NORMAN E. BORLAUG INTERNATIONAL AGRICULTURAL SCIENCE
AND TECHNOLOGY FELLOWSHIP PROGRAM

CGIAR BORLAUG FELLOWSHIP PROGRAM

FISCAL YEAR 2017 NOTICE OF FUNDING OPPORTUNITY
for
BORLAUG FELLOWSHIP PROGRAM 2017, CGIAR BORLAUG

Application Deadline: JULY 16, 2017 @ 11:59 PM EDT

Email: BorlaugProposals@fas.usda.gov; Adam.Carruthers@fas.usda.gov
Website: http://www.fas.usda.gov/programs/borlaug-fellowship-program

Catalog of Federal Domestic Assistance Number (CFDA) – 10.777

USDA Funding Opportunity Numbers:
1. USDA-FAS-10777-0700-10.-17-BSP1, Egypt, Water Management
2. USDA-FAS-10777-0700-10.-17-BSP2, Ghana, Sweet Potato Sensory
3. USDA-FAS-10777-0700-10.-17-BSP3, India1, GIS
4. USDA-FAS-10777-0700-10.-17-BSP4, India2, Improved Tilapia
5. USDA-FAS-10777-0700-10.-17-BSP5, Kenya1, RNA
6. USDA-FAS-10777-0700-10.-17-BSP6, Kenya2, Sweet Potato Beta-carotene
7. USDA-FAS-10777-0700-10.-17-BSP7, Malaysia, Aquafeed
8. USDA-FAS-10777-0700-10.-17-BSP8, Morocco1, Chickpea Leaf Miner
9. USDA-FAS-10777-0700-10.-17-BSP9, Morocco2, IPM
10. USDA-FAS-10777-0700-10.-17-BSP10, Peru, PVY
11. USDA-FAS-10777-0700-10.-17-BSP11, Philippines, CSA
12. USDA-FAS-10777-0700-10.-17-BSP12, Tanzania, Seed Movement
13. USDA-FAS-10777-0700-10.-17-BSP13, Uganda, Bean Germplasm

This announcement is also being distributed through USDA’s EzFedGrants system under the same funding numbers.
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ISSUED BY: USDA Foreign Agricultural Service, Office of Capacity Building and Development

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CDFA) NUMBER: 10.777.

CDFA TITLE: Norman E. Borlaug International Agricultural Science and Technology Fellowship

NOTICE OF FUNDING OPPORTUNITY TITLE: Borlaug Fellowship Program 2017, CGIAR Borlaug

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9. USDA-FAS-10777-0700-10.-17-BSP9, Morocco2, IPM
10. USDA-FAS-10777-0700-10.-17-BSP10, Peru, PVY
11. USDA-FAS-10777-0700-10.-17-BSP11, Philippines, CSA
12. USDA-FAS-10777-0700-10.-17-BSP12, Tanzania, Seed Movement
13. USDA-FAS-10777-0700-10.-17-BSP13, Uganda, Bean Germplasm

This announcement is also being distributed through USDA’s EzFedGrants system under the same funding opportunity number.


PROGRAM TYPE: New

AWARD TYPE: Cost Reimbursable Agreement for U.S. Universities

PROGRAM OVERVIEW, OBJECTIVES, AND PRIORITIES
The United States Department of Agriculture’s (USDA) Foreign Agricultural Service (FAS) announces the availability of funding through cost reimbursable agreements for the Norman E. Borlaug International Agricultural Science and Technology Fellowship Program (Borlaug Fellowship Program). These Fellows have been competitively selected based on research priorities, academic and professional accomplishments, commitment to Borlaug Fellowship Program goals, and leadership qualities. The Fellow’s proposal and research plan appears at the end of this notice. USDA recommends that the program begin in the fall of 2017; however, priority should be given to a time that is appropriate for the Fellow’s proposed research topic. The program’s duration should be 4 months unless otherwise indicated.

Each Fellow has a specific research topic. Here is a summary of the applicants and a brief description of their research topics:

1. Fellow #1, (Male); Egypt, Help the water policy planners to develop new methodologies to measure actual evapotranspiration.
2. Fellow #2, (Male); Ghana, Understanding Ghanaian and West African consumer sweet potato preferences for sweet potato in order to target sweet potato breeding efforts.
3. Fellow #3, (Female); India, Spatial planning for sustainable aquaculture development through Geographic Information System (GIS) modeling in India.
4. Fellow #4, (Female); India, Ex-ante gender impact evaluation of genetically improved Tilapia on farmers in Bangladesh and India will be conducted.
5. Fellow #5, (Female); Kenya, compare the genes expressed during the interaction of *P. infestans* – host (potato-tomato), as a way of understanding why host-specialization of the US-1 genotype still exists in East Africa.
6. Fellow #6, (Male); Kenya, Beta-carotene absorption in sweet potato.
7. Fellow #7, (Female); Malaysia, Novel aquafeed ingredients for fish meal substitutes in aquaculture feed formulation.
8. Fellow #8, (Male); Morocco, Study of genetic variability and population genetic structure of the chickpea leaf miner.
9. Fellow #9, (Male), Morocco, Research the best active ingredients that when used based on early pest detection by Pheromone traps in combination with an effective natural enemy, or other tactics may provide more comprehensive prophylactic and remedial treatments in the context of IPM.
10. Fellow #10, (Female); Peru, study evolution and diversity of *Potato Virus Y*
11. Fellow #11, (Male); Philippines, Climate Smart Agriculture; evaluate the effects of CSA practices and factors affecting adoption to support achievement of widespread adoption of CSA.
12. Fellow #12, (Male) Tanzania; understanding seed flow at the Lake Zone, Tanzania and its effect on quality of seed and spread of viruses.
13. Fellow #13, (Female); Uganda, Bean Germplasm; improve the quality of breeding output which aims at reducing hunger and poverty and improving nutrition through development and dissemination of resilient and nutritious bean (*Phaseolus vulgaris*) germplasm.

Section VII provides each Fellow’s proposal with background information and research plan.

This notice identifies the Borlaug Fellowship Program deadline, legislative authority, eligibility and proposal requirements, funding restrictions, cost share requirements, allowable and unallowable costs,
reporting requirements, program purpose and priorities, focus areas and recommended topics, application and submission information, application review, selection and notification process, agency program contact information, and mailing address.

**FEDERAL AWARD INFORMATION**

**AVAILABLE FUNDING:** Up to $50,000 for each award

**PROJECTED NUMBER OF AWARDS:** 13

**PERIOD OF PERFORMANCE:** 2 years
An extension to the period of performance may be permitted in certain circumstances. The awardee must request an extension at least 90 days prior to the end of the period of performance, including a justification to explain why the statement of work cannot be completed during the original period of performance.

**PROJECTED PERIOD OF PERFORMANCE START DATES:** between August 1, 2017 and January 1, 2018

**PROJECTED PERIOD OF PERFORMANCE END DATES:** between June 30, 2019 and December 31, 2019

**FUNDING INSTRUMENT:** Cost Reimbursable Agreement

**DEADLINE:** Applications must be received by July 16, 2017 by 11:59 p.m. Eastern Daylight Time. Applications received after this deadline will not be considered for funding.

**ELIGIBILITY CRITERIA**

**ELIGIBLE APPLICANTS:** Public and state controlled institutions of higher education.

FAS will accept proposals from U.S. state cooperative institutions or other colleges and universities and minority serving institutions (MSIs). Proposals from smaller academic institutions, MSIs (in particular American Indian, Alaska Native, Pacific Islander, Hispanic, Asian American, and African American institutions) are especially encouraged to apply.

A proposal from a consortium of organizations must be submitted as a single proposal with one U.S. institution serving as the lead and all other organizations as team members, when applicable. An individual mentor must be identified for each CGIAR Borlaug Fellow. A single mentor may not host two fellows simultaneously. The Principal Investigator (PI) and mentor must hold a position at an eligible U.S. institution.

FAS reviews proposed project costs to make certain those costs are reasonable and allowable per applicable federal regulations. This program is subject to the provisions of 2 CFR Part 200, grant, cooperative, joint venture, and cost-reimbursable agreement recipients/cooperators (including, universities, non-profits, States, Cities/Counties, Tribes, for-profits, and foreign organizations) are subject to Title 2 of the Code of Federal Regulations and other legal requirements, including, but not limited to:
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1. 2 CFR Part 25, Universal Identifier and Central Contractor Registration
2. 2 CFR Part 170, Reporting Subaward and Executive Compensation Information
3. 2 CFR Part 175, Award Term for Trafficking in Persons
4. 2 CFR Part 180 and Part 417, OMB Guidelines to Agencies on Government wide Debarment and Suspension (Nonprocurement)
5. 2 CFR Part 200, Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, as adopted by USDA through 2 CFR part 400.

University indirect costs for cost reimbursable agreements are limited to 10% of direct costs in accordance with 7 USC 3319a. A cost share or cost match is not required. Management and Administration (M&A) Costs are not allowable. In addition to the above mentioned, all recipients are subject to the Federal Award’s general terms and conditions, project narrative, and budget narrative, as well as the applicable authorization used to issue the Federal Award.

In addition to the above mentioned, all recipients/cooperators are subject to the Federal Award’s general terms and conditions, project narrative, and budget narrative, as well as the applicable authorization used to issue the Federal Award.

Section I: FUNDING OPPORTUNITY DESCRIPTION

A. PROGRAM DESCRIPTION
The Norman E. Borlaug International Agricultural Science and Technology Fellowship Program promotes food security and economic growth by increasing scientific knowledge and collaborative research to improve agricultural productivity. This program targets promising, early- to mid-career, English-speaking scientists and policymakers from developing or middle-income countries. Fellows spend 8-12 weeks in the United States and work one-on-one with U.S. scientists in their field. Mentors coordinate the Fellows’ training, and they visit the Fellows’ countries for 5-10 days before the training commences at the host institution and within 6-12 months after completion of the training in the U.S. to continue collaborative efforts.

During the program, the Fellows learn new research techniques, gain exposure to the latest scientific developments in various fields of agriculture, access fully-equipped laboratories and libraries, and learn about unique public-private partnerships that help fund agricultural research and science. Equally important, this program provides international scientists and policymakers with opportunities to establish long-term contacts with U.S. scientists and to apply newly gained knowledge from U.S. institutions to their country’s research and development programs.

B. PROGRAM RESPONSIBILITIES OF HOST INSTITUTIONS

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.
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.

Mentor Roles
- 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 conduct a preliminary visit to the Fellow’s institute to conduct an assessment of the facility to understand any strengths and constraints that the Fellow may face and to start the relationship with the Fellow.
- 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 conduct a preliminary visit to the Fellow’s institute to conduct an assessment of the facility to understand any strengths and constraints that the Fellow may face and to start the relationship with the Fellow.
- 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 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.

Mentor Preliminary Visit
- The mentor preliminary visit is a unique part of the CGIAR Borlaug Fellowship Program.
- The mentor will work with the Fellow to plan a preliminary visit to the Fellow’s country of employment. The trip should occur within 6 months of the Fellow’s arrival at the mentor’s institution.
- The mentor should use this trip to finalize the work plan and assess any strengths and constraints the Fellow may face.
- The PI should provide USDA/FAS with an agenda for mentor’s travel, including goals and objectives.
- The PI must consult with USDA/FAS prior to finalizing plans or purchasing plane tickets for the preliminary visit. Mentor’s travel information must be provided for emergency contact purposes and country clearance (if required by the FAS Overseas Office).
- The mentor should plan to meet with the USDA/FASAttaché or staff from the U.S. Embassy while they are traveling, if feasible. USDA/FAS can assist with coordination prior to the trip.

Mentor Follow-up Visit
- The mentor visit is an essential and unique part of the CGIAR Borlaug Fellowship Program. The reciprocal visit is required, not optional.
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 PI must consult with USDA/FAS prior to finalizing plans or purchasing plane tickets for the reciprocal visit. Mentor’s travel information must be provided for emergency contact purposes and country clearance (if required by the 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.

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.

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.

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 shall be calculated based on 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.

Emergency Health Insurance
- The host institution will purchase emergency health insurance for the Fellow for the duration of stay, as required for all J1 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.

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.
- 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.

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 to a local farm, processing plant, private industry, or other related industry 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. USDA/FAS will provide a report template.

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:
  - Explain and demonstrate local bus/transportation options
  - Explain cultural and legal expectations
  - USDA will provide a welcome and orientation packet for mentors

**Progress Reports**
- The Principal Investigator or Mentor will submit **semi-annual** progress reports. The Principal Investigator or Mentor will use Performance Progress Report (SF-PPR) to submit semi-annual progress reports.
- The Principal Investigator or Mentor will submit a final report to USDA/FAS within 30 days after the Mentor visit. USDA/FAS will provide additional guidance and a template for the final report.
- 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 cannot be paid if a progress report is past due, and will not be paid until the required report has been received.

**Financial Reporting**
- Financial reports will follow the Uniform Administrative Requirements for Grants and Agreements, 2 CFR Part 200.
- Invoices will use the Request for Advance or Reimbursement (SF-270).
- Invoices will be submitted electronically to SF-270InvoicesMailbox@fas.usda.gov and copied to the USDA/FAS program manager and USD/FAS program assistant.
- A summary of expenses that aligns expense totals to the agreement’s budget line items must be included.
- A detailed breakdown of expenses must be included with SF-270. Payment will not be processed without supporting documentation.
- A final invoice must be submitted within 90 days of the end of the period of performance for the agreement.
- Costs must be reported in accordance with the regulations that govern the agreement, and must follow the applicable Federal cost principles 2 CFR 200. The institution cannot be reimbursed for costs that are contrary to the specific terms of the agreement or are outside its scope.
- A Federal Financial Report (SF-425) must be submitted semi-annual and within 90 days of the end of the period of performance for the agreement.
- An invoice cannot be paid if a financial report is past due, and it will not be paid until the required report has been received.
SECTION II: APPLICATION AND SUBMISSION INFORMATION

A. ADDRESS TO REQUEST APPLICATION PACKAGE
This announcement contains all instructions and links to all forms required to complete the application. All applications must be submitted as PDF or Word documents. No mailed or facsimile submissions will be accepted. Email address is BorlaugProposals@fas.usda.gov.

B. CONTENT AND FORM OF APPLICATION SUBMISSION
Institutions may submit proposals to host more than one CGIAR Borlaug Fellow. Institutions interested in hosting one or more Fellows should submit a proposal following the guidelines below:

- Complete SF-424 Application for Federal Assistance for a single CGIAR Borlaug Fellow. USDA/FAS cannot accept applications for multiple fellows in a single application.
- 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.
- Provide a program budget using Standard Form -424A- Budget Information Non Construction Programs, including a detailed budget worksheet (see page 12).
- Provide a budget narrative. All line items should be described in sufficient detail to enable FAS to determine that the costs are reasonable and allowable for the project in accordance with federal regulations.
- If attendance at the World Food Prize in Des Moines, Iowa during October 2017 is feasible, then the Fellowship may be extended one additional week, not to exceed 13 weeks, to ensure the Fellow receives up to 12 weeks of training.
  - 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.
- Complete AD-3030, Representations Regarding Felony Conviction and Tax Delinquent Status for Corporate Applicants.
- Complete AD-3031, Assurance Regarding Felony Conviction or Tax Delinquent Status for Corporate Applicants
- Complete the Host University Administrative Checklist on university administrative policies
If not submitting applications through the ezFedGrants portal at https://grants.fms.usda.gov, submit all application materials as attachments to a single email.

- The primary document submitted in response to this NOFO with all information requested should be titled Statement of Work.
- Include all application information that is not a specific form in a single PDF document.

Successful applicants will be required to submit all relevant national certifications and compliance documents prior to awards being issued.

C. UNIQUE ENTITY IDENTIFIER AND SYSTEM FOR AWARD MANAGEMENT (SAM)

All applicants are required to:

1. Be registered in SAM before submitting its application;
2. Provide a valid DUNS number in its application; and
3. Continue to maintain an active SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by a Federal awarding agency.

FAS 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 FAS 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.

FAS is using ezFedGrants, which is an electronic grants management system. Applicant(s) with electronic access are to submit their applications electronically through: https://grants.fmmi.usda.gov. As stated above 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. The registration process can take approximately four 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.
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D. 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 GrantorHelpdesk@fas.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 GrantorHelpdesk@fas.usda.gov.

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 GrantorHelpdesk@fas.usda.gov.

FAS 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 FAS is ready to make a Federal award, FAS 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.

E. SUBMISSION DEADLINES AND TIMES

Submit all application materials in a single email. Include all application information that is not a specific form in a single PDF document. The following forms are required: SF-424, SF-424A, AD-3030, and AD-3031. The primary document submitted in response to this NOFO with all information requested should be titled Statement of Work.

Funding opportunities will be distributed through ezFedGrants and advertised via the USDA/NIFA listserv. All proposals must be submitted through the ezFedGrants portal at https://grants.fms.usda.gov or to the email address below with all required forms. Proposals not submitted by the stated deadline will not be accepted.

CGIAR Borlaug Fellowship Program Proposal Email: BorlaugProposals@fas.usda.gov and Adam.Carruthers@fas.usda.gov

F. FUNDING RESTRICTIONS

Allowable Costs:
To help in this review and to expedite the award process, budgets must include a narrative detailing all line items. The categories listed below are examples of some of the more common items found in project budgets. All 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.

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.

6. Tax Withholding:
CGIAR 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 CGIAR 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; capital improvements; thank you gifts, and other expenses not directly related to the project are not allowed.

G. OTHER SUBMISSION REQUIREMENTS
All applications must be submitted electronically as indicated above.
HOST UNIVERSITY ADMINISTRATIVE CHECKLIST

Please complete the following checklist concerning the university’s policies on providing per diem funds to exchange visitors. This information is for USDA internal use only and does not determine your eligibility to serve as a host institution.

<table>
<thead>
<tr>
<th>Host University Policies</th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>Will the mentor listed in the proposal be present for the majority of the fellowship?</td>
<td></td>
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</tr>
<tr>
<td>Will the mentor be able to spend time meeting with fellow individually each week?</td>
<td></td>
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<tr>
<td>Will the university be able to provide per diem within the first week of the Fellow’s arrival?</td>
<td></td>
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</tr>
<tr>
<td>Will the university be able to provide fully furnished lodging with kitchen facilities?</td>
<td></td>
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</tr>
<tr>
<td>Does the university withhold federal tax on the participants’ per diem and housing?* If so, you must list this expense as a separate line item on the budget.</td>
<td></td>
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</tbody>
</table>

*Note that CGIAR 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). No taxes should be withheld from CGIAR Borlaug Fellows since they are exempt.
**Budget Worksheet**

**Host Institution:**

**Estimated Dates:**

**NOFO# / Country / Fellow#**

<table>
<thead>
<tr>
<th>SF-424 Category</th>
<th>Line Items</th>
<th>Rate</th>
<th>Days</th>
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<tr>
<td><strong>Fellow’s Logistical Expenses</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>TRAVEL/Housing</td>
<td>1. Lodging</td>
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<tr>
<td>TRAVEL</td>
<td>2. Meals and Incidentals</td>
<td></td>
<td></td>
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<tr>
<td>OTHER</td>
<td>3. Federal Tax</td>
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<td>TRAVEL</td>
<td>4. Medical Insurance</td>
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<td>TRAVEL</td>
<td>6. Local Transportation</td>
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<td>TRAVEL</td>
<td>7. Airfare - International</td>
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</tr>
<tr>
<td>TRAVEL</td>
<td>8. Airfare - Domestic (If Applicable)</td>
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<td></td>
</tr>
</tbody>
</table>
| **Subtotal** | | | | | 0

| **Fellow’s Professional Development** | | | | |
| TRAVEL | 1. Field Tours | | | |
| SUPPLIES | 2. Educational Materials and IT Expenses | | | |
| SUPPLIES | 3. Shipping Materials | | | |
| **Subtotal** | | | | | 0

| **Host Institution Fees** | | | | |
| PERSONNEL | 1. Training Coordinator (Salary) | | | |
| FRINGE BENEFITS | 1.b. Training Coordinator (Fringe Benefits) | | | |
| PERSONNEL | 2. Mentor Fee | | | |
| FRINGE BENEFITS | 2.b. Mentor (Fringe Benefits) | | | |
| SUPPLIES | 3. Laboratory Expenses | | | |
| **Subtotal** | | | | | 0

| **World Food Prize Symposium (Oct. 2017; If Applicable)** | | | | |
| TRAVEL | 1. Domestic Transportation | | | |
| TRAVEL | 2. Lodging | | | |
| OTHER | 3. Conference Fee | | | |
| **Subtotal** | | | | | 0

| **Mentor Preliminary Activity (5-10 Days)** | | | | |
| TRAVEL | 1. Mentor Airfare – International | | | |
| TRAVEL | 2. Mentor Domestic In-Country Travel (If Applicable) | | | |
| TRAVEL | 3. Lodging | | | |
| TRAVEL | 4. Meals & Incidentals | | | |
| SUPPLIES | 5. Supplies for Trainings/Workshops | | | |
| **Subtotal** | | | | | 0

<p>| <strong>Mentor Follow-up Activity (5-10 days)</strong> | | | | |
| TRAVEL | 1. Mentor Airfare – International | | | |</p>
<table>
<thead>
<tr>
<th>Category</th>
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<tr>
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<td>TRAVEL</td>
<td>3. Lodging</td>
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<td>TRAVEL</td>
<td>4. Meals &amp; Incidentals</td>
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<tr>
<td>SUPPLIES</td>
<td>5. Supplies for Trainings/Workshops</td>
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</tr>
<tr>
<td>INDIRECT</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Indirect Costs/Overhead (10%)**

**Total Request**
Section III: Application Review Information

All proposals are carefully reviewed by USDA/FAS Program Officers and other FAS staff against the criteria listed below, including others who are experts in a particular field, as appropriate.

A. REVIEW CRITERIA

- **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 length of the program. The budget should include appropriate cost savings where available. Salary and fringe benefits expenses should not be excessive.

B. REVIEW AND SELECTION PROCESS

Other factors may also be taken into consideration such as regional diversity and MSI status in the review process. After review by appropriate offices, it is expected that all applicants will be notified within 2 months after the closing date for applications.

Section IV: Award Administration Information

A. AWARD NOTICES

Applicants should expect to be contacted by program staff for clarification and additional discussion on any budget related issues before final determination of successful applicants. Any notification by the program office regarding the selection of an institution is not an authorization to begin performance. No pre-award costs can be charged. The notice of award signed by the Deputy Administrator of USDA/FAS/OCBD is the authorizing document. This document will be sent by electronic mail to the university. Both parties must sign this document before the agreement is in force. Unsuccessful applicants will be notified of the status of their application by email.

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

Certifications regarding debarment Suspension, Drug Free Workplace, Felony Conviction and Tax Delinquent Status, and other national administrative assurances and policies are required. The cooperator must adhere to administrative requirements, cost principles, and audit requirements as

All successful applicants for all cost reimbursable agreements are required to comply with Standard Administrative Terms and Conditions, which are available online at: 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 ezFedGrants GMO 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.

C. REPORTING REQUIREMENTS:

Primary Investigators are required to submit mid-term and final Fellow’s performance reports on the U.S. portion of the CGIAR Borlaug Fellowship. A final mentor’s visit report including a final evaluation should be submitted no later than 30 days after the completion of the mentor visit.

- Financial reports will use SF-425.
- Progress Reports will use SF-PPR.
- Invoices will use SF-270.

Progress Reports

- The Principal Investigator or Mentor will submit semi-annual progress reports. The Principal Investigator or Mentor will use Performance Progress Report (SF-PPR) to submit semi-annual progress reports.
- The Principal Investigator or Mentor will submit a final report to USDA/FAS within 30 days after the Mentor visit. USDA/FAS will provide additional guidance and a template for the final report.
- 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.

Funding opportunities will be distributed through ezFedGrants and advertised via the USDA/NIFA listserv. All proposals must be submitted through the ezFedGrants portal at https://grants.fms.usda.gov
USDA Notice of Funding Opportunity
2017 CGIAR Borlaug Fellowship Program for
CGIAR BORLAUG

or to the email address below with all required forms. Proposals not submitted by the stated deadline will not be accepted.

After these reports have been reviewed and approved by Trade and Scientific Exchange Division, 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.

Section V: Agency Contact

Applicants can direct questions or request help before the deadline for submission of the application for these funding opportunities via the contact information below:

- CGIAR Borlaug Fellowship Proposals General Email: BorlaugProposals@fas.usda.gov
- CGIAR Borlaug Special Projects: Adam Carruthers, 202-690-4310, Adam.Carruthers@fas.usda.gov

Section VI: Other Information

The USDA Borlaug Fellowship Program began in 2004. More than 800 Fellows from 64 countries have been trained to date. Additional program information is available at http://www.fas.usda.gov/programs/borlaug-fellowship-program.
### Section VII: CGIAR Borlaug Fellow Proposal and Research Plan

<table>
<thead>
<tr>
<th>Fellow Reference Number</th>
<th>Country</th>
<th>Gender</th>
<th>Fellowship Length (in weeks)</th>
<th>Research Focus</th>
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<tbody>
<tr>
<td>1</td>
<td>Egypt</td>
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<td>12</td>
<td>Help the water policy planners to develop new methodologies to measure actual evapotranspiration</td>
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<td>2</td>
<td>Ghana</td>
<td>Male</td>
<td>13</td>
<td>Understanding Ghanaian and West African consumer sweet potato preferences for sweet potato in order to target sweet potato breeding efforts</td>
</tr>
<tr>
<td>3</td>
<td>India</td>
<td>Female</td>
<td>14</td>
<td>Spatial planning for sustainable aquaculture development through Geographic Information System (GIS) modeling</td>
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<td>4</td>
<td>India</td>
<td>Female</td>
<td>14</td>
<td>Ex-ante gender impact evaluation of genetically improved Tilapia on farmers in Bangladesh and India will be conducted</td>
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<td>5</td>
<td>Kenya</td>
<td>Female</td>
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<td>Compare the genes expressed during the interaction of <em>P. infestans</em> – host (potato-tomato), as a way of understanding why host-specialization of the US-1 genotype still exists in East Africa</td>
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<tr>
<td>6</td>
<td>Kenya</td>
<td>Male</td>
<td>16</td>
<td>Beta-carotene absorption in sweet potato</td>
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<td>7</td>
<td>Malaysia</td>
<td>Female</td>
<td>12</td>
<td>Novel aquafeed ingredients for fish meal substitutes in aquaculture feed formulation</td>
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<td>8</td>
<td>Morocco</td>
<td>Male</td>
<td>12</td>
<td>Study of genetic variability and population genetic structure of the chickpea leaf miner</td>
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<td>9</td>
<td>Morocco</td>
<td>Male</td>
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<td>IPM; pheromone traps and biological enemy</td>
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<td>10</td>
<td>Peru</td>
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<td>Evaluate the effects of CSA practices and factors affecting</td>
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<td></td>
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<td>adoption to support achievement of widespread adoption</td>
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<td>11</td>
<td>Philippines</td>
<td>Male</td>
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<td>Understanding seed flow at the Lake Zone, Tanzania and its effect on quality of seed and spread of viruses</td>
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<tr>
<td>12</td>
<td>Tanzania</td>
<td>Male</td>
<td>9</td>
<td>Improve the quality of breeding output through development and dissemination of resilient and nutritious bean (<em>Phaseolus vulgaris</em>) germplasm</td>
</tr>
<tr>
<td>13</td>
<td>Uganda</td>
<td>Female</td>
<td>16</td>
<td>Study evolution and diversity of <em>Potato Virus Y</em></td>
</tr>
</tbody>
</table>
Fellow 1, Egypt, Water Management

Project Summary
Help the water policy planners to develop new methodologies to measure actual evapotranspiration (ETc). The goals of this project are to (1) refine and use the SIMETAW model for water demand planning and (2) use the calibrated Surface Renewal method (SR) to develop and update crop coefficient (Kc) values for various crops in some region in Egypt. Also, this project aims to develop training program to extend the methodology to the water resources engineers, agronomists, extension agents, and growers.

The SIMETAW application program and surface renewal are being used to estimate the demand for irrigation water to improve agriculture water resources management. It has the potential to greatly improve our knowledge about the demand for water in Egypt and it will help farmers with on-farm irrigation efficiency. Information on water demand is also needed to efficiently manage water supply and delivery in the Nile Delta and other regions in Egypt. Our proposal is to develop and collect the information needed to apply the SIMETAW model, test its accuracy, and modify the program as needed to provide the Egyptian government/irrigation engineers with better statistics on water use under different conditions and a cross scales from farm level to basin level. The other activity is to install and operate surface renewal stations to measure crop evapotranspiration and to determine and update crop coefficient (Kc) values.

This will help growers to improve their on-farm irrigation efficiency, and it will help Egyptian water management specialists and hydrologists to better manage water flows through the irrigation networks for better water allocations among different ecosystems’ services in Egypt. The outputs of this effort will be beneficial to both the economy and the environment and enhance the food security at the country level.

Program Proposal

Background
Nowadays water scarcity has become a severe problem in Egypt, and the water resources do not meet the demand. Thus, improved methods to improve irrigation water efficiency are needed. Yearly, many thousands of hectares are reclaimed and added to Egypt’s irrigated area; thus, water will be the biggest limitation in the future. Facing water scarcity in all sectors, in general and agriculture in particular, will load the irrigation sector with very complex challenges and negatively impact the food security of the country.

Mismanagement of water resources in the agricultural sector, over-irrigation and the use of low quality water are all leading to rapid land degradation due to salinity, alkalinity, and waterlogging problems. It is evident that opportunities for the significant capture of new water are now limited. Most river systems suitable for large-scale irrigation have already been developed, few major resources of renewable groundwater remain untapped, and current resources are subject to overexploitation.

Furthermore, through an effective irrigation water management, fundamentally based on an appropriate irrigation scheduling, we can avoid soil salinity, alkalinity, and waterlogging problems
due to over irrigation and, thereby, protect the natural resources. Technically, it is well recognized that improved water use efficiency leads to water saving. Therefore, the main objective of this work is to maximize the benefits of each drop of applied water. This necessitates precisely identifying the water volumes and the right time for irrigation.

The features of the irrigated agriculture, at present and in the future, are mainly related to water savings potential in the agricultural sector at both the farm and basin level. Indeed, nowadays, saving water in irrigated areas is a top technical and political priority to mitigate the looming water scarcity. This research will help the water policy planners to develop a methodology to determine crop coefficients and water use. Daily crop evapotranspiration is commonly estimated as the product of standardized reference evapotranspiration (ETO) and a Kc value that accounts for differences in ET between the reference surface and the crop. The ETO is a measure of regional evaporative demand that approximates the ETC of a 12 cm tall cool-season grass pasture. One of the biggest deficiencies in water use planning is a lack of information on Kc values and crop water use. Although considerable information does exist, much of the literature is out-of-date because of changes in crops, management, and irrigation systems. In addition, the equation for ETO has changed since most of the crop coefficient values were developed. For example, current orchards that are irrigated twice per week by micro-sprinklers are likely to have different ETC than orchards that were surface irrigated every second week 30 years ago.

**Rationale**

In Egypt, the sustainability of water resources, at present and in the future, mainly depends on efficient water use and agricultural water saving potential at both the farm and basin levels. Indeed, technical and political efforts to improve water use efficiency in irrigated areas are top priorities to mitigate looming water scarcity in Egypt. The only possible method to improve irrigation water use efficiency is to provide better information on how much farmers should apply and to show them how to optimize distribution uniformity and application efficiency through better system management. This proposed research will help water policy planners and managers to improve water delivery through better information on water demand, and it will help farmers to improve on-farm efficiency by providing the crop water use information that they need.

One of the biggest problems encountered in water use planning is to obtain accurate information on the agricultural demand for water. The process, however, is time consuming and costly, and new, computer-based modeling is needed to streamline the process. Also, it is difficult to manage and apply the soil, crop, and climate information to estimate the evapotranspiration of applied water (ETaw), which is an estimate of the applied water that contributes to ETC. Thus, the ETaw does not include runoff, deep percolation, in-season effective rainfall, or the difference in soil water content from the beginning to the end of the season.

**The SIMETAW model**

Currently, application programs for water demand planning (i.e., SIMETAW and CUP+) are available to help determine seasonal Kc curves, ETC, and ETaw. Improvements to these application programs are possible if the information on Kc values and growth dates are updated to better match current conditions. In addition, with the looming possibility of climate change, it is likely that the ETO will change, and, therefore, the ETC of various crops will also change. It is critically
important that the methodology be in-place for water policy makers to update Kc values as the climate changes.

The California Department of Water Resources and the University of California have developed the ‘Simulation of Evapotranspiration of Applied Water’ application program (SIMETAW) to help the State of California plan for future water demand by agriculture and for landscape irrigation. The main feature of the SIMETAW program is that it simulates daily weather data from monthly climate data for a user-specified period of years. SIMETAW is a user-friendly program that (i) calculates ETo from simulated weather data, (ii) identifies seasonal Kc curves for a wide range of irrigated crops, (iii) accounts for many factors affecting Kc values that are often ignored in other programs, (iv) computes a hypothetical irrigation schedule for each of the simulated years of data, (v) estimates the effective rainfall, and (vi) calculates the mean ETaw over a specified number of years. When ETaw is divided by the mean seasonal application efficiency, it provides an estimate of the applied water. The SIMETAW model greatly improves our ability to rapidly and accurately determine ETaw within an region of similar ETo. The simulation part of SIMETAW helps to fill in missing data both spatially and temporally. It also provides the opportunity to investigate possible effects of climate change on ETaw.

The SIMETAW application was developed, beta tested, and more recently modified to an application program called “Cal-SIMETAW, which covers all ETo regions. This information is being used by the State to upgrade the Delta hydrology models to improve the management of hydrologic flow through the Delta and to help with statewide water demand planning. This is important for managing outflows, maintaining water quality, protecting the environment, and for efficient on-farm water use. Basic regional information on soils, precipitation, and cropping are stored in a large database that feeds the Cal-SIMETAW model and makes it easier to accomplish statewide planning. Since there are similar problems in coastal areas, the Nile Delta, and the old valley regions of Egypt, we propose a pilot study to collect crop and soil data and to apply the SIMETAW program to determine ETaw for different agroecological zones in Egypt with the ultimate goal to develop a nationwide model like Cal-SIMETAW.

The use of SIMETAW for water resources planning is expanding rapidly around the world. The SIMETAW model has been presented to the Climate Group and the Water Management Groups at the United Nations – Food and Agriculture Organization, and it was discussed the possibility to change their climate data to allow them to use SIMETAW worldwide. Also the Peoples Republic of China has initiated a cooperative project involving SIMETAW, to help them with water resources management.

Since the use of SIMETAW requires considerable data-base management of soil, crop, and climate data, this project is proposed to begin the process of collecting and managing the data needed to operate SIMETAW in the Nile Delta. The first year of the project will mainly be devoted to basic data collection and manipulation. In the second year, the model will be operated, evaluated, and refined.
**Surface Renewal Method**

Surface Renewal (SR) is a new method to measure sensible heat flux (H) using high-frequency air temperature and analyzing the temperature traces to identify a mean temperature ramp amplitude and duration during a sampling period (typically half an hour). Then, the latent heat flux (LE) is calculated as the residual of the energy balance (REB) as: \( LE = R_n - G - H \), where \( R_n \) is measured net radiation and \( G \) is ground heat flux density. The actual crop evapotranspiration (ETa, mm hh\(^{-1}\)) is calculated as \( ET_a = LE / 2.45 \) where LE is expressed in MJ m\(^{-2}\)hh\(^{-1}\) and L = 2.45 MJ kg\(^{-1}\) is the latent heat of vaporization. If the crop is not experiencing water or other ET reducing stress, then \( ET_c = ET_a \). The method offers the possibility to greatly increase knowledge of crop water requirements. The SR method has been tested for more than two decades against lysimeter and other ETa measurements with considerable success. While this is important for California and for irrigated agriculture within the United States, the SR method has tremendous potential to help developing countries, with limited research funding, to improve their knowledge of crop water requirements. This is especially true in Egypt and the arid Middle-East, where limited water supplies are problematic.

The Surface Renewal (SR) method was developed by the University of California at Davis (UCD) to measure \( ET_c \) and use the data with \( ET_0 \) to estimate and update daily Kc values as: \( Kc = ET_c / ET_0 \). There are several energy balance methods to measure LE and estimate \( ET_c \), but the SR method has the advantage of low cost and portability. In Egypt, the agricultural fields are generally small and most method for measuring \( ET_c \) are complicated, expensive, and do not work well in fields with inadequate fetch (i.e. upwind distance of uniform crop). The surface renewal method offers a relatively simple approach for estimating \( ET_c \) that gives good results when properly calibrated and requires less fetch than other methods. As a result, the method has good potential to help Egypt improve badly needed information on crop water requirements and to determine crop coefficients for use in irrigation scheduling and improving irrigation application efficiency.

**Research Plan**

The need for this program:

This program is extremely important because nowadays water scarcity became a serious problem in Egypt and other countries in the region where organization is operating. The Egypt’s irrigation water resources supplies don’t meet the water demand, so we have to find ways and meaning of using irrigation water efficiently. This research will help the Egyptian water policy planners to develop the appropriate methodology to determine the accurate crop coefficients and evapotranspiration for better management of the scare water resources at different levels and produce more crops with limited available water to improve the food security.

The Objectives:

In addition to improving water use efficiency and productivity, wider adoption of water management technology would result in environmental and social benefits to include lowering the demand for the already stressed natural resources; improved soil and water quality (reduced soil salinity, soil and water pollution, waterlogging, and drainage water), improved water equity among farmers sharing the same water delivery system; and reduced climate change impacts. Furthermore, indirect benefits of this project on the production system could be attained including minimized soil-borne diseases, improved fertilizer efficiency, and improved irrigation
management for an effective and sustainable development, and to support decision makers to better manage scarce natural resources in Egypt and increase the food security of the country.

This research work will be investigated to achieve the following objectives:

1. Improve our knowledge and tools by updating our ability to determine crop evapotranspiration to better inform irrigators and water policy makers.
2. Validation of the surface renewal (SR) method for indirect estimation of crop evapotranspiration by comparing SR estimates of ET\(_a\) with other ET\(_a\) measurements.
3. The long-term goal of this project is to upgrade crop coefficients to improve:
   - On-farm irrigation management
   - Increase confidence in the Kc values
   - Improve water demand estimates for regional water resources planning purposes

The Tasks to be completed:

1. Accumulate all available weather data to estimate daily reference ET (ET\(_o\)) within the Sacramento-San Joaquin River Delta and the Nile Delta over the longest period of record available. Where historical data are limited or unavailable, suitable estimates of ET\(_o\) will be made using a calibrated Hargreaves-Samani equation or SIMETAW model depending on the available data.
2. If available, recent climate data will be used to estimate ET\(_o\) using the ASCE-EWRI (2005) method. The results will be compared with data from ET\(_o\) estimated using temperature data from long-term climate stations and the Hargreaves-Samani estimates of ET\(_o\). If possible, isolines of ET\(_o\) will be developed to characterize the spatial distribution of ET\(_o\) across Egypt.
3. Field trials will be conducted using improved agricultural/water management. Data on the Kc values of major crops under different agroecological conditions will be collected and used to verify the simulated data from SIMETAW model.
4. Install surface renewal (SR) stations to measure ET\(_a\) and estimate ET\(_c\) and Kc values to validate SIMETAW model against measurements.
5. Using soil water holding characteristics, cropping patterns, ET\(_o\), ET\(_c\), effective rainfall, and ET\(_aw\) will be determined in a pilot study area of Egypt.
6. In addition to crops, the modified SIMETAW model will be used to estimate evapotranspiration from wetlands and from urban landscapes.
7. Training programs will be conducted for irrigation engineers and extensionists.
8. The SIMETAW model has the ability to estimate ET\(_aw\) from input climate data projections of CO\(_2\), temperature, humidity, etc. This feature will be used to investigate projections of irrigation water demand due to climate change by agro-ecological zones in Egypt.

The deliverables:

1. The modified SIMETAW model and documentation to help with future ET\(_c\) and ET\(_aw\) assessments.
2. Project inception workshop.
3. Presentations to interested scientists, growers and decision makers summarizing the project procedures and results.
4. A training plan for water managers and growers in Egypt.
5. Daily and monthly ET₀ values by user-defined study areas.
6. Updated crop coefficient (Kc) factors to allow for estimating crop evapotranspiration for major crops in different regions within Egypt.
7. Seasonal ETₐw calculations (based on soil water balance calculations) averaged over the period of record.
8. Publications on various topics related to water management, surface renewal, and SIMETAW.

**Proposed schedule: First Phase**

1. *Organization* scientist trained on use of SIMETAW and Surface Renewal (SR) method and plan data collection activities.
2. Begin developing data base management software to organize data into files that SIMETAW can use for analysis.
3. Identify available stations or purchase ET₀ stations and install in pilot study areas
4. Purchase surface renewal stations
5. Install surface renewal stations and conduct field trails and data collection.
6. LGU scientist visit Egypt to assist with the data collection and organizing efforts. Batch processing code will be tested to read and process the crop and soil data. USA and *Organization* scientists will jointly analyze the climate data to develop the spatial- temporal ET₀ estimates.
7. Modify the original SIMETAW model applications as needed to calculate ETₐw for common Egyptian crop types.

**Second phase**

1. *Organization* scientist develop and modify application output files as needed.
2. Design the data management program to display output files in formats useful to the technical staff, and planners. Updated monthly ETc and Kc values for each grid element will be compiled in a format usable by local water managers for post-processing.
3. Compile documentation report.
4. LGU scientist visit Egypt to participate in training classes for *Organization* and national staff as needed.
5. Manuscripts and papers on various aspects of the project will be prepared for publication.

**Expected Outputs/Outcomes:**

1. Adapted surface renewal method and a modified SIMETAW model for Egypt localities and documentation to help with future ETc and ETₐw assessments as a coping strategy with climate change.
2. Surface Renewal (SR) method and SIMETAW model dissemination as a new technology and appropriate tools in Egypt and other countries in the region.
3. A great opportunity will be offered to exchange the knowledge and experiences between *Organization* and LGU scientists on various water management aspects.
4. A proper water management tool to determine the actual evapotranspiration and long term planning of the water demand management at farm level as well as basin level for different ecosystems services will be developed.
5. Improved the knowledge and information of the irrigation engineers on modeling
evapotranspiration and irrigation scheduling.

6. Updated crop coefficient (Kc) factors to allow for better estimating crop evapotranspiration for major crop types in different ecosystems in Egypt.

7. Practical benefits and basic advances on water management and irrigation scheduling introduced.

**Nature of collaboration and the role of counterparts:**
They will be responsible for development and needed modification of the SIMETAW software and for training Egyptian and Organization scientists on use of the software. The LGU counterpart will also work with Organization scientist to determine what data are needed and how the data are to be archived for use in the program. The LGU coordinator will also be involved in training water managers and decision makers on the use of SIMETAW in Egypt. The Organization scientist will be responsible to organize the collection of all data necessary to use the SIMETAW model in Egypt. As the original SIMETAW application program is already developed, the Organization cooperator will mainly collect the data needed to run the model.

The LGU scientist (counterpart) will provide guidance on what data are needed and the format for storing the data. Once the data are collected, collaborators will jointly test the SIMETAW model to insure accuracy. The LGU scientist will provide the SIMETAW model and will modify the model as needed for Nile Delta conditions. The LGU scientist will also participate in training meetings on use of SIMETAW. The counterparts will be involved in data collection and management, testing the SIMETAW model, and training of water managers and decision makers. The climate, soil, and crop data must be archived in data bases that might include Excel files, Access files, or other software files depending on the size of the data sets.
Fellow 2, Ghana, Sweet Potato Sensory

Sensory evaluation is an important field in every institution working with food. It involves a complete understanding of people and the product being worked on. The ultimate goal of sensory evaluation is to lead to adoption of the food product which is also the goal of every scientist who wishes to make a positive impact on the society. Sensory analysis has been widely used in coffee, tea, chocolate, drink industries and breeding efforts to enhance adoption. However, the field of sensory is still a grey area with a lot of varying opinions from different scientists across the globe due to its subjective nature. It is also less developed in many developing countries of which Ghana is no exception. The lack of experts and knowledge of sensory are very key to the limited use of sensory as a tool to develop the organization and country at large. The situation is even more alarming in the universities, which has been tasked to train scientists that will help develop the country. As part of the objectives of organization, improved sweet potato varieties which are desired by consumers are to be bred for the country. This could be made possible only if the consumers are made part of the research through sensory surveys and focus group discussions. To be able to achieve this objective, there is the need to associate with important and recognized leaders in the field of sensory analysis. Therefore, Borlaug fellowship couldn't have come at a much better time to help support scientists. During my fellowship, I hope to gather a lot of knowledge on sensory from sensory experts to enable me become an expert. I also hope to publish and present scientific papers at scientific seminars which is a way of also contributing to knowledge. Since we are in a global village and development usually depend on group efforts, I hope to develop good partnership with various people with common interest.

How my research interests and scientific background relate to the goals of my program proposal

There seems to be a disconnect between scientist in most African countries and the general public. As a young scientist, I have always wanted to work on something that connect me with the people. Hence, sensory evaluation seems to be perfect career that will help provide this platform. As a food scientist, I have always been interested in working on anything related to sensory and for three years, I have been working for organization on sensory. I strongly believe that, the time has come for me to upgrade my knowledge in this field hence my program proposal.

Sweet potato is an underutilized crop in Ghana with enormous potential as an income generation and a food security crop and has been found to be a good source of micronutrients. Despite its huge potential, it is currently not well integrated into the average Ghanaian diet with a low utilization compared to other prominent root and tuber crops. Sweet potato breeders have struggling to fully understand what exactly to the Ghanaian consumer wants when it comes to sweet potatoes. There seems to be divided opinions as to whether Ghanaians prefer sweet type or non-sweet sweet potatoes with some publications suggesting Ghanaians like non-sweet sweet potatoes. Earlier research by Owusu-Mensah (2016) and Baafi (2014) focused on total sugars to group sweetness and do not really relate it to whether consumer preference. Baafi (2016) also focused on group discussions to conclude that non-sweet sweet potatoes is preferred by Ghanaians. The groups where however not grouped based on gender. The modern research needs to take into cognisance the importance of gender roles in other to better understand the society. There is also the need to relate preference to texture, and browning as they all affect consumer judgement.
This divided opinions could be as a result of a lack of standardized methodologies employed by the various scientist, a lack of clear understandable terminologies about sweet potatoes attributes, lack of sensory experts and lack of appropriate promotion strategies. Hence as part of my proposal goals, I will seek to generate appropriate lexicons for boiled and fried sweet potatoes in Ghana, to evaluate sensory profile selected released varieties for sweetness by a trained panel, to conduct consumer preference of selected sweet potatoes across the major agroecological zones in Ghana, to evaluate textural and nutritional profile of sweet potatoes and to conduct focus group discussions on men’, women’, boys’ and girls’ sweet potato sweetness preferences.

b. How will your participation in this program contribute to the enhanced agricultural productivity and/or food security in your country?
Agriculture is the most important sector of Ghana’s economy in terms of contribution to the GDP. It accounted for about 39% of GDP in 2005 and for about 40% of export earnings (WB; Apullah, 2003). Although Ghana’s natural potential for agriculture is high, the country is not self-sufficient in terms of food production (FAO, AQUASTAT; Wolter, 2008). Ghana’s population is increasing at a faster rate and will require promoting underutilized crops to cope with this increase. Sweet potato has been found to be one of the most important root crops in the world with more than 133million tonnes annual production worldwide. It is a major staple crop in most tropical countries rich in micronutrients. Unlike other starchy staples, it can be cultivated 3 times in a year. According to Bechoff et al., (2016), higher yield, a major focus of recent breeding research, has no effect on farmers’ adoption decisions because farmers will not see the need to adopt more productive varieties when there are marketing constraints along the value chain. According to them, understanding farmer preferences coupled with focus on high yield and disease resistance can be beneficial in increasing adoption of varieties. The Borlaug fellowship program will help in accomplishing my program proposal which is aimed at promoting sweet potatoes in the subregion to combat malnutrition and food insecurity.

7. RESEARCH PLAN
The research will focus on sensory testing of sweet potato varieties that will be tested in Ghana after the Fellow returns to Ghana. Orange fleshed sweet potato (OFSP) is a key crop in sub-Saharan Africa. OFSP can provide both energy (carbohydrates) and vitamins and minerals (particularly Vitamin A), both of which are needed by limited resource consumers in much of Africa. Unfortunately, considerable work is still needed to understand the acceptability of OFSP in Africa. As OFSP varieties are examined for their agronomic prospects, shelf-life, nutritional profiles, processing potential of each variety is tested, the sensory properties must be examined to determine if the variety can become a widely accepted product. The project will enhance an existing study on sweet potatoes that breeds and examines cultivars for sweet potato production in Africa. The sensory work to begin this enhancement to the projects in Ghana and other organization locations in Africa studying sweet potato will take place at Kansas State University (KSU). Specifically, the work will improve and expand the sensory studies (flavor, texture, appearance) that are conducted on the sweet potato cultivars in Ghana. Currently, a minimal amount of sensory data is collected (basic texture, flavor, color), but in order to better understand the consumer properties of the sweet potatoes much more sensory data is needed. This enhanced data can be matched with horticultural practices, growth, yield, and genetic information that is already being collected and will provide considerably more information that can be related to desirable eating qualities.
The plan incorporates 3 aspects: 1) training for the fellow to better understand the processes for sensory testing, 2) design and testing of the protocols that will be implemented once the fellow returns to Ghana, and 3) development/expansion of a sensory lexicon to describe differences in sweet potato cultivars in order to provide more scientific technical information on the sensory properties. Two research papers are planned from the projects in addition to actual protocols and questionnaires that will be developed for the fellow to use when he returns to Ghana to conduct continuing research on sweet potato cultivars.

<table>
<thead>
<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Familiarization and visitation</td>
<td>Visit to host university sensory lab to meet host supervisor and grad students to discuss workplan</td>
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</tr>
<tr>
<td>Week 2</td>
<td>Knowledge acquisition on sensory</td>
<td>Participate in sensory lectures and practicals</td>
<td>Stationaries, laptop, digital camera</td>
</tr>
<tr>
<td>Week 3</td>
<td>Knowledge acquisition on sensory</td>
<td>Participate in sensory lectures and practical sessions</td>
<td>Stationaries, laptop, digital cameras</td>
</tr>
<tr>
<td>Week 4</td>
<td>Field visit</td>
<td>Visit to sweetpotato breeding trial sites to select materials</td>
<td>Stationaries, digital camera</td>
</tr>
<tr>
<td>Week 5</td>
<td>Initiating research</td>
<td>Screening panelist for sensory activities</td>
<td>Serving trays, plates and cups, palate cleansers, refreshments, camera, tablet, laptop</td>
</tr>
<tr>
<td>Week 6</td>
<td>Conducting descriptive sensory</td>
<td>Develop lexicons for selected sweetpotato genotypes</td>
<td>Serving trays, plates and cups, palate cleansers, refreshments, camera, tablet, laptop</td>
</tr>
<tr>
<td>Week 7</td>
<td>Conducting consumer survey</td>
<td>Carry out consumer preference survey at selected sites</td>
<td>Serving trays, plates and cups, palate cleansers, refreshments, camera, tablet, laptop</td>
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<tr>
<td>Week 8</td>
<td>Focus group discussions</td>
<td>Conduct focus group discussions on preference for sweetness with groups segregated into men, women, boys and girls</td>
<td>Refreshments, stationaries, tablet, laptop</td>
</tr>
<tr>
<td>Week 9</td>
<td>Analyses</td>
<td>Carry out various nutritional and textural analysis in Kansas state university lab</td>
<td>Texture analyser, HPLC,</td>
</tr>
<tr>
<td>Week 10</td>
<td>Organization of data</td>
<td>Data entry, validation and analysis</td>
<td>Tablet and laptop</td>
</tr>
<tr>
<td>Week 11</td>
<td>Meeting with supervisor</td>
<td>Discussions with supervisor on data obtained</td>
<td>Tablet and laptop</td>
</tr>
<tr>
<td>Week 12</td>
<td>Writing of manuscript</td>
<td>Writing of manuscript</td>
<td>Tablet and laptop</td>
</tr>
<tr>
<td>Week 13</td>
<td>Writing of manuscript</td>
<td>Writing of manuscript</td>
<td>Tablet and laptop</td>
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Fellow 3, India 1, GIS

Fish is the primary source of animal protein for 3.1 billion people\(^1\). Fish containing essential amino acids, omega-3 fatty acids, as well as various vitamins (D, A and B) and minerals (including calcium, iodine, zinc, iron and selenium), which contribute a significant positive nutritional impact on human diet. The current levels of wild capture fisheries are declining and unsustainable. About half of the demand for fish is now met by aquaculture. Analysis of future fish supply-demand scenarios suggests that farming of fish and other aquatic products will need to double production by 2030 to meet growing demand\(^2\).

The increased aquaculture production must occur in a context where to be far more efficient in utilizing productive resources necessary for food production, such as land and water. Poor spatial planning for aquaculture site selection is a major constraint to sustainable development and expansion of the industry\(^3\).

Aquaculture farms are more viable if located at areas with easy access to good quality water, land resources and good quality seeds for sustainable production\(^4\). Different species will have specific biological needs such as temperature and good water quality that have to be fulfilled to secure high production and to minimize fish disease risks. Arrangement for clustered farmers within zones suitable for aquaculture, can facilitate the implementation of area-based management strategies, such as having access to common post-harvest and marketing services, as well as coordinated approaches for risk management including response to disease outbreaks\(^3\).

All these bio-physical and socio-economic criteria associated for site selection can be integrated by implementing a systematic spatial planning strategy through GIS modeling. Good spatial planning and management will help to implement sustainable farming practices and boost productivity of aquaculture in order to meet the growing demand for fish for food, income and nutrition. This aligns well with Organization’s mission to reduce poverty and hunger by improving fisheries and aquaculture, as well as contributes to CRP FISH (Organization Research Program on fish agri-food systems)’s Flagship 1 (Sustainable Aquaculture):

- **Cluster 3 (Aquaculture systems):** GIS suitability analysis will help in bringing together the bio-physical and socio-economic criteria for identifying the locations that are suitable for sustainable aquaculture development and improving productivity. The geospatial data collected for GIS modeling and the GIS suitability analysis results have the potential for supporting the objectives of other two clusters in the Sustainable Aquaculture flagship of FISH CRP:

- **Cluster 1 (Fish breeds and genetics):** Mapping the spatial distribution of farmers and markets can help to achieve effective dissemination of improved fish strain across targeted areas and ensure the benefits of improved strains are accessed by poor and marginal farmers including women in an equitable way.

- **Cluster 2 (Feeds, fish nutrition and health):** Facilitate the delineation of aquaculture management areas to achieve better biosecurity planning and disease control through aquaculture improvement programs (AIPs) and/or zonal improvement programs (ZIPs), helping to promote the
India has the second largest population in the world after China. According to the Indian government statistics, 22% of its population is below its official poverty limit. Odisha and Assam are among the top 10 states having high poverty rate, each consisting of 32.59% and 31.98% respectively. The 2016 Global Hunger Index (GHI) ranked India a lowly 97 among 118 developing countries having serious levels of widespread hunger and undernourished population. Organization is presently collaborating with Government of Odisha and Assam in India to support sustainable growth of aquaculture and to boost the production at the scale needed to meet Indian’s growing demands for fish for food, income and nutrition.

Organization had developed a GIS modeling methodological framework for recommendation domains for pond aquaculture 10 years ago. The purpose of this study is to refine the recommendation domains GIS modeling methodology and to develop the enhanced GIS-based models to improve spatial planning and management of sustainable aquaculture development in both States of Odisha and Assam context.

OBJECTIVES
The main objectives of the study are to:
- Develop the enhanced GIS modeling methodology to map the potential areas for inland aquaculture development by integrating bio-physical and socio-economic factors influencing the selection of suitable sites.
- Map the existing and potential areas for inland aquaculture development in Odisha and Assam States by employing GIS modeling.
- Estimate the carrying capacity for targeted culture systems (e.g. reservoirs, community water bodies) and technologies (e.g. cage culture, stocking of hatchery seed) to be used for fish production enhancement strategies.
- Recommend the suitability of aquaculture zoning and site selection for strategic development.

EXPECTED OUTPUTS
- Enhanced GIS modeling methodological framework for map the potential areas for inland aquaculture development in Odisha and Assam States and replicable across other states in India and other countries.
- Suitability maps for inland water resources for undertaking different kinds of fish farming systems (e.g. pond, cage/pen, rice-fish).
- Estimated carrying capacity (e.g. tonnes/ha or tonnes/km²) for targeted culture systems and technologies to be adopted.
- Recommendation on aquaculture zoning strategy in suitable locations.
<table>
<thead>
<tr>
<th>Week #</th>
<th>Activities</th>
<th>Purpose</th>
<th>Deliverables &amp; Materials needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 01-02</td>
<td>1. Literature review</td>
<td>Conduct the literature review and revise work plan.</td>
<td>Suggested methodology and revised work plan.</td>
</tr>
<tr>
<td>*Week 03-04</td>
<td>2. Initial visit by mentor</td>
<td>Conduct assessment, discuss work plan, and initiate the research.</td>
<td>Final work plan.</td>
</tr>
<tr>
<td>Week 05-11</td>
<td>Collect data and conduct the research</td>
<td>Collect all required data for GIS modeling and conduct the preliminary analysis.</td>
<td>Data collected and preliminary analysis of result.</td>
</tr>
<tr>
<td>4. Organization Borlaug Fellowship (Organization fellow conducts research at US LGU)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Week 12</td>
<td>Organization fellow visits US LGU</td>
<td>Arrives US and settle at the LGU, revise the agenda and milestones for the scientific exchange duration.</td>
<td>Final agenda and milestones for the scientific exchange duration.</td>
</tr>
<tr>
<td>*Week 13-15</td>
<td>Review the methodology and learn new technology</td>
<td>Present the research progress, methodology and preliminary result; Review the methodology and exposed to new technology such as satellite image processing in US; Visit Clark Labs at Clark University, Massachusetts a week for knowledge sharing and exchange on the GIS models build on IDRISI software (subject to the possibilities of logistic</td>
<td>Revised methodology and training. Material needed: GIS or Remote Sensing software.</td>
</tr>
<tr>
<td>*Week 19-21</td>
<td>Draft research paper</td>
<td>Interpret the analysis result and draft the research paper.</td>
<td>Draft of research paper.</td>
</tr>
<tr>
<td>*Week 22-23</td>
<td>Draft fellowship report</td>
<td>Prepare the presentation in USDA and draft the fellowship report.</td>
<td>Draft of fellowship report.</td>
</tr>
</tbody>
</table>
### USDA Notice of Funding Opportunity
**2017 CGIAR Borlaug Fellowship Program for CGIAR BORLAUG**

<table>
<thead>
<tr>
<th><strong>Week 24</strong></th>
<th><strong>Organization fellow visits USDA</strong></th>
<th>Present scientific findings and summarize the exchange activities, achievements and challenges, finalize the fellowship report.</th>
<th>Final fellowship report.</th>
</tr>
</thead>
</table>
Fellow 4, India 2, Improved Tilapia

Aquaculture in developing countries is largely based on unimproved fish strains which are often genetically similar or inferior to their wild counterparts (Ponzoni et al 2007). However, dissemination and adoption of genetically improved (GI) fish (for instance improved breeds of tilapia in Asia-GIFT strain, Egypt-Abbassa strain, Ghana -Kosombo strain and Malawi-Oreochromis shiranus strain), has significantly increased production and household consumption (Rai et al., 2014, Rai et al., 2012, ADB, 2005). Potential challenge for adoption and scaling of GI fish by farmers is to incorporate selection traits that benefits both gender (women and men) fish farmer as well farmer as both consumer and producer perspective, especially small producers and women. In order to address these challenges, the study plan to conduct ex-ante impact evaluation of improved strain adoption. The proposed study will aim to assess the potential impact of GI fish on the (a) economic benefits (income, production), (b) non-economic benefits (i.e. nutrition) and (c) identified farmer preferred indicator (from Organization ongoing study “Gender preferences of and impacts on women and men fish farmers regarding genetically improved fish”). Specifically, the study’s objectives are two-fold:

First, to assess production and consumption patterns and factors influencing preferences for fish traits. With this the aim is to estimate the intensity and extent of GI fish adoption in farming communities. For this, we will estimate a baseline scenario for production, consumption and marketing and forecast the likely changes on the livelihood (in terms of income, nutrition) of farmers with adoption of GI fish.

Second, to ex ante evaluate, in a gender-integrated way, the potential benefits and costs (economic, non-economic and farmer preferred indicator) of GI fish to farmer as producers and consumers. This will direct us to provide the outcomes of GI fish adoption on poverty and food consumption?

With these aims, the study will address the following research questions:

**Farmer preferences**: What are the farmer’s (either as producer or consumer) gender-differentiated needs and preferences for improved tilapia? Do women and men farmer needs or preferred traits differs from improved tilapia? If yes, in what way and to what extent are they differ? And what should be the implications of these differences for fish breeding programs?

**Income**: What is the expected impact on farmer’s income if they grow GI fish? And, how gender relations and norms influence these likely income effects and what the implications for Organization program?

**Nutrition**: What are the expected impact on nutrition on household members if they grow GI fish? And, how gender relations and norms influence these likely nutrition effects and what are the implications for Organization program?

The extent to which GI fish provide benefits to women and men farmers as consumer and producer are not examined yet. Further, women are always considered as natural custodians of food and nutrition security of household. In past few years, there is increasing attention towards intra-household allocation of food items that is dependent on different products and different fish species. Two factors are critical to food and nutrition security: (1) availability of low-value fish products through regional aquaculture value chains, and (2) the ‘divisibility’ and preparation of low-value fish products
were analytical and agronomic of study gender post I program. indicators farmers changes tilapia what following for will despite commercialization improved India. them with rotational the 1994. Bangladesh. The dimension heterogeneity among family members (Thilsted, 2012). The proposed study will focus on understanding the heterogeneity in the impact of production and nutritional status of farmer’s family with gender dimension by combining cross-country study and comparative micro-level assessment. The proposed study will consider adoption of tilapia by small-scale farmers in India and Bangladesh. Genetically improved farmed tilapia (GIFT) were first introduced in Bangladesh in 1994. In 2005, on request of Bangladesh Fisheries Research Institute (BFRI, government institute), the latest generation of GIFT sent to strengthen Bangladesh breeding program (Ponzoni, 2010). In 2012, WorldFish sent some families in 8 different cohorts to Bangladesh, in collaboration with USAID-funded Aquaculture for Income and Nutrition (AIN) project, to setup multiplication centers based on rotational mating between these cohorts in Bangladesh. On the other hand, WorldFish has a project with Rajiv Gandhi Centre for Aquaculture (RGCA) in India since 2012 on GIFT. Where WorldFish helped them to establish their breeding program of GIFT. It was the first official introduction of GIFT to India. Now it is independent from the breeding program of GIFT in Malaysia. They have produced 5 improved generations of GIFT until now in India. It will be likely to be released for distribution and commercialization soon. In both the countries the impact assessment of GM fish is not carried so far, despite the program in Bangladesh is well established now. To address the research questions, we will use a mixed method approach. A primary household survey will be conducted in both countries for empirical analysis.

At present, in both these countries, Organization is conducting a study “Gender preferences of and impacts on women and men fish farmers regarding genetically improved fish” addressing the following research question:

What are the gendered preferences and needs of women and men smallholder farmers relating to tilapia characteristics and how can these effectively be addressed through breeding programs, and changes in fish practice?

This is addressed using two approaches: 1) systematic literature review and b) empirical study in the targeted area of GIFT dissemination and distribution. From the identified preferred fish traits by farmers and the feasibility of inclusion of these in breeding program, potential farmer preferred indicators will be developed. The proposed study can take advantage of findings from this ongoing program.

I am looking forward for this fellowship as a learning platform which could help me to realize my post- doctoral fellow project goals, the WorldFish aims for this work, and my own aspirations as a gender researcher in the long run. One of the prime reason, I am interested in conducting the proposed study for that it will be enrichment of “Gender and Genetically-enhanced fish” study which is prime goal of my post- doctoral fellowship with WorldFish. With my on-the job experience so far, I am adept in paper and proposal writing, framework design using intervention (on-farm technology evaluation, agronomic experiments, crop cut survey) and non-intervention approaches (Socioeconomic surveys and GIS data analysis), data collection using Computer assisted personal interview software’s like Survey be and Open Data Kit (ODK) software’s, research and statistical analysis along with ArcGIS knowledge. The projects I have been involved aimed to provide policymakers and other stakeholders analytical insights, technical assistance and explain impact pathways with reality check to promote policy and regulatory reforms that increase space for enhancing productivity in agriculture. In my previous organization, I worked on M&E aspect of USAID funded projects, where USAID indicators were required to be estimated with monthly, quarterly, and annual targets to estimate area
covered and farmers benefitted from the technology, constraints faced by farmers. My work contributed to design and implementation of different sampling techniques like ‘credible inference technique’, designing indicators for data from all relevant weak and strong-ties were collected using triangulation approach, consider geographically-differentiated entry with aim to evaluate the uptake and impact of technologies with external validity. I believe my potential qualification and demonstrated skills would be a suitable match for the need of the program proposal.

Information on the gendered impacts of improved strains will provide clear ex ante feedback on the utility of the strains released to date, the extent to which they meet needs of both poor women and men, if and how they influence gender roles and relations, and critical information to inform what changes may be needed to address any shortcomings or opportunities. These data—together with gendered data on the impact of GI fish on the livelihood of farmers in terms of income and nutrition status—will provide the possibility to target breeding programs more directly, effectively, and equitably to meet the needs of both poor men and women. We expect the results of this study will have implications for policy programs that support start-up and uptake of GI fish. And in the long run, the study will provide a foundation for future ex-post evaluation after adoption of GI Fish.

Reference

## USDA Notice of Funding Opportunity
### 2017 CGIAR Borlaug Fellowship Program for CGIAR BORLAUG

<table>
<thead>
<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Draft of proposal • Timeline and milestone • Project partners/contributors (country specific)</td>
<td>During this week, it is expected to finalize draft proposal with specific research objectives, questions and research methodology. The study proposed a primary survey, so we expect we can think of potential partner, coordinator and survey region in Bangladesh and India. We will also organize a meeting with Borlaug mentor and Organization team (breeding, gender and monitoring &amp; evaluation expert) considering the different dimensions of the proposed project.</td>
<td>Online storage space • Desk space • Internet</td>
</tr>
<tr>
<td>Week 2</td>
<td>Sampling instruments</td>
<td>This week is expected to draft sampling instruments (sampling region, sampling methodology (size, unit of survey and sampling strategy), survey questionnaire</td>
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</tr>
<tr>
<td>Week 3</td>
<td>Data cleaning, management, storage • Survey Preliminary Analysis</td>
<td>We expect that by this week, survey will be finished or close to finish. Preliminary analysis in line of proposal and supervision of assigned mentor can be done.</td>
<td>Quant analysis software (Stata)</td>
</tr>
<tr>
<td>Week 4</td>
<td>Draft outline of paper • Identification of authors/contributors</td>
<td>We expect to prepare a draft outline of paper based on prelim analysis.</td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td>Detailed outline of paper</td>
<td>We expect to prepare a detailed outline of paper with empirical methods identified for analysis.</td>
<td></td>
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<tr>
<td>Week 6</td>
<td>Analysis and writing for paper</td>
<td>We expect to do analysis in line of draft paper in this week and next following weeks</td>
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<tr>
<td>Week 7</td>
<td>Analysis and writing for paper</td>
<td>As above</td>
<td></td>
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<tr>
<td>Week 8</td>
<td>Analysis and writing for paper</td>
<td>As above</td>
<td></td>
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<td>Week</td>
<td>Task Description</td>
<td>Notes</td>
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<tr>
<td>9</td>
<td>Analysis and writing for paper</td>
<td>As above</td>
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<tr>
<td>10</td>
<td>Draft paper to be emailed out to contributors</td>
<td>We expect to share a draft paper to all the authors and experts for their inputs.</td>
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<tr>
<td>11</td>
<td>Analysis and writing for paper</td>
<td>We expect to keep revising the paper</td>
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<tr>
<td>12</td>
<td>Analysis and writing for paper</td>
<td>As above</td>
<td></td>
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<tr>
<td>13</td>
<td>Incorporation of inputs from other authors and experts</td>
<td>This and following week we expect to work on comments and suggestion received to revise paper and draft policy recommendation that uptake of GI fish in vision of Organization program</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Incorporation of inputs from other authors and experts</td>
<td>As above</td>
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Fellow 5, Kenya 1, RNA

*Phytophthora infestans*, the pathogen that causes late blight disease is continually found on potato and tomato in east Africa. Late blight of tomato and potato can occur at any stage of plant growth after emergence under favorable weather conditions. The two hosts are rarely intercropped but more often are found growing in close proximity. Despite this, the *P. infestans* genotypes attacking potato and tomato are different in east Africa as a result of host specialization. Recent evidence is from an ongoing pathogen population displacement in which the old US-1 lineage has been displaced on potato by a new clonal genotype named KE-1. The US-1 tomato-adapted genotype still persists implying selective displacement of the old lineage. Further evidence of the genotype differences is from effector data generated by screening of the Avr-blb1 (ipiO) *in planta* expressed effector gene (unpublished data). The ipiO gene has four effector variants, ipiO1, ipiO2, ipiO3 and ipiO4. The US-1 on potato does not express any of the four variants while the tomato-adapted genotype expresses the virulent ipiO-4. A similar genotype to the KE-1 lineage in Ethiopia has however managed to displace the US-1 tomato lineage in that country. This means despite the host-specialization observed, new genotypes are able to attack the two hosts. The presence of a single genotype on two or more hosts implies that management practices for late blight need to consider all the hosts. Crucially though, the possibility of a host-jump where the tomato-adapted US-1 lineage is able to attack potato in a field environment could complicate disease epidemiology. This is because most small-scale farmers do not pay much attention to the few diseased, mostly volunteer potato plants growing near their potato crops. Results generated to-date show that the tomato-adapted US-1 lineage could be virulent on a potato carrying RB resistant gene as the genotype lacks all the avirulent variants (ipiO1, ipiO2) of the Avrblb1 effector and expresses the virulent iPiO4 variant. The RB gene is of importance in east-Africa as it is one of the late blight resistance gene pyramided in a 3R transgenic potato.

The neutral markers (SSR, mtDNA haplotype) used to characterize the *P. infestans* population shows no variation in the two host adapted genotypes. Therefore, the possibility to study effector differences between US-1 potato and tomato lineages via expression studies will help understand whether there are effector-genes that could point to the host-specialization. The study will involve looking at genes being expressed during the infection and establishment of the pathogen on the two hosts. Samples will be processed with RNAlater and the resulting material sequenced with Illumina Hiseq (RNAseq). The resulting information will help develop economic, efficient and sustainable management of late blight disease in east Africa, which are host and genotype-specific. Moreover, the study will help test the hypothesis that specific virulence observed on the two hosts is probably controlled by different avirulence genes in *P. infestans*.

Potato and tomato are the most important vegetable crops that suffer the devastating effects of late blight disease caused by *P. infestans*. The disease limits the production of these vegetables especially in the tropical highlands where most small-scale farmers are found. Although different approaches for an effective late blight management in east Africa including use of fungicides, cultivar resistance and farmers’ knowledge and education has been adopted, none of them has been effective due to dynamic changes in *P. infestans* population. In many parts of the developing world, it is assumed that the US-1 lineage was dominant, if not exclusive on potato and tomato and has since been replaced by introduced clonal lineages or sexual populations. It would appear however that the
US-1 lineage was not replaced on tomato in most areas including parts of east Africa. To clarify the real facts regarding host-specialization of the US-1 tomato-adapted genotype, the present study will be undertaken.

The information generated will be part of measures that will help to limit the feared late blight disease hence increase food security and the livelihood of farmers. With increased global trade and movement, the risk of introducing new variants of a particular pathogen is increasing. To better understand the pathogen will provide strong scientific background for policymakers in their decision-making to avoid this to happen. Moreover, the information on the effector differences of the host adapted genotypes will be useful in the development of a regional IDM program against late blight management and will also be vital for national breeding program of potato and tomato.

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<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials needed</th>
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<tbody>
<tr>
<td>Week 1-2</td>
<td>Project discussion and planning</td>
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<td>Import &amp; export permits to send culture plates of the three clonal genotypes to the host institution.</td>
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<td></td>
<td>Sending of isolates to the host institution</td>
<td>LGU mentor visits CGIAR Center</td>
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<tr>
<td>Week 3-4</td>
<td>Prepare pathogen inoculum from the 3 clonal genotypes (KE-1, US-1 potato and tomato and infect the potato and tomato hosts grown in the green house. Inoculate the hosts and do sampling at three time points (24hrs, 48hrs and 72hrs)</td>
<td>Borlaug Fellow travels to U.S.LGU</td>
<td>6-8 weeks old green house grown potato and tomato plants of cultivars with intermediate resistance to late blight.</td>
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<tr>
<td>Week 5-7</td>
<td>RNA preparation</td>
<td></td>
<td>RNA prep kits</td>
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<tr>
<td>Week 8-10</td>
<td>Sequencing</td>
<td></td>
<td>Illumina HiSeq (RNAseq)</td>
</tr>
<tr>
<td>Week 11-14</td>
<td>Bioinformatics analysis and analytical program</td>
<td></td>
<td>Mapping of the <em>P. infestans</em> genome ASM14294v1.20 using TopHat v2.1.0 and Bowtie2 v2.1.0. Differentially expressed genes identified using Cufflinks v2.1.1.</td>
</tr>
<tr>
<td>Week 15-16</td>
<td>Mentor and Fellow to review the research, challenges and results</td>
<td>Follow-up visit by LGU mentor to CGIAR Center</td>
<td>None</td>
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Fellow 6, Kenya 2, Sweet Potato Beta-carotene

Application of caco2 cell for the absorption and metabolism of β-carotene from OFSP puree products

Vitamin A deficiency continues to be a major health problem in sub-Saharan Africa (SSA) which has an estimated prevalence of 19.1% in 36 countries in the region. It causes blindness, retarded growth and high mortality rates. Various strategies such as Vitamin A supplementation, dietary diversity and food fortification are applied to combat this problem, but have not succeeded due to high costs which makes them unsustainable. Biofortification offers a viable and sustainable food based alternative with a huge potential of combating vitamin A deficiency in sub-Saharan Africa. Sweetpotato (Ipomoea batatas L. Lam) is a low-priced crop, which is part of staple foods in most of sub-Saharan Africa that can be a year-round source of vitamin A. Most varieties of biofortified Orange-fleshed sweetpotato (OFSP) contain 3000 - 16000 μg 100 g-1 of β-carotene and this will contribute to 250 - 1300 μg 100 g-1 Retinol Activity Equivalents (RAE).

In SSA, the importance of sweetpotato as a food crop is growing rapidly, out pacing other staple crops. Uganda, Rwanda, Malawi, Tanzania and Kenya are the top producers of sweet potato in the region. Most sweetpotato is consumed as boiled or steamed roots at household level, however processing of OFSP based products offers the opportunity to increase demand for the crop, create value addition and thereby expand the incomes of smallholder producers and improve access to Vitamin A rich products to a wider population. Through the work spearheaded by organization, bakeries and supermarkets are making and selling products such as bread, buns, doughnuts, cookies and cakes by incorporating OFSP puree to substitute up to 50% of wheat-flour in Kenya, Rwanda, Malawi and Mozambique. Processing OFSP in to bakery products can affect amount of β-carotene available for consumption whereas exposure to heat, light, oxygen and changes in mass balance during processing and baking can cause degradation and isomerization of carotenoids, thus adversely affecting RAE. Also, processing affect the physicochemical properties of the food matrix in which β-carotene is contained, which may impair or improve bioaccessibility and bioavailability. To increase utilization of these products and to know how to better direct efforts to develop and implement programs to improve the vitamin A status of populations at risk of deficiency, information on nutritional value, bioaccessibility and bioavailability is needed.

In vitro models can be a useful and productive approach in many if not all of the life sciences. Furthermore, coupling in vitro studies with in vivo testing .The use of Caco-2 cells in defining nutrient bioavailability can be even more productive as in vitro studies are by nature less expensive, rapid, and often allow greater manipulation and simplification for mechanistic studies of physiological processes at the level of the cell. For studies of intestinal absorption of nutrients, the use of intestinal cell cultures has facilitated our understanding of the mechanisms of absorption of many nutrients. Of the major cell lines used in nutrition research, the Caco-2 cell line has become widely used and characterized for a broad range of nutrient uptake studies. In most cases, the use of Caco-2 cell monolayers has proven useful for elucidating mechanisms of nutrient uptake. Although numerous studies have demonstrated the health benefits of OFSP, information regarding the digestion, absorption, and metabolism of OFSP from processed products such as bread, buns, doughnuts is quite limited. To better understand the digestion of these OFSP in processed products will be subjected to an in vitro digestion method which simulates both the gastric and small intestinal phases of the process. These results are the first to demonstrate uptake of OFSP carotenoids and derivatives by human intestinal cells and to support the
potential importance of OFSP processed products as healthier products compared to standard conventional products. The goal of this research is to apply in vitro digestion and caco-2 cells culture methods to estimate bioaccessibility and bioavailability of β-carotene in OFSP puree-wheat bakery products for Sub-Saharan Africa. The following specific objectives will be pursued to a

The specific objectives are

To determine efficiency of carotenoid micellarization during simulated in vitro digestion of OFSP puree-wheat bread, doughnuts and cookies/biscuits at 20%, 30%, 40% and 50% (W/W) substitution.

**Hypothesis:** OFSP puree product paste will be efficient micellized during simulated digestion

To assess uptake and secretion of Micellarized β-carotene by Caco-2 human intestinal cells.

**Hypothesis. β-carotene from OFSP puree products will be taken up, absorbed and metabolized by caco2 cells**

To determine absorption efficiency and bioavailability of β-carotene from OFSP puree products by caco2 cells.

**Hypothesis. β-carotene from OFSP puree will be efficiently absorbed into caca 2 cell and converted to vitamin A**

Organization established food and nutritional evaluation laboratory that is integrated within Biosciences for East and Central Africa (BeCA) hub nutrition platform. This facility has capability to carry out high quality food chemistry and nutritional analysis to support root tubers and banana research programs. Although they continues to offer high valued support to OFSP biofortification, nutrition and product development, there is need to increase its capacity on in vitro and in vivo techniques of assessing carotenoids and micronutrients bioavailability in RTB. If awarded with the Borlaug Fellowship, I will acquire knowledge and skills on different aspects of in vitro and cell culture techniques to assess bioavailability of micronutrients in staple foods and learn more on the opportunities in sub-Saharan Africa. I will be exposed to transferable skills on international best practices in food science, nutrition and health from the American counterparts which will be useful in addressing the challenges of malnutrition and food insecurity in sub-Saharan Africa.

I choose to apply for Borlaug Fellowship, after very careful consideration. I strongly believe that the program will actualize my professional training goals through the exposure to diverse American system offered in this fellowship. This will enrich my knowledge in specific areas of micronutrients bioavailability in staple foods, a gap that I am very keen on filling. Granted an opportunity to be a Borlaug fellow would mean having access to high quality and proven mentorship. I envision myself working as a post-harvest and nutrition expert in the next ten years and I believe that the Borlaug Fellowship will provide me the ideal environment to help me realize my dream. I would also like to engage with the diverse cultures available in the US where I will experience and appreciate new ideas, languages, cultures, philosophies and lifestyles. This would be invaluable to me upon return to my country.
<table>
<thead>
<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials needed</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>Sample Preparation</td>
<td>Sample prepared at CGIAR Center and shipped to host institution</td>
<td>Dry ice for shipping the samples</td>
</tr>
<tr>
<td>Week 2</td>
<td>Travelling and Arrival at host institution</td>
<td>Arrival at host institution Induction in to host institution laboratory Meeting with mentor to review research proposal, methods and work plan</td>
<td></td>
</tr>
<tr>
<td>Week 3</td>
<td>Presentation of Research Proposal</td>
<td>Finalize on research proposal, laboratory methods and work plan Present the research proposal</td>
<td></td>
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<tr>
<td>Week 4</td>
<td>Lab work</td>
<td>Training on Carotenoids extraction and analysis Simulated digestion Coca-2 Cell culturing</td>
<td>Laboratory reagents including; Chromatographic grade solvents, Carotenoid standards, reagents for in vitro digestion, and culturing Caco-2 cells, and Caco-2 cells (American Type Culture Collection (ATCC®HTB37™)).</td>
</tr>
<tr>
<td>Week 5</td>
<td>Lab work</td>
<td>Training on Carotenoids extraction and analysis Simulated digestion Coca-2 Cell culturing</td>
<td>Laboratory reagents including; Chromatographic grade solvents, Carotenoid standards, reagents for in vitro digestion, and culturing Caco-2 cells, and Caco-2 cells (American Type Culture Collection (ATCC®HTB37™)).</td>
</tr>
<tr>
<td>Week 6</td>
<td>Lab work - Data Collection</td>
<td>Carotenoids extraction and analysis Simulated digestion Coca-2 Cell culturing</td>
<td>Laboratory reagents including; Chromatographic grade solvents, Carotenoid standards, reagents for in vitro digestion, and culturing Caco-2 cells, and Caco-2 cells (American Type Culture Collection (ATCC®HTB37™)).</td>
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### LAB WORK - DATA COLLECTION

**Carotenoids extraction and analysis**

**Simulated digestion**

**Coca-2 Cell culturing**

**Laboratory reagents including:**

- Chromatographic grade solvents,
- Carotenoid standards,
- Reagents for in vitro digestion, and culturing
- Caco-2 cells, and Caco-2 cells (American Type Culture Collection (ATCC®HTB37™)).

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**Week 7**

Lab work - Data Collection

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**Week 8**

Lab work - Data Collection

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**Week 9**

Lab work - Data Collection

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**Week 10**

Lab work - Data Collection

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**Week 11**

Lab work - Data Collection

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**Week 12**

Lab work - Data Collection
| Week 13 | Lab work -Data Collection | Carotenoids extraction and analysis  
Simulated digestion Coca-2 Cell culturing | Laboratory reagents including:  
Chromatographic grade solvents, Carotenoid standards, reagents for in vitro digestion, and culturing Caco-2 cells, and Caco-2 cells (American Type Culture Collection (ATCC®HTB37™)) |
|---|---|---|
| Week 14 | Data Analysis | Data analysis; Mean and SD, ANOVA, Tukey’s test  
Tables, charts etc. |
| Week 15 | Report writing | |
| Week 16 | Presentation of report and Return to Kenya | |
Fish is among the main sources for protein in human consumption and also provides essential nutrients required for human health including children growth. Seafood comes from capture and culture fisheries. Last few decades wild capture fisheries is the major sources of fish but recently the capture fisheries production has been stagnant and aquaculture has become more important (FAO, 2016). Growing global population will increase demand for seafood in the future and aquaculture has been seeing to be further growing. In order for the aquaculture industry to grow and to meet future consumption demand, more new technology are required to improve and increase its production but in the same time being more sustainable. Safe and nutritious fish are very important to the people however there are many factors related to fish nutrition that need to be take into the account in order to achieve balance in nutritious consumption, production and sustainability.

In Aquaculture, feed is the major component and the most expensive in its operational cost. Good quality feed is required to improve aquaculture production because fish need all the nutrients especially protein for their growth. It can be produced from a good formulation with ingredients that contain enough nutrients. Basically, fishmeal and fish oil are the major source of protein used in feed ingredients besides soybean and other protein sources.

However, there are some issues in the use of fishmeal and fish oil in the fish feed industry. It was claimed that because of demand from aquaculture, more fish is caught to produce fishmeal or fish oil than for human consumption (FAO 2015). The intense fishing harvest for aquaculture feed may reduce the supply of food fish in this world. Further with the growing in aquaculture, fishmeal demand for feed will increasing. However, threats such as El Nino and others will cause reduction in the supply of fishmeal thus, can contribute to the volatility in fishmeal and fish oil prices.

Currently, there are many efforts to find a solution in fish nutrition, by improving its ingredients and also to reduce the dependence on fishmeal in the diets. The increasing cost of fish food ingredients such as grains, fishmeal, and soybean meals has encouraged researcher to find a cheaper and abundant substitutes. An improved feed formulation which contain less fishmeal but rich in protein is required to supply the nutrients requirement of fish. This contribute for finding novel ingredient to replace fishmeal to produce sustainable feed. However, the major challenge for the aqua-feed industry is to find alternative feed resources that are sustainable and have all the necessary nutrients and qualities as fishmeal, while minimizing undesirable side effects such as slower growth, decreased animal health and changes to the nutritional content of the end product.

My research interest was built on the anticipation to find a solution to produce a sustainable feed for tilapia aquaculture by reducing the use of fishmeal in the feed. In this research I am planning to use alternative ingredients as a fishmeal replacer such as insect meals, plants, algae, animal processing products, or single-cell organisms like yeast and bacteria. However, my preference would be to work on insect meal (eg: black soldier fly meal) and to learn how it’s produced. If there are any available feed additive I would like to combine it with the ingredient to tailor the nutrient requirement as a sustainable protein source for Tilapia. Many ingredients are more complex than fishmeal so detail investigation is needed in order to determine their nutritional values. The detail composition of the ingredients and diet should be evaluated as this is the critical information because
its variability can affect the nutrient value of the ingredients. The ingredient digestibility will also be evaluated because nowadays aquaculture feed are formulated based on the digestibility nutrients and its energy. The digestibility energy and digestibility of ingredients in feed is to measure the amount of the energy or nutrient that is not excreted in faeces. The values of digestible protein in each ingredient are important to formulate a well-balanced and sustainable diets.

Basically, this research can be aligned with Organization research strategy. Organization is implementing its research on FiSH as part of research program. Part of the objectives is to achieve sustainable production of fish to improve the livelihoods and nutrition of poor people. The research on feed is also part of the Organization research component which includes the activities in developing novel feed ingredients for replacement of fishmeal in shrimp and fish diets and to develop novel ingredients for fish feeds.

I believe that my education background in aquaculture nutrition and my experience from my previous employer and my current research in Organization would help me to design this research. Currently in Organization, I am working on Blue Economy Challenge project partnering with CSIRO to provide a sound basis for a smallholder shrimp and tilapia farmers to use a type of feed additive produced by CSIRO. The goal of this project is to develop a cost effective formulation with zero or minimal fishmeal use in the diet but in the same time demonstrates potential increases in growth rates.

In this fellowship I hope to strengthen my skill set in fish nutrition and to learn new technology on feed preparation, feed analysis, and method to measure digestibility and the application of the selected based material. The knowledge gain from this fellowship will contribute to my professional and the opportunity to conduct research with the US university team will enhance our work through the creation of new networking and enhance the collaboration between Organization and the University.

The output and outcome from this fellowship can be share with Organization’s partners, stakeholders, donor and also public through Organization communication platform. Besides it could be shared through social networking such as Research Gate, Linkedin and others. The report and scientific paper will also be produced. It is anticipated that knowledge gain from this fellowship can also be transferred to the local Governments working with Organization such as Malaysia Fisheries, for them to achieve the aquaculture production target and to produce sustainable production.

References:

FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp

FAO 2015. GLOBEFISH - Analysis and information on world fish trade. Rome, Italy.
<table>
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<tr>
<th>Week #</th>
<th>Activity Type</th>
<th>Purpose</th>
<th>Materials needed</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>Initial Visit by mentor</td>
<td>Conduct assessment, finalize work plan including choices of feed ingredients for tilapia feed trial</td>
<td>Journals, reports</td>
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<tr>
<td>Week 2</td>
<td>Initial Visit by mentor</td>
<td>Advice and training by mentor in related to the research plan</td>
<td>Journals, reports</td>
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<td>Week 3</td>
<td>Borlaug Fellowship (Scientist conducts research at U.S. LGU)</td>
<td>Settling, Research preparation and experiment setting</td>
<td>Fish feed trial stations, Fish feed trial units include for digestibility study, Selection of raw materials for feed</td>
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<td></td>
<td></td>
<td>- Set up tanks</td>
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<td>- Set up digestibility experiments</td>
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<td>- Planning for feed formulation including feed ingredients selection and determine the proximate composition</td>
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<td>- Visit to alternative ingredient for fishmeal replacer mills</td>
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<td>Week 4</td>
<td>Borlaug Fellowship (Scientist conducts research at U.S. LGU)</td>
<td>Research preparation and experiment set up</td>
<td>Fish feed trial stations, Feed making station and facilities</td>
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<td></td>
<td>- Prepare feed formulation for Tilapia based on choices of ingredients</td>
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<td>- Feed making</td>
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<td>Week 5</td>
<td>Borlaug Fellowship (Scientist conducts research at U.S. LGU)</td>
<td>Experimental conduct</td>
<td>Fish feed trial stations, Fish feed trial units include for digestibility study, Laboratory for proximate analysis and digestibility analysis</td>
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<td></td>
<td>- Tilapia feeding trial</td>
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<td>- Digestibility study</td>
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<td></td>
<td>- Proximate analysis for feed</td>
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<td>Week</td>
<td>Fellowship Details</td>
<td>Experimental conduct</td>
<td>Analytical Details</td>
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</tbody>
</table>
| Week 6 | Scientist conducts research at U.S. LGU | - Tilapia feeding trial  
- Digestibility study  
- Proximate analysis for feed | - Fish feed trial stations  
- Fish feed trial units include for digestibility study  
- Laboratory for proximate analysis and digestibility analysis |
| Week 7 | Scientist conducts research at U.S. LGU | - Tilapia feeding trial  
- Digestibility study  
- Proximate analysis for feed | - Fish feed trial stations  
- Fish feed trial units include for digestibility study  
- Laboratory for proximate analysis and digestibility analysis |
| Week 8 | Scientist conducts research at U.S. LGU | - Tilapia feeding trial  
- Digestibility study  
- Proximate analysis for feed | - Fish feed trial stations  
- Fish feed trial units include for digestibility study  
- Laboratory for proximate analysis and digestibility analysis |
| Week 9 | Scientist conducts research at U.S. LGU | Laboratory analysis  
Digistibility analysis  
- In vivo and in vitro method | Laboratory for proximate analysis and digestibility analysis |
| Week 10 | Scientist conducts research at U.S. LGU | Laboratory analysis  
Digistibility analysis  
- In vivo and in vitro method | Laboratory for proximate analysis and digestibility analysis |
| Week 11 | Scientist conducts research at U.S. LGU | Data analysis and interpretation | Statistical software SPSS |
| Week 12 | Borlaug Fellowship (Scientist conducts research at U.S. LGU) | Planning for presentation or preparation of journal: - Visit USDA in Washington, DC to present scientific findings, summary of scientific exchange activities, obstacles, and achievements | - peer review journal list - draft journal - Draft report |
Fellow 8, Morocco 1, Chickpea Leaf Miner

Chickpea (*Cicer arietinum L.*) is the fourth largest grain legumes in the world; the cultivated area is up to 13, 98 million ha, producing more than 13, 73 million tones. In Morocco, chickpea is the second important legumes covering an area exceeding 72500 ha and producing more than 62500 tones (FAOSTAT, 2014). Unfortunately, the average yield remains low. This low production of chickpea is related to several factors, mainly drought and diseases and insect pests. Chickpea leaf miner *Liriomyza cicerina* R is the most important insect that causes severe damage on chickpea in Mediterranean region, including Morocco and the Middle East. The grain yield losses caused by this pest were on average 20% for winter planting and 42% for spring-sown crop (Sabraoui et al., 2016)

Currently, farmers use insecticides for the control of Leaf miner. However, the widespread use of pesticides is neither an economic option for farmers nor an environmental friendly means of controlling pests. *Organization* uses integrated Pest Management approach as its strategy for the control of pests and diseases in the areas it serves (North Africa, West and Central Asia) where host plant resistance is the cornerstone of this approach.

My fellowship will focus on the *study of genetic variability and population genetic structure of the chickpea leaf miner* in Morocco. During my period in US, I hope to benefit from practical knowledge on *molecular techniques related to insects* by gaining an in-depth understanding and practical experience about the identification of population structure, geographical distribution, and evolution of *Liriomyza cicerina* biotypes.

The study of genetic variability and evolution of *L. cicerina* populations in the different growing areas of chickpea in Morocco through the support of the fellowship will generate important information on the virulence of the pest. This type of information will help breeders design adequate gene deployment strategies and select the adequate varieties to plant in the different regions of the country as such to others countries of *Organization* mandate.

My research interest being integrated pest management on cereals and food legumes and my scientific background on ecology from my Master degree fit in well with my research/training proposal. **How will your participation in this program contribute to the enhanced agricultural productivity and/or food security in your country?**

My participation in this program will help me gain experience on the population genetics of the chickpea leaf miner. Using this knowledge and results from my studies will help breeders develop and use the right germplasm for the different chickpea producing areas in Morocco. The development of these resistant cultivars to Leafminer will contribute in enhancing chickpea production in Morocco and thus increase the livelihood of farmers in the country. The results generated in Morocco will also be used, if positive, through other countries of *Organization* mandate.

**Research Plan**
The research objective is to study the genetic variability, population structure and geographical loci of chickpea leaf miner in six producing regions of chickpea in Morocco using molecular techniques.
Week 1-2: Orientation with the lab and insect molecular genetics training concerning the use of SSR, DNA barcoding, DNA extractions and PCR amplifications.
Outcome: Good knowledge on insect molecular techniques.

Week 3-4-5: DNA extraction of chickpea leaf miner by using Kits methods (Quiagen) and amplification of DNA by PCR techniques.
Outcome: Isolation and amplification of Liriomyza cicerina DNA.

Week 6-7: Performing the electrophoresis of different samples from six regions of Morocco.
Outcome: Identification of genetic variability, population structure and its geographical distribution of the chickpea leaf miner.

Week 8-9-10: Collect and analysis of data.
Outcome: writing a final report/publication.

Week 11-12: Establishing network with the lab and writing proposal for future collaboration.
Outcome: Network and collaborative project
Fellow 9, Morocco 2, IPM

In Morocco, food legumes occupy the second place in the crop rotation system after cereals. Legumes are a big part of Green Morocco Plan (GMP) Strategy that started in 2008 which aims to boost legumes production in growing regions between 40 to 80% by 2020. Unfortunately, the average yield remains low. The weak productivity of these crops is related to several factors of abiotic stress (mainly drought) and to a large number of insect pests, that cause extensive damage and require the development of control methods.

Pesticides play a sensitive role in food Legume systems in Morocco. They are applied in order to protect crops, but they can have negative impacts on environment and human health. Integrated Pest Management (IPM) integrates host plant resistance, chemical, biological, and agrotechnical methods of pest control.

In this approach, Insect pheromones, especially sex pheromones, have successfully contributed to pest management programs around the world since many years. This technique of pest control promises to be an important component of the ongoing challenge to develop alternatives that may help to solve major environmental and human health problems associated with chemical pesticide. Pheromones also facilitate early pest detection or and could be used in Mass trapping or disruption of mating in populations of insects. Research is needed for *Lixus algirus* called also stem borer, one of most serious pest of faba bean in Mediterranean areas including Morocco. This fellowship will focus on the chemical identification and isolation of the main pheromones of this insect pest but also study of their behavioral effects. I hope to gain an in-depth understanding and practical experience about the identification and characterization of the main chemical signals compound used by this insects, and to study the Electrophysiological Responses of the Male Antenna to Compounds Found in the Female Sex Pheromone Gland of Stem borer. My research interest on Pheromone use started on 2013, by monitoring and studying the Population dynamics of the three Lepidoptera on Mint crop using synthetic sex pheromone, my scientific background fits in well with my program proposal.

For other part of this fellowship, I particularly would like to learn how the Environmental Protection Agency (EPA) as primarily responsible for regulating pesticides in the United States functions in general with regard to pesticide use. Since that there are no pesticides registered against insects of pulses (Chickpea, Lentil and Faba bean) in Morocco, there is a strong need to identify and to develop our knowledge concerning new selective chemical insecticides, soft pesticides and biocides registered on major insects pests of food legumes crops in USA: the amount, frequency, and timing of their use for best management of insect pests and less risk on natural enemies, the environment and on human health.

My interest as a Research Assistant on Food Legume Entomology is to propose in our research program at *Organization* the best active ingredients that when used based on early pest detection by Pheromone traps in combination with an effective natural enemy, or other tactics may provide more comprehensive prophylactic and remedial treatments in the context of an integrated pest management program (IPM). My two years working at *Organization* I have realized that advances in IPM mean that the farmers can produce more with low cost. All IPM options tested and developed
will be extended to farmers through participatory approaches that can improve food security and sustainable productivity of Food legumes in Morocco.

Therefore, my participation in this program will contribute in enhancing of insect pest surveillance and detection by identification of sex pheromone, a very important aspect in IPM approach, and to propose the best choice of insecticides selected from the EPA Office Pesticide Programs, to conduct in several field and Lab trials at Organization.

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<thead>
<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials needed</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Introduction and orientation at Host Institution / Laboratory.</td>
<td>Review should be done at the end of 2 week, this review include previous research work theoretical knowledge on some topic.</td>
<td>Books, articles, newsletter on the some topics.</td>
</tr>
<tr>
<td>Week 2</td>
<td>Development and Presentation of the research proposal.</td>
<td></td>
<td></td>
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<tr>
<td>Week 3</td>
<td>Familiarizing with laboratory facilities.</td>
<td>Introduction and training on different protocols and methods for pheromones extraction, analysis and the use of techniques (GC/MS, Electroantennogram Analysis ...)</td>
<td>Gas Chromatography/Mass Spectrometry (GC/MS) and Electroantennogram and others laboratory tools used for detection of Pheromone.</td>
</tr>
<tr>
<td>Week 4</td>
<td>Insect Collection and Extraction of Pheromone</td>
<td>Collecting the weevils and Extraction of Abdominal glands from weevil then stored until analysis.</td>
<td>Fine brand new razor, chloroform, screw cap vials, Freezer.</td>
</tr>
<tr>
<td>Week 5</td>
<td>Pheromones determination using (GC/MS).</td>
<td>The components of the extract will be identified by matching the peaks, comparing mass spectra of the peaks and those from literature.</td>
<td>Gas Chromatography/Mass Spectrometry (GC/MS). Literature for comparing peaks.</td>
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<tr>
<td>Week</td>
<td>Activity</td>
<td>Activity</td>
<td>Activity</td>
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<tr>
<td>Week 6</td>
<td>Electrophysiological Responses of the Male Antenna to Compounds Found in the Female Sex Pheromone Gland of faba bean Stem</td>
<td>Study of sensitivity of receptor cells to sex pheromone extracts.</td>
<td>Electroantennogram Analysis. Female Sex Pheromone identified.</td>
</tr>
<tr>
<td>Week 7</td>
<td>Organizing and analysis of data obtained.</td>
<td>Calculation, interpretation of results.</td>
<td>Different software (Statistical software...)</td>
</tr>
<tr>
<td>Week 8</td>
<td>Learning from the Environmental Protection Agency (EPA), Identify insecticides registered on major insect pests of Food legumes crops in USA.</td>
<td>Understanding the role of EPA, Organization, activities, and identify insecticides registered on major insect pests of Food legumes crops in USA.</td>
<td>Manual, guide.</td>
</tr>
<tr>
<td>Week 9</td>
<td>Report writing on activities conducted, experience gained from training.</td>
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Fellow 10, Peru, PVY

Potato virus Y (PVY) is an important plant pathogen, whose host range includes potato and others economically important crops such as, tobacco, tomato, and pepper. PVY has a worldwide distribution and possess a big variability, however the mechanisms that promote and maintain its population structure and genetic diversity are still unclear.

The study of evolution and diversity of this highly damaging potato pathogen will improve the management of risk associated with PVY and will also allow to anticipate the next emerging problems associated with the genetic variability of this virus to finally improve the available detection methods and therefore, the phytosanitary status of the germplasm to be distributed. Organization currently have initiated a study using a next generation sequencing approach to verify organization’s PVY virus collection (30 isolates) which is an important effort to develop methodologies to diagnostic, if not all almost all PVY strains. Additionally to organization’s PVY virus collection, 300 plants were collected from different potato producer regions in Perú, in surveys executed in different time (2009 – 2011). This project will take the information from these surveys to the next level by characterizing and analyzing the genetic diversity and also variability between same strains collected in different regions and time.

The objective of this project will be to characterize isolates of PVY virus from over 300 samples collected in the principal cities producer of potato in Peru, using small RNA sequencing and to associate these strains with the geographic origin of the sample to address the relative distribution of strains, also improve the description of the diversity of this potato pathogen in Peru and finally determinate the variability between strains over the time. This project will involve capacity building in next generation sequencing, data analysis, bioinformatics, phytopathology and viral sequence analysis. The outcome of this project, in addition to the formation of a long-term collaboration between organization and a U.S. University, will provide the information needed to improve diagnostic tools for PVY strains present in the potato germplasm.

My background in molecular biology, plant virology, and my 10 years of experience working at Virology laboratory give me the tools to achieve the goals of this project. In addition, this opportunity would contribute to capacity building in NGS technology and data analysis and facilitate technology and knowledge transfer to other staff at organization after the project is finished.

Potato virus Y (PVY) is a serious problem in potato production regions, substantially affecting both tuber yield and quality. PVY is well-known for their propensity to rapid evolution through accumulation of mutations and even more rapidly through recombination. Biological significance of these recombination events between PVY strains is not yet fully understood, In recent research it has been noticed that PVY-NTN can be found all over America, in Colombia and Chile phylogenetic analysis using capsid protein sequences show that the analyzed isolates cluster in a group closely related to PVY-N and PVY-NTN; However there is still little information available about recombinant PVY strains present in Peru and their variability. This project allow us obtain Advances in knowledge of genomic diversity of PVY to finally provided more and more insights into PVY evolution. In this sense, the knowledge of the variability of the circulating species in Perú and the additional possibility of having highly reliable, sensitive and specific diagnostic methods are highly valuable elements to manage crops accordingly and contribute to the control of this virus.
Fellow 11, Philippines, CSA

My current work is on climate-risk vulnerability and ex-ante Climate Smart Agriculture (CSA) prioritization. This research proposal can link my research interest on impact evaluation and my current work. My colleagues at organization have strong expertise on CSA but an additional mentor, who is an expert on impact evaluation, is needed in order to complete my proposed research. Aside from new learnings and networks, I hope to accomplish a research design that can be successfully implemented in my country after the fellowship.

In the Philippines, the Department of Agriculture (DA) through its Adaptation and Mitigation Initiative in Agriculture (AMIA) is supporting local communities to plan and implement strategies in managing climate risks. In 2016, AMIA launched integrated field-level action for establishing CSA communities. AMIA envisions to achieve outcomes at scale by promoting the proven CRA practices, from its initial pilot sites to wider agricultural landscapes across the country. Thus, evidences on the effectiveness of CSA practices could help realize this vision. Moreover, my research outputs would contribute to organization’s commitment to helping the Philippine government in its prioritization and investment planning for CRA practices.

The goal of my research is to evaluate the effects of CSA practices and factors affecting adoption to support achievement of widespread adoption of CSA. Specifically, it aims to:

- Describe the adopters and non-adopters of CSA practices using their socio-economic characteristics;
- Identify the factors influencing the adoption of CSA practices;
- Determine the ex-post effects of CSA practices on yield, selected input costs, and environmental benefits; and
- Provide a robust estimation of the effects of CSA practices on yield and selected inputs costs using rigorous counterfactual framework.

Given the impacts of climate change, CSA has received significant attention in the past years. However, like most new technologies, CSA practices remain at low levels of adoption because of the lack of evidences on the effectiveness of these approaches.

Evaluation of the potential economic as well as environmental outcomes resulting from such investments through the adoption of CSA practices (i.e., productivity enhancing and/or risk coping and/or resource conserving practices) are necessary for donors, policy makers, development agents, and researchers. It is important to validate the effectiveness of these approaches to aid decision makers in planning for investment in the dissemination of effective CSA practices.

Selection bias is a major constraint in assessing impacts. This bias occurs when pre-existing conditions affect outcomes in a way that is not truly attributable to the intervention. For example, farmers with larger farm area achieve higher rates of return than farmers with smaller farm area even if they adopt similar technologies due to economies of scale. My research will provide a more accurate assessment of the effects of CSA practices, which have important implications for widespread adoption of these
practices. A rigorous counterfactual framework (e.g., Propensity Score Matching, Difference in Difference, Randomized Control Trial) will be used to accurately evaluate effects of CSA practices on key outcomes (e.g., income). Moreover, my research will explore extended cost and benefit analysis to account for environmental costs and benefits of adopting CSA practices.

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<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials needed</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>Orientation</td>
<td>Consultation and finalize workplan with mentor, meeting with other experts</td>
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<tr>
<td>Week 2</td>
<td>Desk study (literature review)</td>
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<td>Access to journal articles</td>
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<td>Week 3</td>
<td>Framework development</td>
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<tr>
<td>Week 4</td>
<td>Consultation</td>
<td>Consultation with mentor and USDA experts</td>
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<tr>
<td>Week 5</td>
<td>Methodological design (detailed evaluation plan, summarizing sample, location, data collection plan, and key indicators)</td>
<td>Detailed ex-post impact evaluation plan</td>
<td>CAPI software license</td>
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<tr>
<td>Week 6</td>
<td>Consultation</td>
<td>Consultation with mentor and USDA experts</td>
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<tr>
<td>Week 7</td>
<td>Consultation</td>
<td>Consultation with mentor and USDA experts</td>
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<td>Week</td>
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<td>Week 9</td>
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<tr>
<td>Week 10</td>
<td>Report writing</td>
<td>Summary report including analysis of pilot study</td>
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<td>Week 11</td>
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<tr>
<td>Week 12</td>
<td>Survey questionnaire refinement and identification of study site of full impact evaluation</td>
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<tr>
<td>Week 13</td>
<td>Visit by mentor to study site and meet with stakeholders/donors</td>
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<td>Week 14</td>
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**Fellow 12, Tanzania, Seed Movement**

Based on my research interests and experience, I propose to use the CGIAR Norman Borlaug Fellowship in understanding seed flow at the Lake Zone, Tanzania and its effect on quality of seed and spread of viruses. Additionally, the opportunity will enable me to learn modeling techniques relevant in studying epidemiology of crop pests and diseases under different climate change scenarios. Specifically, I would like to study how human activities and relationships influence seed movement and in turn, affect the epidemiology of sweet potato viruses. This will consist two components:

a) Assessing the relationships between farmer multipliers, their customers and other stakeholders within the seed system. This includes understanding factors that influence a farmer’s decision to buy from a certain multiplier.

b) Studying how seed movement contributes to the spread of sweet potato viruses.

To achieve the first component interviews will be conducted with select stakeholders along the seed value chain including farmer multipliers, pre-basic seed producers and farmers. The data obtained will be analyzed using the Impact Network Analysis (INA) tool to understand socioeconomic factors affecting farmer access to clean seed. Impact Network Analysis is a tool developed by the University of Florida to assist in evaluating system management strategies such as crop breeding networks, seed systems, and integrated pest and disease management.

The information obtained from the first component will help identify areas in which to conduct the second component. The second component will involve collecting leaf samples from sites identified based on the level of seed flow. The leaf samples will then be tested for viruses through polymerase chain reaction (PCR). The results obtained will be fed into the INA tool to generate the biophysical layer of the seed system. Data on pathogen movement will be used to validate the temperature dependent virus transmission sub-model developed by CIP to enable predictions of risk and potential for virus spread on global, regional or national scales.

My research interest is to enhance farmers’ access to quality planting material for vegetatively propagated crops which are key staples in many nations within sub-Saharan Africa. I am currently involved in efforts geared towards developing a sustainable seed system for sweet potato at the Lake Zone, Tanzania. My focus is to enhance the capacity of farmer-multipliers to produce clean seed as an enterprise. This involves training them on technical aspects of seed production including capacities to identify and manage sweet potato viruses as well as insect pests. For instance, with partners from the National Agricultural Research Institutes in Tanzania and Uganda we tested the use of low cost insect-proof net tunnels at seed-producer level to protect planting material from attack by virus vectors. As part of this initiative I investigated degeneration of planting material maintained in the net tunnels over time following virus infection. This activity was also part of a larger project aimed at developing seed degeneration models for roots, tubers and banana (RTB) crops. This includes studying comparative epidemiology of seed degeneration to identify and understand scenarios whereby on-farm management, resistant varieties, and seed replacement management strategies would be most optimal. Further to the degeneration research I am interested in understanding the current distribution of sweet potato viruses at the Lake Zone, Tanzania and how it will vary under different climate change scenarios. Modeling the dynamics of sweet potato viruses and vectors will
help address their effects on crop productivity under various climatological conditions. Due to climate change the world is currently facing erratic weather patterns and consequently differing pest and disease pressures which makes it difficult to manage using existing knowledge. Smallholder farmers in developing countries are the most affected since they are not able to adapt given their low economic capacities. Addressing this requires generating information that will aid the precise prediction of changes in abiotic and biotic constraints with climate change. I am interested in learning modeling techniques to better understand how changing virus prevalence due to climate change and farmer practice in reusing material for several years could impact crop yield.

Knowledge generated through this Fellowship will help seed system practitioners understand stakeholder interactions within the seed system i.e. who is talking to who, why and how this can be improved to contribute towards a self-sustaining seed system. A better seed system will increase farmer access to quality planting material therefore reducing yield losses and contributing directly to improved food security and livelihoods. Understanding how sweet potato virus incidences will change in the future vis a vis climate change will help develop reliable management practices. Good management of viruses will increase productivity hence lead to increased incomes and better livelihoods among smallholder growers.

In addition, the fellowship will enable me expand my knowledge on sweet potato seed systems especially in deciding which technological and market interventions are suitable for who, where and when. Studying the spread of viruses will help enhance my capacity in assessing current and future distribution of pests and diseases.

Activities to be conducted in the USA:
- Impact network analysis of seed movement.
- Learning modeling techniques relevant to assess the impact of climate change on prevalence of crop pests and diseases and hence yield.

Activities to be conducted in Tanzania:
- Stakeholder interviews on seed movement.
- Collection and PCR testing of leaf samples from select locations at the Lake Zone.
- Validation of the temperature dependent virus transmission sub-model using data on virus spread.

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<tr>
<th>Week #</th>
<th>Work Subject</th>
<th>Summary</th>
<th>Materials Needed</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Visit by mentor and fine-tuning research activities</td>
<td>Meet U.S. LGU mentor and revise work plan. Agree on specific research activities and methodologies.</td>
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</tr>
<tr>
<td>Week 2</td>
<td>Develop questionnaires and identify areas to conduct the survey</td>
<td>Develop research tools and agree on areas to conduct the interviews.</td>
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<tr>
<td>Week 3</td>
<td>Conduct interviews with farmer multipliers and farmers</td>
<td>Generate information on interactions between farmer multipliers and their customers including what influences decisions to sell/buy.</td>
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<tr>
<td>Week 4</td>
<td>Interview other seed system stakeholders including pre-basic seed producers</td>
<td>Data obtained will help understand the relationships between farmer-multipliers and other seed system stakeholders.</td>
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<tr>
<td>Week 5</td>
<td>Analyze survey data and generate a report.</td>
<td>A report on interactions along the seed value chain will be developed to help understand dynamics of seed flow. Data obtained will also be analyzed through INA in the next step.</td>
<td></td>
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<tr>
<td>Week 6</td>
<td>Settling in the USA</td>
<td>Familiarize myself with the LGU host and prepare for Impact Network Analysis of data obtained from the Lake Zone, Tanzania.</td>
<td></td>
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<tr>
<td>Week 7</td>
<td>Impact Network Analysis of data obtained from Tanzania</td>
<td>Identify socioeconomic linkages among seed system stakeholders.</td>
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<tr>
<td>Week 8</td>
<td>Learning modeling techniques relevant to assess the impact of climate change on prevalence of crop pests and diseases and hence yield.</td>
<td>Learn techniques essential in modeling the dynamics of pest and diseases under various climatological conditions. This will include learning how to use remote sensing and GIS tools.</td>
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<tr>
<td>Week 9</td>
<td>Learning journeys to select sweet potato seed and root producers in the USA</td>
<td>Exchange experiences and learn best practices in sweet potato seed production and identify technologies/elements that can be applied in sub-Saharan Africa.</td>
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</table>
Fellow 13, Uganda, Bean Germplasm

My general objective is to enhance my knowledge and skills to improve the quality of our breeding output which aims at reducing hunger and poverty and improving nutrition in the tropics through development and dissemination of resilient and nutritious bean (Phaseolus vulgaris) germplasm. Organization implements its Bean Research in Africa through a program made up of an international network of bean researchers, 30 national agricultural research institutions, and more than 350 partner organizations. As a result of the program’s interventions, more farming families have access to improved and marketable bean varieties, new crop management techniques, micronutrient rich bean based products, niche market varieties and products, and bean related skills and knowledge that help to increase incomes and boost food and nutrition security. This fellowship opportunity is envisioned to positively impact bean breeding activities and ultimately contribute to food security in Africa. I am proposing activities that will contribute to the modernizing of the common bean breeding program so as to increase the rate of genetic gains being delivered. I envisage this program to increase in size (both scale and quality) and to result in more accurate selection (higher heritability) through higher-quality phenotyping, DNA marker technology and better use of phenotypic and genotypic data in making selection decisions and faster breeding cycles in developing superior common breeding lines that will be utilized in African environments. Some of these activities include; early generation selection, high throughput field and molecular data generation and analysis for both gene discovery work and marker assisted selection (MAS). Specifically; I propose genomic selection tool through which I will use phenotypic and genotypic data of the parental lines to predict performance of the progenies and advance best lines as well as select new parents for new crosses in the early generations. Through this, I will estimate the heritability of the different traits (resistance to BCMV/BCMNV, yield and iron/zinc,) and the gains being made. I believe that this work will greatly only enhance my ability for germplasm improvement and envisage learning more especially on QTL related work from my US mentor. I also hope to get an exposure to field management practices, harvest and post-harvest activities from which I hope to learn new ideas of improving our data management system and seed quality maintenance, to reduce post-harvest losses. There is also much interest in getting exposure to mechanized activities that contribute to quality seed production in common bean for possible adoption and maintaining seed flows when dealing with many partners.

For the genomic selection activities, I am suggesting introgression of bc3 and l genes for resistance to Bean Common Mosaic Virus (BCMV) and its necrotic strain (BCMNV) in four market classes (small red, long sugar, large brown and short sugar) of climbing bean with high seed iron (61.8-82.0 ppm) and zinc (32.9-45.4 ppm) content and high yield. The climbing beans were developed from three high iron parents (MAC42, GITANGA and NGWIN/CAB2) and they were susceptible to BCMV in field evaluation trials conducted at Kawanda and Kachwekano in Uganda. Incidences of Angular leaf spot, root rot and Anthracnose were low possibly due to the low disease pressure recorded during the evaluation period. Validation of the presence/absence of the bc3 and l genes that confer resistance to BCMV/BCMNV will be conducted using the SW13 and ROC11 (or an identified SNP) markers. Crosses will be done using selected lines with pyramided resistance genes; prr, Phg2, Co4, Co5, l and bc3 for four key diseases (Pythium root rot, Angular leaf spot, Anthracnose and BCMV/BCMNV developed at organization (Mukankusi et al, 2015; Okii et al., 2016) and the selected high iron/high yield lines in the different market class backgrounds. The main objective is to introgress resistance genes for BCMV/BCMNV in all the four market classes while improving both Fe/Zn content and yield. The additional resistance genes in
the background will be beneficial considering that all these diseases are major challenges farmers are currently facing.

In conclusion, I believe this exchange program will expose me to greater ways for improving my contribution to the bean breeding program at organization. As such more new improved lines will be available to the organization partners especially considering the precision of marker assisted selection and line development within a shorter period of time. My interaction with my US mentor and his breeding program team in this field could also result in future research collaboration that could lead to a better enhanced agricultural productivity and food security in Uganda.

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<tr>
<th>Year</th>
<th>Week</th>
<th>Work subject</th>
<th>Summary</th>
<th>Materials needed</th>
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<tbody>
<tr>
<td>1</td>
<td>Week 1</td>
<td>Initial visit by mentor to CGIAR center</td>
<td>Visiting research facilities at CGIAR center and finalizing on work plan</td>
<td>Travel documents</td>
</tr>
<tr>
<td>1</td>
<td>Phenotyping at CGIAR center</td>
<td>Phenotype selected lines (desirable background) in BCMV/BCMNV in the screen house and field (obtain yield, Iron and Zinc data) and estimate heritability</td>
<td>Screen house, Pots/Buckets, Soil &amp; fertilizer, DNA extraction kit</td>
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<tr>
<td>1</td>
<td>Week 2-5</td>
<td>Orientation and initiation of research at LGU</td>
<td>Visit the research facilities and get acquainted with LGU breeding program. Genotype each line and develop genomic selection model of breeding value (predict breeding value of individuals and select superior lines for generating F1)</td>
<td>Travel documents, DNA shipment documents, Genotyping protocol, Markers (SW13 and ROC11) and other laboratory reagents</td>
</tr>
<tr>
<td>1/2</td>
<td>Population development at CGIAR center</td>
<td>Generate about 50 F1 seeds per cross and advance to F2 (about 300 F2 seeds expected per population)</td>
<td>Screen house, Pots/Buckets, Soil &amp; fertilizer, Crossing kit</td>
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<tr>
<td>2</td>
<td>Week 6-10</td>
<td>Population development (cycle 2) and selection of best F2 at CGIAR center</td>
<td>Genotype F2 (Use genomic selection model to predict the value of each and select best F2 lines) Field management practices Harvest and post-harvest practices</td>
<td>Travel documents DNA shipment documents Genotyping protocol Markers (SW13 and ROC11) and other laboratory reagents</td>
</tr>
<tr>
<td>2</td>
<td>Data handling and presentation of</td>
<td>Cross selected F2 and obtain F1, Self F1 to obtain F2 Genotype F2 (Use genomic selection model to predict the value of each and select best F2 lines) Self the best F2 (for field breeding/phenotyping)</td>
<td>Screen house Pots/Buckets Soil Crossing kit</td>
<td></td>
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<tr>
<td>2</td>
<td>Week 10-16</td>
<td>Data analysis and reporting Power point presentation(s)</td>
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<td>research findings</td>
<td>Manuscript development and publication</td>
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