-Award costs: Not Allowable

Cost Share or Match requirements: A cost match or cost share is not required.

Funding Instrument

USDA will enter into a cost reimbursable agreement under 7 USC § 3319a with selected universities.

C. Eligibility Information

Eligible Applicants

Proposals may be received from U.S. State Cooperative Institutions or other colleges and universities, including minority serving institutions (MSIs).

A single mentor may not host two fellows simultaneously. Both the PI and mentor must hold positions at an eligible U.S. institution.

Eligibility Criteria

All applicants must have an active registration in the SAM database at www.sam.gov – pending or expired registrants are not eligible. This requirement must be met by the closing date of the announcement and will not be waived. Please contact the program officer listed if you have questions about this requirement.

In addition to obtaining a DUNS number and registering in SAM, you must also obtain Level 2 eAuthentication to apply for this funding opportunity in ezFedGrants (eFG). You must submit an online form requesting access. Normally you will receive an email within 24 hours of your submission, if your request is approved. After this occurs, you will need to schedule an appointment with an LRA. Once you meet with the LRA, your Level 2 eAuthentication should be granted within 2 to 3 days after that meeting. See Section D of this NOFO for detailed information.

Maintenance of Effort (MOE)

MOE is not allowable.

D. Application and Submission Information

Key Dates and Times

Application Start Date:	05/21/2018
ezFedGrants Posting Date:	05/21/2018
Application Submission Deadline:	06/18/2018 at 11:59PM EST
Anticipated Funding Selection Date:	Approximately 2-3 weeks after the submission deadline, subject to the availability of funding
Anticipated Award Date:	Approximately 2-3 weeks after selection, subject to the availability of funding

Address to Request Application Package

This NOFO represents the full application information.

Applications will be processed through the ezFedGrants portal at https://grants.fms.usda.gov – prospective applicants are encouraged to register for this portal. Applicants that are unable to access the ezFedGrants portal should contact the program manager for alternative submission instructions. Note that if selected, registration is a requirement of performance.

Content and Form of Application Submission

Institutions must be able to host multiple groups over the period of performance and should submit a proposal following the guidelines below:

- Required forms and certifications, including:
  - SF-424 version 2.1, with an OMB Expiration Date of 10/31/2019
  - SF-424A version 1.0, revised July 1997. This should be accompanied by a detailed budget worksheet and a detailed budget narrative (NOTE: A budget narrative must be provided). All line items should be described in sufficient detail that would enable FAS to determine that the costs are reasonable and allowable for the project per federal regulations. An example budget narrative is included in the appendix, but is not required.
  - AD-3030, revised February 2016
  - AD-3031, revised February 2016
- Indicate the name of the institution applying to host the Fellows.

- Indicate the country, research interest, and reference number.
- Identify a Primary Investigator.
- Identify a Mentor. A Mentor may not be assigned to multiple Fellows who are in the U.S. at the same time.
- Provide a tentative research plan based on the Fellow's research proposal and action plan, including topics covered, field visits, and other activities.
- Include a narrative description of the proposed fellowship, how it will be administered, and the role of the university faculty and support staff.
- Provide a summary of relevant institutional capabilities for hosting international scientists and policymakers in the proposed field.
- Briefly describe the research expertise and international experience of the mentor in the Fellow's field of interest.
- Provide a one to two page curriculum vitae for the mentor and other collaborating researchers involved in the proposed program.
- Identify the expected skills or knowledge to be acquired by the Fellow at the end of the program
- If attending the World Food Prize, the budget should include time and funding for the Fellow and Mentor to attend. An adjustment to the Fellow's M&IE must be made for the time spent in Iowa.

The SF-424 and SF-424 A can be completed within the ezFedGrants platform. However, the other required forms must be downloaded from the Forms sections on Grants.gov. The Certification regarding Lobbying and the Grants and Agreement Coversheet will be sent to you along with this NOFO.

Unique Entity Identifier and System for Award Management (SAM)
The link below provides information on 2 CFR §25.110. Please read.

https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=7a45f973880240465cd255471f1380ef&ty=HTML&h=L&mc=true&n=pt2.1.25&r=PART

FAS is using ezFedGrants to post NOFO's and issue agreements, which is an electronic grants management system. Applicant(s) with electronic access are to submit their applications electronically through:

https://grants.fms.usda.gov

Before you can apply, you must have a DUNS number, be registered in SAM, and have access to the ezFedGrants website).

Applicants are encouraged to register early. Due to recent changes in the SAM platform, the registration process can take 6-8 weeks to be completed. Therefore, registration should be done in sufficient time to ensure it does not impact your ability to meet required submission deadlines.

DUNS number. Instructions for obtaining a DUNS number can be found at the following website: http://www.dnb.com/duns-number.html
The DUNS number must be included in the data entry field labeled "Organizational DUNS" on the Standard Forms (SF)-424 forms submitted as part of this application.

System for Award Management. In addition to having a DUNS number, applicants applying electronically through ezFedGrants must register with SAM. Step-by-step instructions for registering with SAM can be found here:

www.sam.gov

Failure to register with SAM will result in your application being rejected during the submissions process.

ezFedGrants System Access and Electronic Signature

Level 2 eAuthentication. The next step in the registration process is to obtain a Level 2 eAuthentication account that will allow access to the ezFedGrants system. Instructions for getting a Level 2 eAuthentication account can be obtained by emailing ezFedGrants@cfo.usda.gov.

You may also request Level 2 eAuthentication online at:
https://www.eauth.usda.gov/MainPages/index.aspx

If you experience any issues with self-registration or have eAuthentication-related questions, please contact the eAuthenticationHelpDesk for assistance:
By email to eAuthHelpDesk@ftc.usda.gov

Requesting a role in ezFedGrants.
After obtaining eAuthentication, users will need a role in the system. Descriptions of the roles available and instructions on how to request a role can be obtained by emailing ezFedGrants@cfo.usda.gov

You may also go into the link below for instructions on requesting eFG access. The document is called “External Portal Access Request Submission”.

https://www2.nfc.usda.gov/FSS/Training/Online/ezFedGrants/access_user_roles.php

Electronic Signature. Applications submitted through ezFedGrants constitute a submission as electronically signed applications. When you submit the application through ezFedGrants, the name of your Signatory Official on file will be inserted into the signature line of the application.

If you experience difficulties accessing information or have any questions please email the Helpdesk at ezFedGrants@cfo.usda.gov.

The Federal awarding agency may not make a Federal award to an applicant until the applicant has complied with all applicable DUNS and SAM requirements and, if an applicant has not fully complied with the requirements by the time the Federal awarding agency is ready to make a Federal award, the Federal awarding agency may determine that the applicant is not qualified to receive a Federal award and use that determination as a basis for making a Federal award to another applicant.

Intergovernmental Review

This program is not subject to E.O. 12372.

Funding Restrictions

This will be a cost reimbursable agreement issued under 7 USC § 3319a. University indirect costs for cost reimbursable agreements are limited to 10% of modified total direct costs (MTDC).

Allowable Costs:

1. Salaries and Fringe Benefits:
Requested funds may be allocated toward salaries, fringe benefits, or the combination thereof. No more than 20% of the requested funds may be allocated toward salaries, consultant fees, fringe benefits, or the combination thereof. Only individuals that hold positions at eligible U.S. institutions should be listed in this category.

2. Travel:
For domestic travel, provide the purpose of the travel and information used in calculating the estimated cost, such as the destination, number of travelers, and estimated cost per trip. There are several restrictions associated with traveling on federal funds. In most cases, airfare must be purchased in economy class from a U.S. carrier. Travelers must also adhere to federally mandated domestic per diem guidelines. Additional information may be found in the circulars listed in the "Legislative Authority" section of this announcement.

3. Supplies:
All personal property excluding equipment, intangible property, and debt instruments as defined in this section.

4. Other Direct Costs:
Other Direct Costs are those anticipated charges not included in other budget categories, including materials and supplies, lab fees, publication costs, reasonable consultant fees, computer services, sub-awards (the level of detail required for the sub-award budget is the same as the recipient organization), equipment rental, facility rental, conferences and meetings, speaker fees, honorariums.

5. Indirect Costs:
Indirect Costs may not exceed 10% of direct costs (7 USC 3319a).

6. Tax Withholding:
Borlaug Fellows (as trainees, *not* students) are considered EXEMPT INDIVIDUALS under the IRS Substantial Presence Test for tax purposes. The exemption falls under one or both of the following categories: either the Foreign Government-Related Individuals standard or the Closer Connection Exception. Tax treaties might also exist between the U.S. and the Fellow's home country. The only requirement is to complete IRS Form 8843 (Sections 1 and 2). No taxes should be withheld from Borlaug Fellows since they are exempt.

Unallowable Costs:

General purpose equipment (no particular scientific, technical, or programmatic purpose) and scientific equipment exceeding $5,000 or more; entertainment; any stipend or remuneration for the fellow, other than ordinary allowances for meals and supplies; capital improvements; thank you gifts, and other expenses not directly related to the project are not allowed. "Please note, Borlaug Fellows (as trainees, not students) are considered EXEMPT INDIVIDUALS under the IRS Substantial Presence Test for tax purposes. The exemption falls under one or both of the following categories: either the Foreign Government-Related Individuals standard or the Closer Connection Exception. The only requirement is to complete IRS Form 8843 (Sections 1 and 2). These funds are for federal financial assistance; as such no taxes should be withheld from Borlaug Fellows since they are exempt."

Management and Administration (M&A) Costs:

M&A costs are not allowable.

Indirect Facilities & Administrative (F&A) Costs.

By statute, indirect costs for cost reimbursable agreements cannot exceed 10% of direct costs.

Other Submission Requirements

All applications must be submitted electronically as indicated above.

E. Application Review Information

Application Evaluation Criteria

Prior to making a Federal award, the Federal awarding agency is required by 31 U.S.C. 3321 and 41 U.S.C. 2313 to review information available through any OMB-designated repositories of government-wide eligibility qualification or financial integrity information. Therefore application evaluation criteria may include the following risk based considerations of the applicant: (1) financial stability; (2) quality of management systems and ability to meet management standards; (3) history of performance in managing federal award; (4) reports and findings from audits; and (5) ability to effectively implement statutory, regulatory, or other requirements.

Technical Expertise and Experience (40 points)
Mentor must have appropriate technical background to provide the desired, advanced training. If necessary, other appropriate collaborating scientists should be identified to meet any of the objectives which the mentor cannot address. Mentor's experience and knowledge of relevant agricultural conditions within the Fellow's country or a similar location will be considered as appropriate. The trainer's experience with international training and adult-education will also be considered.

Overall Program (35 points)
The overall program plan and design should be relevant to the Fellow's objectives background. The program plan should be thorough, and it should help achieve the desired post-program deliverables and the Fellow's research goals and objectives. Relevant agricultural practices within the region of the university will be considered as appropriate. Relevant university resources should be identified. Additional resources/organizations should be identified as appropriate. Site visits and meetings should be meaningful to the content of the program, if included.

Budget (25 points)
The proposed budget should be appropriate for the number of Fellows and length of the program. The budget should include appropriate cost savings where available and narrative should accompany each line item. Host is strongly encouraged to use the Budget Worksheet provided in this NOFO.

Review and Selection Process

In all cases, the Program Manager will ensure application is submitted on time as specified in this announcement. Also, the Program Manager will ensure the organization is capable of delivering the program/activities as described in the announcement based on the applicant's project narrative.

Qualified applications will be referred to a panel of 2-3 program staff and/or technical experts, and adjudicated among the criteria described above. In general, the highest-rated proposal will be

selected, however, FAS may occasionally select out of score order for policy reasons, such as geographic distribution, incorporation of minority-serving institutions, past experience, etc.

Confidentiality and Conflict of Interest

Technical and cost proposals submitted under this funding opportunity will be protected from unauthorized disclosure in accordance with applicable laws and regulations. FAS may use one or more support contractors in the logistical processing of proposals. However, funding recommendations and final award decisions are solely the responsibility of FAS personnel.

FAS screens all technical reviewers for potential conflicts of interest. To determine possible conflicts of interest, FAS requires potential reviewers to complete and sign conflicts of interest and nondisclosure forms. FAS will keep the names of submitting institutions and individuals as well as the substance of the applications confidential except to reviewers and FAS staff involved in the award process. FAS will destroy any unsuccessful applications after three years following the funding decision.

F. Federal Award Administration Information

Notice of Award

Notice of award will be given to the institution via email. This email is not an authorization to begin performance. The notice of Federal award signed by the grants officer (or equivalent) is the authorizing document through electronic means. It should also indicate if there are any pass-through obligations that successful applicants are required to meet upon receiving award funds, including specific timeline requirements.

Administrative and National Policy Requirements

All successful applicants for all grant and cooperative agreements are required to comply with Standard Administrative Terms and Conditions for Overseas Federal Assistance Awards, which can be found on the FAS website:

https://www.fas.usda.gov/grants/general_terms_and_conditions/default.asp

The applicable Standard Administrative Terms and Conditions will be for the last year specified at that URL, unless the application is to continue an award first awarded in an earlier year. In that event, the terms and conditions that apply will be those in effect for the year in which the award was originally made.

Before accepting the award the Recipient should carefully read the award package for instructions on administering the grant award and the terms and conditions associated with responsibilities under Federal Awards. Recipients must accept all conditions in this NOFO as well as any Special Terms and Conditions in the Notice of Award to receive an award under this program.

Reporting

Federal Financial Reporting Requirements. The Federal Financial Reporting Form (FFR), as known as the SF-425, must be submitted semi-annually (the reporting period ending every 6 months after the start date of the agreement) within 30 days of the end of the reporting period, with the final FFR submitted within 90 days of the end of the agreement. The required form is available online at:

https://www.grants.gov/web/grants/forms/post-award-reporting-forms.html#sortby=1

At the top of the website select **FORMS**, and from the drop down box select **POST AWARD REPORTING FORMS**.

Program Performance Reporting Requirements.
Performance Progress Reporting must be submitted semi-annually (the reporting period ending every 6 months after the start date of the agreement) within 30 days of the end of the reporting period, with the final PPR submitted within 90 days of the end of the agreement, and should include details the activities undertaken and progress made during the reporting period.

Program Performance Requirements.

- Ensure that each Fellow completes the Borlaug Fellowship Program Evaluation.
- A brief Fellow final report before the fellow departs the U.S. (Template will be provided).
- The Principal Investigator or Mentor will submit a final report to USDA/FAS within 30 days after the Mentor visit. (Template will be provided).
- The Principal Investigator or Mentor will submit semi-annual progress reports.
- Reports should include the following:
    - Summary of activities, accomplishments, and any problems encountered or overcome
    - Photographs, when possible
    - Completed program evaluations and action plan
- An invoice/claim cannot be paid if a progress report is past due, and will not be paid until the required report has been received.

Close Out Reporting Requirements.

Within 90 days after the end of the period of performance, or after an amendment has been issued to close out a grant, whichever comes first, recipients must submit a final FFR and final progress report detailing all accomplishments and a qualitative summary of the impact of those accomplishments throughout the period of performance.

After these reports have been reviewed and approved by OCBD, a close-out notice will be completed to close out the grant. The notice will indicate the period of performance as closed, list any remaining funds that will be de-obligated, and address the requirement of maintaining the grant records for three years from the date of the final FFR.

The recipient is responsible for returning any funds that have been drawn down but remain as unliquidated on recipient financial records.

G. Awarding Agency Contact Information

Contact and Resource Information

For all general questions, contact:
Tim Sheehan, Branch Chief
Hours of operation: 9:00 AM – 4:30 PM Eastern Standard Time
Telephone: (202) 690-1940
E-mail address: BorlaugProposals@fas.usda.gov
1400 Independence Ave, SW #3226-South
Washington, DC 20250-1031

H. Additional Information

1. Extensions

Extensions to this program are allowed.
Applicants may request a no-cost extension in order to complete all project activities. The request must be submitted 60 days prior to the expiration of the performance period. Requests for extensions are subject to approval by FAS.

2. Prior Approval

The Recipient shall not, without the prior written approval of the FAS Program Manager, request reimbursement, incur costs or obligate funds for any purpose pertaining to the operation of the project, program, or activities prior to the approved Budget Period/Performance Period.

3. Budget Revisions

a. Transfers of funds between direct cost categories in the approved budget when such cumulative transfers among those direct cost categories exceed ten percent of the total budget approved in this Award require prior written approval by the FAS Program Manager.

b. The Recipient shall obtain prior written approval from the FAS Program Manager for any budget revision that would result in the need for additional resources/funds.

c. The Recipient is not authorized at any time to transfer amounts budgeted for direct costs to the indirect costs line item or vice versa, without prior written approval of the FAS Program Manager.

Appendix A

Borlaug Fellowship Program for Africa and Middle East

Index of Fellowships

Fellow Reference Number	Country	Gender	Fellowship Length (weeks)	Research Focus
3	Algeria	Female	12	Investigation of factors affecting body reserve mobilization and their impact on ewe reproduction and lambs growth performances in low input production system of Algerian semi-arid region.
4	Egypt	Female	12	Integrated Pest Management of pests on vegetable hydroponic crops in greenhouses.
5	Ethiopia	Male	12	Improving outbreak investigation capacity for anthrax cases in human and animals: mainly through supporting the capacity for isolation and molecular characterization of Bacillus anthracis in Ethiopia.
6	Ethiopia	Male	12	To implement molecular plant breeding (MPB) to enhance the efficiency of developing high-yielding wheat cultivars with durable stem rust (SR) resistance varieties for Ethiopia.
7	Ghana	Female	12	Developing a technology for utilizing spent mushroom substrates (SMSs) as sustainable fertilizers for cocoa cultivation.
9	Liberia	Male	12	Assessing growth and yield performances of cocoa in Agroforestry (Intercropping) system.
12	Mozambique	Male	12	Physiological and molecular responses to drought stress in maize.

Individual Proposals and Action Plans

Fellow #3, Algeria, Female/ NOFO: USDA-FAS-10777-0700-10.-18-0031

"Investigation of factors affecting body reserve mobilization and their impact on ewe reproduction and lamb growth performances in low input production system of Algerian semi-arid region."

1. Goal

The goal of my research is to contribute to the improvement of the productivity of sheep breeding in low input systems.

2. Specific Objectives

Investigation of factors affecting body reserve mobilization and their impact on ewe reproduction and lamb growth performance raised in low input production systems in semi-arid region in Algeria.

3. Background Information

Sheep farming systems in the semi-arid regions of Algeria are agro-pastoral systems –low input characterized by insufficient forage supply and a diet based on spontaneous annual vegetation of natural pastures, which induce low productivity.

Body Condition Scoring (NEC) is designed to study the evolution of body reserves along a production cycle. It allows one to establish dietary strategies with practical recommendations based on threshold scores for each phase of the production cycle. A strong relationship between body condition and performances of reproduction, growth and productivity was noticed in a previous study showing also different evolution profiles between ewes subject to the same breeding conditions. So the modalities of accumulation of the reserves and their mobilization in the ewes seem in resilient systems a determining element of the performances of flocks and the sustainability of the systems. We aim to understand females' abilities of ewes of local breeds to mobilize their body reserves and their impact on breeding performance, growth of lambs in extensive sheep farming (low input) in the semi-arid region.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

I hope to acquire knowledge and statistical tools to help me understand and illustrate through models the links between natural resources, body scores, and performance of sheep.

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

Algeria, despite the large amount of resources, remains deficient in terms of meat production; it has resorted to importation, to fill the deficit and mitigate speculation. Currently our country is one of the big importers of red meat in the Arab world.

Understanding our production systems and resilience strategies developed by animals can help us better strengthen the sector and bring better development projects to increase productivity.

Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

-Week 2: Documentation
-Week 3: Learn the general linear model
-Week 4: Learn the mixed model
-Week 5: Learn linear regression
-Week 6: Learn logistic regression
-Week 7: Effect physicochemical analyzes on blood recovered from ewes in Algeria
-Week 8: Effect analyzes to estimate cellular stress in sheep
-Week 9: Modeling
-Week 10: Modeling
-Week 11: Modeling
-Week 12: Modeling

Fellow #4, Egypt, Female/ NOFO: USDA-FAS-10777-0700-10.-18-0034
"Integrated Pest Management of pests on vegetable hydroponic crops in greenhouses."

1. Goal

The goal of my research is to improve the ability for the conduction of works about the control of pests on vegetable hydroponic crops in greenhouses through the training on innovative technologies applied in IPM programs.

2. Specific Objectives

The specific research objectives are:

a. To explore and assess global best practice IPM strategies for vegetable hydroponic crops in greenhouses.

b. Identify emerging and innovative technologies associated with biological control agents available for commercial application whilst maintaining overall quality of vegetables.

c. To consider and gauge the feasibility of adopting entomovectoring in a commercial greenhouse environment for vegetable production.

d. To make practical and commercially viable recommendations to growers adopting IPM in intensive greenhouse hydroponic production of vegetables.

3. Background Information

Hydroponics systems consist of not using soil as substrate for plant production. It has been widely used for production of vegetables such as tomatoes, strawberries, cucumbers, peppers, eggplants, and ornamentals. The major advantage with such a system is the absence of weeds and other soil-borne pests, no toxic pesticide residue, better use of water, better control over nutrient and oxygen, increased crop quality and yields. The number of challenges for hydroponic vegetable production includes the need to produce large quantities of fruit per unit area against the optimizing light availability. The enhancement of climate control and growing medium has led to increased yield production.

Inadvertently, these adjustments have resulted in conditions of pests and diseases proliferation. Food safety and the limited number of chemical controls available for greenhouse hydroponic vegetables are the underlying motivation for primary producers to adopt Integrated Pest Management (IPM) strategies.

However, biological control without some form of chemical control is almost impossible. It is also not about total control of pests, but rather effective management of the pests. The timing and method of release of bio-agents is critical to the success of pest control and this is achieved through regular monitoring and scouting to enable early detection of pest presence. IPM is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides. IPM includes the necessary phytosanitary measures, monitoring and diagnostic system, good agricultural practices and the management of natural enemies with the minimum amount of pesticides (when needed). IPM is thus an important part of Integrated Plant Production Management and sustainable crop production intensification. By enhancing the ecosystem

function, by making the agricultural ecosystem healthier, more ecosystem services are provided: in this case-pest control.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

I hope to accomplish during my fellowship are:

a. Update the knowledge about the plant production and protection considering reduced reliance on pesticides as a principle element of its focus on sustainable production intensification and pesticide risk reduction.

b. Trained on the innovative technologies associated with biological control agents available for commercial application under hydroponic system.

c. Practice IPM strategies for vegetable hydroponic crops in greenhouses.

d. Update the knowledge about IPM programs which have demonstrated that pesticide use can often be reduced considerably without affecting yields or farmer profits.

e. Improve the ability for the conduction of works about IPM for vegetable hydroponic crops in greenhouses in Egypt.

The proposer of this fellowship is a Researcher of Acarology at Plant Protection Research Institute, Agricultural Research Centre, she is already engaged in researches on biological control (Abo-Shnaf et al., 2011) and mite taxonomy (Romeih et al., 2005, 2010; Romeih & Abo-Shnaf, 2006). The applicant visited ESALQ-USP, Brazil twice on a post-doctoral fellowship offered by TWAS-CNPq (Process # 190033/2012- 6) and (Process # 190047/2014-3, CNPq – TWAS, PDJ 2014), which enabled her to publish five comprehensive articles (Abo-Shnaf et al., 2013, Abo-Shnaf & Moraes, 2014, Moraes et al., 2015, Abo- Shnaf & Moraes, 2016 and Abo-Shnaf et al., 2016) in addition to other four articles in preparation (Abo- Shnaf & Moraes, 2017a, b and Abo-Shnaf et al., 2017 c, d). It is the understanding of the proposer that this fellowship program will allow her to become better qualified for her future researches on IPM.

This training program will allow the proposer to augment a career in IPM in vegetable hydroponic production system in Egypt and better qualified for her future researches. It is the first step to start an ambitious program in Egypt with the help of some of the better specialists in American Institutions. The expertise of U.S. mentor will thus be helpful for advancement of knowledge of the proposer.

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

Agriculture is one of the main livelihoods of the Egyptian people. In order to get a maximum yield, use of pesticide is gaining momentum now-a-days. It is the need of the moment to control pests. IPM is the key for an up-to-date and respectful environment integrated crop protection system. The possibility to control pests already resistant to chemical products, low cost treatment and almost zero pesticide phytotoxicity

are the main advantages of such a system. Research on IPM engaging the bio-agents in Egypt are scanty. Additionally, Egypt receives a lot of environment pollution from the extensive use of pesticides. This is considered a major challenge for Egyptian products policy and decision makers- the physical scarcity of safe food to satisfy and sustain the life and development. The demand is rocketing and the available renewable quantity is diminishing because of unsustainable extraction, weather changes, population growth, urbanization, and agricultural and industrial expansions. In response to all the challenges that are facing pest management in Egypt, IPM has developed a better use of the existing bio-agents to protect vegetables under a hydroponic system and the environment from pollution through discouraging the development of pest populations and to keep pesticides to levels that are economically justified and also to minimize risks to human health and the environment. This will safeguard the food resources (quantity and quality) under the conditions of an increasing population.

Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

a. Week 1: Arrival in USA / Visiting the American Institution and other organizations interested with IPM programs / Literature survey on IPM strategy.
b. Week 2: Attending some lectures and training concerning vegetables hydroponic production.
c. Week 3: Attending some lectures concerning IPM programs.
d. Weeks 4-5: Training on IPM processes / Scouting / Monitoring / Recording / Pest identification / Action threshold.
e. Week 6-10: Training on Physical controls / Cultural controls / Chemical controls / Biological controls.
f. Week 11: Training on entomovectoring.
g. Week 12: Visiting some greenhouse hydroponic vegetables treated with IPM programs/ Report preparation.

Methodology:
The work will be carried out at an American Institution, with visits to facilities and institutions concerned with IPM strategy.

Literature collection:
Collecting literature that will facilitate the work of IPM for vegetable hydroponic plants in greenhouses in Egypt.

IPM is a common sense, proactive approach to crop protection which gives due consideration to the following steps:

1. Monitoring and scouting to detect initial pest and disease presence and then the levels of infestation.
2. Recording of pests and diseases, to log and track increases or decreases in pest and disease densities, the area of infestation within the crop and specific location of individual plants.
3. Recording data on climate and weather forecasting, seasonality of crops, pests and disease, and surrounding cropping programs.
4. Establishment of economic thresholds to assist in correct timing of application of the control strategy.
5. Predicting and assessing economic, ecological and sociological consequences.
6. Selection, integration and implementation of cultural, physical and biological control strategies.

7. Utilising chemical controls as a last resort and giving due consideration to the choice of pest or disease specific products with the least toxic formulation and using an alternative chemical group where applicable.

Physical controls:
It focuses on the methods and options to enhance the growing environment of vegetables and the protection from the various climate and naturally occurring pest elements. There is an abundance of tools available to physically manipulate and steer the climate, according to the vegetable crop demands as well as attempting to reduce pest and disease incursion or proliferation. The main limitations and variations in the levels of controls implemented are related to the level of investment and cost/benefit outcome.

Cultural controls:
It focus on alter the environment, the condition of the host or the behavior of the pest to prevent or suppress an infestation. It disrupts the normal relationship between the pest and host and makes the pest less likely to survive, grow or reproduce. Many cultural practices may be adjusted through vegetables management techniques. The notable areas to consider include propagation material, plant nutrition, water management, growing media, crop maintenance, genetics and resistance.

Chemical controls:
Pesticide usage requires an evaluation of the benefits in relation to the costs of its introduction (efficacy and economy of use) but also in terms of the hazard and the risk under a particular set of conditions where the pesticide is to be used. Pesticides represent the only rapid method of intervention when pests exceed levels causing economic damage. Pesticides are considered to be evil because they are generally acknowledged to have a potential negative impact on our health and environment, and because their use may lead to problems of pest resurgence, secondary pests and pest resistance.

Biological controls:
Is the use of natural enemies (predators, parasitoids and pathogens) as Biological Control Agents (BCAs) to manage or suppress both pests and diseases population levelling process. These BCAs may be naturally present in the greenhouse vegetable crops or may be commercially produced by a biocontrol rearing agent who then supplies the recommended or required BCAs in bulk for release into the greenhouse environment. There are biological chemical products where the active ingredient is derived from a living organism (plant, animal, microorganism, etc.) with or without modification.

Strategies of biological control methods:
The three main strategies of biological control include classical methods, augmentation and conservation bio-control as follows:

1. Classical control: Greenhouse vegetable cultivation provides an opportunity to establish production facilities in various geographical locations. Importing and releasing BCAs becomes the selected or preferred option.
2. Augmentation: Involves mass rearing and then releasing of arthropod BCAs into crops either in a preventative form of biological control or due to an imbalance in arthropod BCA to pest presence. By enhancing the number of BCAs, balanced pest numbers is the aim.
3. Conservation control: Includes modifying the environment and the conditions to better suit BCAs. In a greenhouse system this is achievable through retention within the structure of BCAs by eliminating disruptive conditions like wind, rain and extreme temperatures. It is also possible to maintain conservation of BCAs through the integration of banker, pollinator and companion plants within the greenhouse vegetable crops.

Entomovectoring: Is an innovative delivery technology for bio-control agents. The basis of this technology involves harnessing a pollinator to vector a form of microbial bio-control and depositing this microbial formulation on the flowers of the crop being pollinated. Bumble bees have been widely used for successful pollination in greenhouse vegetables. There are significant benefits to greenhouse vegetable growers through this technology, but there are also noticeable limitations.

Expected Output of this research project will be:

a. Better qualification of the candidate through training on the innovative technologies of IPM in commercial application in greenhouse hydroponic system.

b. Support research on hydroponic system, aiming at minimizing chemical control of pests and increasing the dependence on environmentally safe methods, to produce clean crops for local and foreign markets.

c. The feasibility of adopting entomovectoring in commercial greenhouses.

d. Well practice on IPM strategies for different pests and diseases on vegetable hydroponic crops in greenhouses.

e. Gain practical and commercially viable recommendations to growers adopting IPM in intensive greenhouse hydroponic production of vegetables.

f. Improve the ability for the conduction of works about IPM for vegetable hydroponic crops in greenhouses in Egypt.

Fellow #5, Ethiopia, Male/ NOFO: USDA-FAS-10777-0700-10.-18-0035
"Improving outbreak investigation capacity for anthrax cases in human and animals: mainly through supporting the capacity for isolation and molecular characterization of Bacillus Anthracis in Ethiopia."

1. Goal

The goal of my research is to contribute for the national strategy developed to prevent and control anthrax in humans and animals in Ethiopia.

2. Specific Objective(s)

The objective of this study is to improve laboratory capacity for anthrax diagnosis at national and regional level, mainly through human resource capacity building on anthrax diagnosis.

3. Background Information

Anthrax is a zoonotic bacterial disease caused by Bacillus anthracis and it affects many domestic and wild animals and humans. In Ethiopia considering the importance of the One Health approach in prevention, combating and control of zoonotic diseases, the tripartite ministries, Ministry of Livestock and Fisheries, Ministry of Health and Ministry of Culture and Tourism (through the Ethiopian Wildlife Protection Authority), in collaboration with development partners (FAO, USAID, CDC, Ohio State University and other partners) established a national One Health Platform (OHP) with various technical working groups. Since the national OHP was established, various activities have been undertaken. One of the tasks was developing a list of priority zoonotic diseases as an entry for a multi-sectoral joint action to reduce and combat the impact of zoonotic diseases on public and animal health as well as on the national economy. The national zoonotic disease prioritization was conducted using a tool developed by CDC and resulted in 5 priority zoonotic diseases for inter sectoral collaboration of which Rabies and Anthrax are the two top priorities.

Following the development of the list of priority zoonotic diseases, the three ministries, in collaboration with development partners planned to formulate strategies for the prevention and control of Anthrax through a One Health approach. Thus currently a National Strategy for the Prevention and Control of Anthrax was developed by the national anthrax technical working group. Anthrax is an endemic disease in Ethiopia which occurs mainly in May and June every year ('anthrax season') in several farming localities of the country, causing disease both in humans and livestock. Recent surveillance data (2009 to 2013) showed, a total of 5,197 human cases were reported with 86 human anthrax deaths (Case Fatality Rate: 1.7 %). Moreover, from 2014 -216, a total of 2,218 human anthrax cases with a case fatality rate of 3.16% were reported. In livestock from 2009 to 2016 a total of 71,360 cases were reported from which 12,217 animals died with the disease.

To date in both public and animal health sector, outbreak reports of anthrax are based on history and clinical signs and there is no laboratory confirmed cases at either the regional or national level. National Animal Health Diagnostic and Investigation Center's (NAHDIC's) experience for the diagnosis of anthrax is limited to polychrome Methylene blue staining techniques (M'Fadyean stain), that is through staining blood smears from peripheral blood vessels and observing the square ended, blue rods in short chains surrounded by pink capsule through direct microscopy. Apart from this, confirmatory diagnostic

capacity either with molecular techniques (PCR) or through culture using gamma phage is not yet established.

In addition to limitations in confirming anthrax, biosafety and biosecurity issues are also of major concern for culture and identification of Bacillus anthracis at the national and regional veterinary and public health laboratories. There is no harmonized SoP for collection, transportation and handling of samples from anthrax suspected cases and confirmatory test protocol for Bacillus anthracis diagnosis at all level in the country. In addition, laboratory staff's at regional and national level are not well experienced and trained on confirmatory diagnostic techniques of anthrax.

Thus, currently Ethiopia has developed national strategic plan aimed to significantly reduce and ultimately control the public health impact of anthrax in humans and animals in the country through sustained surveillance, laboratory diagnosis, prevention and control systems and community awareness. The vision is to ensure anthrax is no longer a significant public and animal health problem in Ethiopia by 2030. The guiding principle was that Prevention and control of anthrax in animals effectively reduces its impact on public health and the national economy

Hence, in order to achieve this national plan improving the national and regional animal and public health laboratory capacity for anthrax diagnostics is very important. As I am currently member of the national anthrax technical working group and coordinating bacteriology laboratory at the national animal health referral laboratory this will be great opportunity for me to attend basic skill and knowledge and upgrade our labs capacity to isolate and identify Bacillus anthracis.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

During the fellowship period I have planned to be familiar with advanced diagnostic techniques of Bacillus anthracis like culture and identification with gamma phage, identification with PCR and sequencing of the isolates. If possible I can collect samples from anthrax suspected cases of animals and process the samples at US labs or if transporting anthrax suspected cases to US is impossible I may process samples provided by US laboratories. Our laboratory has future plan of conducting confirmatory test for anthrax at National level hence, the experience that I will gain will be useful to strengthen the diagnostic capacity of NAHDIC. It will be a pleasure for me to work with senior researchers at USA Universities and Research centers. This will be more useful when I return back to my home country and where I will apply the knowledge and skill I have acquired for establishing anthrax diagnostic capacity at national and regional lab level in Ethiopia

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

Improving livestock productivity through providing appropriate animal health services in the country could play a vital role in Ethiopia's poverty reduction, sustainable economic growth and food security programs. I anticipate that, the outcome of this work will give insights in to the different pathways that would impact on the sustainable prevention and control of anthrax in the country and significantly contribute to the achievements of growth and transformation plan (GTP II) of the country.

Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

University and Laboratory orientation and staff introduction on week 1 and 2

Attend practical training on anthrax culture and phage typing on week 3 and week 4

Perform culture, isolation and identification of samples by phage typing on week 3 and 4

Attend practical training on identification of Bacillus anthracis by PCR and genotyping (sequencing of Bacillus anthracis) from week 5 to 8

Conduct genotypic characterization of Bacillus anthracis from week 5 to 8

Compile the result and prepare report on week 9 and 10

Conduct capacity building training on anthrax diagnosis for Experts at National labs of Ethiopia and expand to regional lab experts on week 11 and 12

Expected outcomes are: after accomplishing the research collaboration Bacillus anthracis isolates causing anthrax outbreaks in Ethiopia will be characterized for the first time, the national animal health laboratory will be capable of isolating and identifying Bacillus anthracis from disease outbreaks occurring in the country and capacity building training will be organized for regional and national laboratory staffs on anthrax diagnosis. All this activities will support the successful implementation of the national strategic plan on prevention and control of anthrax in Ethiopia.

Material, equipment and laboratory consumables for Bacillus anthracis isolation, identification and molecular characterization are expected to be arranged by the program organizers.

Fellow #6, Ethiopia, Male/ NOFO: USDA-FAS-10777-0700-10.-18-0036
"To implement molecular plant breeding (MPB) to enhance the efficiency of developing high-yielding wheat cultivars with durable stem rust (SR) resistance varieties for Ethiopia."

1. Goal

My goal is to use molecular plant breeding (MPB) to enhance the efficiency of developing high-yielding wheat cultivars with durable stem rust (SR) resistance for Ethiopia.

2. Specific Objective(s)

My objective is to learn how to use genome-wide association studies (GWAS) and genomic selection (GS) so I can 1) identify genes associated with durable SR resistance and 2) develop GS models for SR resistance, yield, and other key traits.

3. Background Information

Increasing food production in developing countries against the background of rapid population growth, malnutrition and the depletion of natural resources remains an ever-present food security challenge. Wheat is one of food security crop in Ethiopia and cultivated on 1.6 million hectares of land with a production of 3.9 million metric tons. About 4.6 million smallholder farmers engaged on wheat production in Ethiopia. However, average yield is low due to biotic and abiotic stresses. A major biotic stresses is stem rust (SR, Puccinia graminis f.sp. tritici). Host resistance is the primary means of controlling. Resistance to SR can be imparted by single genes that confer complete resistance to specific races. There is also race non-specific, adult plant resistance (APR) that is controlled by genes with small to moderate effect. Controlling SR with single genes is relatively easy using marker-assisted selection (MAS) to efficiently breed and combine the genes into new cultivars to obtain resistance to multiple races. Unfortunately, the single genes are quickly defeated by the evolving pathogen, thus requiring a continual search for new genes and monitoring pathogen populations to predict which genes will be effective. For SR, the UG99 lineage of races in East Africa have displayed virulence on many currently deployed Sr genes and new races are evolving, such TKTTF race that caused a 2013-14 epidemic in Ethiopia where nearly 50% of the acreage was planted to a susceptible variety.

Traditional breeding is effective but inefficient for several reasons. First, a breeding cycle can take many years from the time a cross is made, progeny generated, seed increased, and sufficient testing executed to produce heritable phenotypes required for selection: this limits genetic gain per season. Next, variety development requires phenotyping many lines to find one that is acceptable for all traits. This is very expensive for multiple traits that require testing over multiple sites and seasons. The early stage of phenotyping (stage-1) is characterized by evaluating 1,000s of lines in few environments such that selection at this crucial stage is primarily based on phenotypic data that may have low heritability and poor predictive value.

The use of biotechnology tools will greatly accelerate the development and release of new cultivars to growers. Thus growers will have faster access to new germplasm with better disease resistance and yield. The breeders will be able to better respond to new challenges. This will improve the economic situation for farmers that depend on wheat farming. Molecular Plant Breeding (MPB) can mitigate the limitations

of traditional plant breeding. GWAS can be used in complex populations to identify markers for key APR genes for use in MAS to rapidly breed them into elite lines. Genomic selection can be used for genes with small effects on SR and yield. In GS, a training population (TP) is phenotyped and genotyped. That data is used to create a model that is used to predict the value of individuals that are related to the TP. The predicted values (termed genomic estimated breeding values, GEBV) are used in selection either in lieu of observed phenotypes, or as a supplement to the phenotypes. Using GEBVs in selection can greatly shorten the duration of a breeding cycle by eliminating the inbreeding, seed increase, and phenotyping steps: this can increase genetic gain per season compared to phenotypic selection. Stage-1 lines can be genotyped and selection can be done using GEBVs thus eliminating stage-1 trials. This can save money as genotyping can cost less than phenotyping multiple traits. In addition, the GS prediction model can be created using data from multiple locations and seasons, thus leveraging data from all trials to select stage-1 lines that would otherwise be selected based on very limited trialing data. If stage-1 trials are conducted, then GEBVs can be combined with phenotypes to enhance selection.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

This fellowship will train me in the statistics, procedures, and operational steps needed to execute GS and GWAS within the Ethiopian Institute of Agricultural Research (EIAR) wheat breeding program and begin to fully integrate MPB into our program. These learning goals are very relevant to my objective of improving the efficiency of breeding for SR and yield. Both GWAS and GS have been successfully applied to yield and SR resistance and could have a dramatic impact EIAR wheat breeding. This is especially relevant as centralized marker services have been established for major genes (HTPG at ICRISAT, India) and genome-wide markers (IGSS at ILRI, Kenya). The fellowship will give me the knowledge to use these services effectively and to implement MPB. I have a strong background in plant breeding; I know the principles of marker-assisted selection. My US mentor has expertise applying MAS, GWAS and GS within a variety development program.

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

Wheat is a major crop in Ethiopia, yet the yield is low and SR epidemics threaten food security. Breeding can address these problems but traditional approaches are inherently inefficient. MPB can address three significant sources of the inefficiency: 1) the long duration of a breeding cycle, 2) the cost and practicality of accurately phenotype 1,000s of lines in early stages, and 3) the ability to infer genetic values from phenotypes. The US mentor has experience in using MPB to address all three of these issues. I will learn this technology and return to apply it to wheat breeding in Ethiopia where I will also lend my expertise to breeders of other crops. This should result in the more rapid release of high yielding cultivars with durable pest resistance and be a great economic benefit to Ethiopian farmers and the people they serve.

Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

For the fellowship, I’m planning 12 weeks of activities to learn in detail the new science of genome-wide association studies (GWAS) and genomic selection (GS) under the supervision of US mentor. I am also

design the next work plan of the research activities after this fellowship to implement the knowledge and experience obtained to my wheat breeding program to serve the resource poor farmers by developing high yielding and rust resistant wheat varieties.

I - Weekly plan for the fellowship
Week 1: Arrive in US, settle into housing, town, University, and get to know the Ohio State University wheat breeding team. Assessment of current EIAR wheat breeding program.
Week 2: Basics of quantitative genetics and introduction to R software: set up on computer, basic programming in R
Week 3: Analysis of phenotypic data with emphasis on testing large sets of lines
Week 4: Analysis of current phenotypic data for SR and yield from past trials
Week 5: Introduction to GWAS using GAPIT: Principles, theories and practices of GWAS; access data files, imputation of missing data, choice of model
Week 6: Assessing diversity of populations. Running GAPIT: Learn the output files and their interpretation, selection of genes and QTL
Week 7: Advanced GWAS models such as SUPER, write up results from analysis
Week 8: Introduction to genomic selection. Principles, theory and practices
Week 9: Use of rrBLUP package to obtain GEBVs
Week 10: Use of BLR package to obtain GEBVs
Week 11: Integration of results from GWAS and GS into the EIAR breeding program: Integration of MAS and GS into program
Week 12: Summarize results and write report on results, experiences, concepts learned

II- Future Research Action Plan

The project will work with phenotypic and genotypic data from three populations

1. A set of ~900 lines from the wheat portion of the CIMMYT Seed of Discovery program (SeeDs). These lines are derived from a linked-top cross population and are 25% exotic pedigree. The lines are derived from 182 three-way crosses (elite1/exotic1//elite2). Twenty-six elite lines were used in the crossing. The result is a selected set of lines with adapted height, and maturity that possesses great diversity. They will be used to search for new APR or single genes for SR resistance as diverse wheat lines have been shown to possess novel genes for SR resistance. Some of these have been screened for SR resistance in other countries and that data will be made available to us by CIMMYT. We will supplement existing SR data for this population with data generated by EIAR. All lines have been genotyped with the DArTseq genotyping-by- sequencing technology and 7,180 SNPs have been obtained after filtering.

2. A diverse set of 376 bread wheat lines adapted to East Africa obtained from CIMMYT by EIAR. This set is being phenotyped for morphological traits and for resistance to Septoria tritici by EIAR. These will be genotyped with DArTseq technology by the Integrative Genotyping Service and Support (IGSS) program.

3. A set of 376 breeding lines from the EIAR wheat program based in Kulumsa station. The lines are adapted to East Africa and are selections made from past crosses involving elite local, CIMMYT, and ICARDA parents. These lines have been screened for maturity, height, thousand kernel weight, yield and resistance to SR and Yellow Rust. They will be further evaluated for these traits. These will be genotyped with DArTseq technology by the IGSS program.

All lines will be phenotyped for SR resistance in an SR hotspot (Kulumsa, Debrezeit, Arsi-robe and Sinana) with high levels of natural infection. We will have three replications per season. Stem rust

severity will be estimated as a proportion of the stem of the plant affected by the disease, where 0% = immune and 100% = completely susceptible. Severity will be recorded from the time of disease appearance until the crop attains physiological maturity. Host plant response to infection will be scored using the description of Roelfs et al., (1992), where, immune = 0.0, R= 0.2, MR= 0.4, MR-MS= 0.6, MS = 0.8, MS-S= 0.9 and
S= 1.0.

The phenotypic data will be analyzed first within a location and trial to assess the need to remove outlier observations. Data from individual trials will be combined as feasible so analyses of multi-environment trials (MET) can be executed. The emphasis from the MET analyses will be 1) analysis of GxE interactions using clustering and Additive Main Effect and Multiplicative Interaction (AMMI) models and 2) assessing stability of line performance using regression, AMMI, and variance approaches. Collectively the phenotypic analyses will be used to generate the most reliable value for use in GWAS and GS.

Population 1 has already been genotyped with DarTSeq markers. We will genotype populations 2 & 3 using the same technology at the IGSS facility at the BecA-Hub, ILRI in Nairobi. The IGSS is a Bill & Melinda Gates Foundation funded partnership between DArT and ILRI to bring high throughput, dense, genotyping-by-sequencing based genotyping capacity to breeders in Africa. The IGSS lab can execute all of the genotyping, bioinformatics, and analytical support needed for this project. The wheat lines will be genotyped for major Sr genes (possibly Sr2,22,26,35,42,tmp,Cad) using the HTPG facility at ICRISAT in India when that panel is assembled, tested, and verified. Note: the genotyping of populations 1 & 2 will be heavily subsidized by IGSS.

The genetic data will be used to assess diversity and population structure within each population. That information will be used to inform the other analyses. The phenotypic and genotypic data will be combined to execute GWAS and GS analyses. The GWAS will be executed using the GAPIT package in R.
From the GWAS we will assess marker significance, r2 values, and additive effect. Results will be compared between populations and where possible to information in the literature. The analysis will identify putatively novel Sr and APR genes as well as document the frequency of Sr and APR genes in these populations. The analyses will identify genomic regions that can be targeted for MAS to introgress useful genes into wheat cultivars adapted to Ethiopia.

The accuracy of GS will be assessed using cross-validation. We will also see if a model built on one population can predict values in the other populations. The results will allow us to assess the utility of GS for SR resistance and other traits in these populations and within the EIAR wheat breeding program (via population 3).

All cost related to field phenotype and genotype for this project will be covered by EIAR and IGSS.

Fellow #7, Ghana, Female/ NOFO: USDA-FAS-10777-0700-10.-18-0037
"Developing a technology for utilizing spent mushroom substrates (SMSs) as sustainable fertilizers for cocoa cultivation."

1. Goal

The goal of my research is to develop a technology for utilizing spent mushroom substrates (SMSs) as sustainable fertilizers for enhanced productivity in cocoa cultivation and economic development in Ghana.

2. Specific Objective(s)

Specific objectives of proposed research: to investigate some biochemical properties of SMSs of 3 mushroom species; determine the effect of SMSs of the mushroom species on microbial quality and physico-chemical properties of the soil; and establish effect of SMSs of the 3 mushroom species at different concentrations on germination, growth and nutrient composition of cocoa seedlings (2 varieties used in Ghana) for developing a technology for utilizing SMSs of the 3 mushroom species as sustainable fertilizers for cocoa cultivation.

3. Background Information

Several cocoa cultivation areas in Ghana are located in the forest zones, surrounded by mainly farming communities, some of which have timber industries. Efforts to minimize environmental pollution while improving livelihoods and reducing malnutrition has included establishment of mushroom cultivation industry in some of these communities because of availability of sawdust from the timber industries. Mushrooms are usually cultivated on various agro-industrial "wastes" including sawdust, rice straw and cassava peels supplemented with rice bran and quick lime. When used for mushroom cultivation, these agro-industrial "wastes" are called substrates (1, 2). After harvesting mushrooms from substrates for some time, either little or no mushrooms fruit (sprout) on the substrate. At this point, the substrate is referred to as spent mushroom substrate (SMS). SMS contains nutrients and biochemical compounds such as enzymes and siderophores, which can further be utilized to maximize the agro-industrial value chain

(3). Cocoa is a major contributor to Ghana's economy. Low soil fertility impacts very negatively on cocoa yield

(4). As such, soil fertility in cocoa cultivation is of utmost importance. It is therefore essential to explore several sustainable (readily available, cost effective, safe and environmentally friendly) options for improving soil fertility for cocoa cultivation. Therefore, determination of SMSs of specific mushroom species which are efficacious as sustainable fertilizers for specific varieties of cocoa will result in a technology which will enhance cocoa productivity for income and economic development for most stakeholders in the cocoa industry.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

I produced mushroom hybrids on my research attachment at Laboratoire des Symbioses Tropicales & Méditerranéennes to compare some biochemical properties of the parent and hybrid strains. Additionally, I investigated the efficacy of cultures of the parent and hybrid mushroom strains as biofertilizers for wheat and tomato cultivation. Results of this study were very encouraging as we proved that efficacy of mushroom species as biofertilizers are both mushroom and plant species-specific. Also, our team realized that mushroom parent and hybrid strains had different effects on microbial activity of tomato cultivation substrate after plant harvest. However, we did not identify the microbes present in the tomato cultivation substrate after harvest. As different microorganisms have been reported to have either beneficial (e.g. growth promotion) or detrimental (e.g. pathogenicity) effects on plants, it is very relevant to identify the kind of microorganisms whose growth are either promoted or suppressed by mushroom cultures. Moreover, I was a resource person on several training workshops held both within and outside my Institute for various individuals and groups on mushroom cultivation technology. On the Australian Government funded project I am leading, which will end in February 2018, I am empowering women and girls by establishing mushroom cultivation industry in 2 communities in Ayum Forest Area. Major economic activities of these communities include cocoa cultivation and timber production. This proposed research will be a significant expansion of the research I conducted during the attachment and will be novel for cocoa cultivation in Ghana. Furthermore, I can eventually transfer the technology developed during the fellowship in the communities around the Ayum Forest Area to facilitate adoption of the technology.

I hope to hone my technical and soft skills, improve my network base and team-work through collaboration with my U.S mentor, other members of her/his team and participation in other activities on the fellowship. Some practical experience I plan to improve include experimental design and bioassay, chromatography, molecular and bioinformatics techniques using state-of-the-art equipment and software, available to my U.S mentor, which will enhance my ability to conduct relevant internationally competitive research both during and after the fellowship. Additionally, I plan to improve my (scientific) writing through journal and other publications from results obtained during the fellowship in liaison with my U.S mentor.

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

Utilization of the technology of SMS as sustainable fertilizers for cocoa cultivation would extend the agro-industrial value chain, minimize improper disposal of SMSs, thereby reduce environmental pollution related socio-economic problems. Moreover, expenses and risks associated with use of chemical fertilizers by cocoa farmers and other stakeholders in the cocoa industry would be minimized with use of SMSs as fertilizers for cocoa cultivation. The process of SMSs for cocoa cultivation utilization could also create jobs and (alternative) income streams for youth and other actors in the mushroom and cocoa industries in Ghana. Hence, there would be an improvement in economic status of most stakeholders in these industries. It is expected that utilization of SMS would consequently result in improved growth rate and yield of cocoa beans for enhanced productivity in cocoa cultivation in Ghana. Utilization of the outputs of this proposed research would ultimately have a positive impact on economic development of Ghana

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Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

The proposed weekly workplan for the time spent in the U.S. institution are as follows:

Week 1:

Participation in university and laboratory orientations and staff instructions; discussions with U.S. mentor to modify and/or finalize experimental design and work plan; pre-experimentation preparations such as location of materials and consumables, media preparation, etc

Weeks 2 - 4:

Preparation of soil for cocoa seed sowing using SMSs of 3 mushroom species at different concentrations in nursery/greenhouse under shade; Sowing of cocoa seeds (2 varieties) in nursery/greenhouse; soil sampling and analyses of microbial loads and microbial diversity using both cell culturing and molecular identification techniques, data collection, analyses of results obtained

Weeks 5 - 7:

Extraction and analyses of some fungal biochemical compounds (e.g. siderophores, ergosterol, etc) in

SMSs of the 3 mushroom species used as well as the soils prepared for cocoa seed sowing using chromatography and other techniques; determination of soil pH and other physico-chemical characteristics; Analyses of results obtained; drafting of report

Week 8:

Determination of nutritional profile (especially potassium, nitrogen and phosphorus content) of SMSs of the 3 mushroom species used as well as the soils prepared for cocoa seed sowing using Atomic Absorption Spectrophotometry (AAS) after microwave digestion and AOAC methods; Analyses of results obtained; drafting of report

Week 9:

Harvest of cocoa seedlings (at 8 weeks); investigation of cocoa seedling growth parameters (e.g. root and shoot length, root and shoot biomass, leaf number and size, etc); preparation of media for cell culturing; analyses of data, drafting of report

Week 10:

Analyses of microbial loads and microbial diversity of the soil used for cocoa plant sowing after seedling harvest using both cell culturing and molecular identification techniques, data collection, analyses of data; drafting of report

Weeks 11-12:

Determination of nutritional profile (especially potassium, nitrogen and phosphorus content) of the leaves of the seedlings obtained using AAS and AOAC methods; analyses of nutrient composition and other physico-chemical characteristics of soils used for cocoa seedling production; Analyses of results obtained; drafting of report. My U.S mentor (and her/his team) and I will also have periodic meetings on need bases and depending on her/his availability.

Some equipment and consumables which will be needed for specific aspects of the proposed research include

1. Cell culturing for determination of microbial loads – (Selective) culture media, distilled water, PBS, vortex, glass beads or any other cell spreader, pipettes, pipette tips, test tubes, eppendorf tubes, disposable petri dishes, ethanol, cotton, medium sized latex-free disposable gloves, incubators, autoclave, colony counter, permanent marker, glassware, pH meter,etc

2. Molecular identification – Shaking incubator, heat block, water bath, (micro)centrifuges, Gel Electrophoresis equipment and consumables, FastPrep Instrument with the spin kits (both for soil and general purpose), Thermal Cycler, DNA ladder, Tris-acetate-EDTA buffer, ethidium bromide, agarose, UV Camera and transilluminator connected to PC, relevant primers, buffers, bovine serum albumin, Taq DNA polymerase, 1.5 ml eppendorf tubes, snap cap PCR tubes, pipettes, pipette tips, medium sized latex-free disposable gloves, DNase, ice bucket, MiliQ distilled water, permanent marker, pH meter,etc

3. Nutritional, biochemical and other physico-chemical characteristic determination – High Performance Liquid Chromatography (HPLC) equipment and consumables (Symmetry® C18 5 µm reverse-phase column, Photodiode Array Detector, HPLC grade solvents, etc), Microplate Absorbance Reader / spectrophotometer, sonicator, Fast Protein Liquid Chromatography (FPLC) system with consumables, microwave digester, certified reference materials, Atomic absorption spectrophotometer with Xenon lamp for multi-element analyses, pH meter, 96-well plates, multi-channel pipette, culture media, cyclohexane, potassium hydroxide, methanol, distilled water, medium sized latex-free disposable gloves, glassware, permanent marker, etc

4. Plant growth parameters determination – Weighing scale, SMSs of 3 mushroom species, soil, black bags (about 30cm high and 20cm wide) for sowing cocoa seeds, sample labeller, permanent marker, greenhouse with shade, zip-lock bags, plant root scanner, image analyses software,etc.

By the end of my stay in the U.S institution, I would have

1. obtained data about some biochemical properties (such as mineral, siderophore and ergosterol content) of SMSs of 3 mushroom species which could affect soil fertility and both root and shoot growth as well as leaf nutritional profile of 2 varieties of cocoa seedlings;

2. deciphered the effect of different concentrations of SMSs of the 3 mushroom species on the growth and nutritional profile of cocoa seedlings as well as the nutritional profile and microbial quality of the soil for cocoa sowing both before sowing and after harvest of the seedlings obtained;

3. established the correlation (if any) among the studied biochemical properties of SMSs of the 3 mushroom species, the nutritional, biochemical and other physico-chemical characteristics and microbial quality of the soil used for cocoa sowing both before sowing and after harvest of the seedlings, and growth parameters of the seedlings of the studied cocoa varieties;

4. determined the optimal concentration(s) of the SMSs of each of the 3 mushroom species which is most suitable for use as sustainable fertilizers for the two varieties of cocoa studied based on the results of all the experiments carried out. This will essentially be the technology developed for utilizing specific SMSs as sustainable fertilizers for cocoa cultivation; and

5. considerably drafted at least one research article from results obtained from this proposed research for publication in (a) reputable high impact factor journal(s) in order to disseminate the knowledge gained during the research to the scientific community and other readers. The Borlaug Fellowship will be duly acknowledged in all research outputs of the fellowship including journal publication(s).

The expected overall outcome of this proposed research is enhanced productivity in cocoa production which will result in improved economic status of cocoa farmers and other stakeholders in the cocoa industry in Ghana as well as the economy of Ghana as a whole through utilization of SMSs as sustainable fertilizers in cocoa cultivation.

In addition, I expect that by the end of the fellowship period, there would be a significant improvement in my technical, inter-personal, and soft skills (such as communication, team work, and networking) through the practical experience and exposure gained on my fellowship. This will better place me as a professional in academia.

Fellow #9, Liberia, Male/ NOFO: USDA-FAS-10777-0700-10.-18-0039
"Assessing growth and yield performances of cocoa in Agroforestry (Intercropping) system."

1. Goal

The goal of my research is "To assess and evaluate the intercropping system that will provide optimum shade for cocoa cultivation in Liberia in order to enhance cocoa yield".

2. Specific Objective(s)

-To evaluate Terminlia ivorensis effect on cocoa budwood garden growth performance.

-To compare and evaluate intercropping techniques of cocoa clones budwood garden in the united state

-To assess and observe other intercropping systems for cocoa cultivation.

3. Background Information

The cacao (Theobroma cacao L.) is native to the undergrowth of the Amazon forest. This is why, since its introduction in Liberia, as in many other countries, farmers have grown cacao under shade trees in order to create light conditions that are similar to those found in native forests To obtain these light conditions, several techniques have been developed: under managed natural forest, under natural regrowth or under artificial shade. The plant species associated with cacao provide food, wood and medicinal treatments. The combination of multiple plant species in cacao plantations to diversify and support household production for greater social, economic and environmental benefits meets the definition of agroforestry. In cocoa research in Liberia, intercropping cocoa with plantain, Gliricidia sepium and Terminalia ivorenesis (timber crop) is being introduced and factored in the cocoa rehabilitation process of farms without proper research findings on the planting distance, canopy spread, allo-chemical effects and planting design. It is well documented that timber crop like Treminalia ivorenesis and plantain do well when intercropped with cocoa in Ghana and Nigeria due to the fast growth nature. With the eyes browse raising threat of climate change; researchers determine to research the proper intercropping planting knowledge for farmers which will enable them to adequate attain optimum yield. Therefore, this intercropping research will provide reliable information that will fill the gap of unavailability of cocoa intercropping knowledge in Liberia for farmers in order to increase cocoa yield for economic gain.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

My research activities during the fellowship will widen my scope in Tree Crops research and gives me the ability to design yieldable cocoa intercropping system which will be best for Liberia's cocoa sector. During my fellowship, I hope to unveil the impact of shade trees on cocoa growth, how optimum shade or intercropping can lead to optimum cocoa yield and the best way such can be incorporated in Liberia's cocoa agroforestry system. This is what I intent to accomplish. As an agronomist and someone who has been working in the cocoa sector of Liberia, my proposed research will adequately impact the smallholders in the sector and thereby address the research gap in the cocoa sector with the knowing goal

“To assess and evaluate the intercropping system that will provides optimum shade for cocoa cultivation in Liberia in order to enhance cocoa yield”. Achieving such goal, the need for a scientific mentor is vital in providing guidance and direction in this regards. The mentor experienced in intercropping and conducting such research will shift and impact my research direction in a positive way meeting the goal of the research.

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

The need to enhance Agricultural productivity in any giving country is triggers via agricultural research that leads to productivity. Therefore, with the understanding of the Borlaug Fellowship, one can say that it is vital in contributing to agricultural research gap filling which will cause farmers to acquired high crop yields due to research findings. Notably, the cocoa sector in Liberia will only boom if needed research is done on constraints that affects cocoa growth performances. Due to this, the Borlaug fellowship will address the research gap smallholders faced in knowing the best intercropping system and techniques that can lead to optimum cocoa yield. This will thereby result to economic development and food security in Liberia.

Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

Week 1

Planned activity: Meeting and introduction to mentor; getting to know research facilities and orientation.

Outcome: Identified intercropping plant to be used.

Week 2

Plan activity: Presentation on my on-going research (in Liberia) to my mentor and other staffs.

Outcome: Mentor knowing research gap and cocoa sector in Liberia.

Week 3

Plan activity: Assessing intercropping cocoa data and reading related literatures

Week 4-8

Plan activity: Blocking cocoa research farm and taken data on plant growth parameters

Outcome: Complete data taken

Week 9-10

Plan activity: Field work conclusion

Outcome: 100% completed

Week 11

Plan activity: Data Analyses & presentation

Outcome: submission of research report

Week 12

Plan activity: Submitting research plan and timetable to mentor for home country research follow-up.
Outcome: Keeping in contact with mentor.

Fellow #12, Mozambique, Male/ NOFO: USDA-FAS-10777-0700-10.-18-0042
"Physiological and molecular responses to drought stress in maize."

1. Goal

To select elite genotypes for use in breeding programs of maize.

2. Specific Objective(s)

i. To screen the physiological variability of the response to drought stress among the maize cultivars.

ii. To evaluate the differential gene expression in response to drought in maize seedlings of different cultivars

iii. To produce transgenic plants overexpressing the genes selected in objective 2.

3. Background Information

Maize cultivars respond to drought stress differently. Some are more tolerant (i.e., they manage to survive drought stress) and others are less tolerant (in extreme situations they end up dying). My research focuses precisely on identifying (through biotechnology approaches) drought tolerant cultivars for use in breeding programs. Upon the identification, I will genetically modify the selected cultivars to enhance their ability to tolerate drought stress.

4. Describe what you hope to accomplish during your fellowship. How do your research interests and scientific background relate to the goals of your proposal? How will working with a mentor in the U.S. help you to achieve your research goals?

During my fellowship I hope to fulfill my strong desire to be trained in biotechnology techniques that will help me perform my scientific duties in Mozambique. If I get selected, I hope to finish the fellowship with skills in the physiology of drought stress and plant molecular biology techniques. Parameters such as leaf water potential, leaf gas exchange, chlorophyll fluorescence and leaf water content are of huge importance for the preliminary screening of the cultivars ability to tolerance drought stress. Secondly, and more important, I expect to gain a deep knowledge in molecular biology techniques, namely polymerase chain reaction, agaroses gel, plant transformation. I have a basic experience with PCR and gel, but since I am new to molecular biology, I feel I need to reinforce my skills in order to develop the capacity to think and work both independent and creatively in plant molecular biology. My scientific background on this field relies on the practical lectures I attended during the first year of my PhD studies, where we basically performed PCR and run agaroses gel. I also had theoretical lessons and presentations on plant transformation, but I did not have too much hands-on work in this matter. U.S. universities are known worldwide for their excellence in science and especially in biotechnology. In light of this, I am sure that working with a mentor in the U.S. will help me to improve my skills in plant biotech, especially the development of drought tolerant plants.

5. How will a Borlaug Fellowship contribute to enhanced agricultural productivity, economic development, and/or food security in your country?

First, I am a lecturer at the Eduardo Mondlane University. At this university, we have a tight and close relationship to the rural communities: through our knowledge extension programs we share the results of our research. A Borlaug Fellowship would help me sharpen my research skills in plant biotech. As a well-trained lecturer and researcher, my work will impact a huge number of students and farmers and through them the skills will be spread throughout the country to other people, namely students, farmers, policymakers and scientific fund donors. Through this network, capacity would be built in the country to boost crop production, food security and economic development.

Provide a weekly list of activities that links to your proposal's goals and objectives. Note that part of the first week is generally used for university and laboratory orientations and staff introductions.

Week 1: Introduction to the university, lab and staff.
Refinement of my research proposal with my mentor.
Planning the specific activities to be developed in the following weeks

Week 2: Setting up the experiment
Main materials: seeds of at least five different maize cultivars, plant growth chambers and related facilities.
Outcome: I expect to have seedlings by the end of the week.

Week 3 to 4: Beginning of data collection.
Measurements of physiological parameters that will help us preliminarily evaluate which cultivars have a better performance than others in drought conditions.
Parameters: chlorophyll fluorescence, gas exchange and plant water relations
Collection of leaves for molecular biology analysis
Outcome: after the data analysis, I will be able to select elite genotypes for further analyses in the following weeks. Another important outcome for me will be to have a manuscript on these preliminary results submitted for publication.

Week 6 to 12: Evaluating the expression profile of drought-stress related genes.
Outcome: to submit a manuscript on the molecular diversity of the response to drought stress among the cultivars.
Plant transformation
Evaluation of the improvement in the tolerance to drought stress of the transgenic plants produced in the previous step.
Note: I have the notion that plant transformation is a time consuming process, but I am highly interested in having theoretical and practical experience with this process.