The Department of Agriculture (USDA) – Foreign Agricultural Service (FAS)
Global Programs

Notice of Funding Opportunity (NOFO)
2020 Norman E. Borlaug International Agricultural Science and Technology Fellowship

NOTE: If you are going to apply for this funding opportunity and have not obtained a Data Universal Numbering System (DUNS) number and/or are not currently registered in the System for Award Management (SAM), please take immediate action to obtain a DUNS Number, if applicable, and then to register immediately in SAM at www.sam.gov. It may take 4 weeks or more after you submit your SAM registration before your registration is active in SAM. Detailed information regarding DUNS and SAM is also provided in Section D of this NOFO, subsection, Content and Form of Application Submission.

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

A. Program Description

BACKGROUND

Since 2004, the U.S. Congress has made funds available to the Borlaug Fellowship Program to advance USDA's agricultural research goals of promoting collaborative programs among agricultural professionals of eligible countries, agricultural professionals of the United States, the international agricultural research system, and United States entities conducting research by providing Fellowships to individuals from eligible countries who specialize or have experience in agricultural education, research, extension, or other related fields. Fellowships promote food security and economic growth in eligible countries by educating a new generation of agricultural scientists, increasing scientific knowledge and collaborative research to improve agricultural productivity, and extending that knowledge to users and intermediaries in the marketplace. The collaborative nature of the training and research programs not only benefits the Fellow, his or her home institution, and partner country; the U.S. host institution, its professors, researchers, and students; and the global agricultural sector by improving agricultural productivity, systems, and processes in partnering nations through the transfer of new science and agricultural technologies.

Objectives

USDA identifies Borlaug Participants based on country-specific topics of importance to international agricultural trade. USDA then places Participants with U.S. research institutions for 10-12-week intensive programs. These programs are expected to contribute to the strategic goals and objectives of the Participant and the institutions through a hands-on experience in a "real-world" agricultural research scenario, providing opportunity for application of research agendas where they can have a direct impact on food security and economic growth in an emerging economy. It is hoped that host institutions will share the knowledge gained through the program in their classroom and extension

work with their faculty, students, extension officers, and constituents; and that they will continue to maintain professional contacts with the Participants after their departure from the United States.

SCOPE OF WORK

The selected institution will design and implement a training program to meet the Participant's proposed research goals and objectives to the closest extent possible. The selected institution will also include leadership and communication training to help the fellow better communicate research conducted under their fellowship to policy makers in their respective countries to help implement science based agricultural policies. The Participant's proposed research and training objectives, and full descriptions are in the appendix which can be quickly accessed vis the link in the table:

Fellow specific objectives:

- **Algeria – Animal Disease Eradication (page 19)**
- **Algeria – Leishmaniasis Risk Assessment (page 20)**
- **Algeria – Indigenous Plant use as Bio-Insecticide (page 23)**
- **Egypt – Food Contact Material Assessment (page 25)**
- **Egypt – Food Additives and Regulations (page 27)**
- **Jordan – Genetically Engineered Regulations (page 28)**
- **South Africa – Foodborne Illnesses Regulations (page 30)**
- **Tunisia – Conservation of Tunisian Olives (page 32)**
- **Bangladesh–Highly Pathogenic Avian Influenza Bioinformatics (page 34)**
- **Bangladesh – Newcastle Disease Vaccine (page 36)**
- **Cambodia–Vapor Heat Treatment of Fruit Fly (page 38)**
- **Costa Rica–Banana Fusarium Wilt (page 40)**
- **Guatemala–Medfly Gene Editing (page 42)**
- **Honduras–Aflatoxins and Mycotoxins in Food Grains (page 44)**
- **Mongolia–Animal Health (page 46)**
- **Philippines–Biotechnology/Animal Health (page 48)**
- **Sri Lanka– Rice Biotechnology (page 49)**
- **Sri Lanka–Rice Biotechnology (page 51)**
- **Sri Lanka–Biotechnology/Plant Health (page 53)**
- **Sri Lanka–Blister Blight Disease in Tea (page 55)**
- **Vietnam–Tilapia Aquaculture (page 57)**
- **Vietnam–Soybean Biotechnology (page 59)**
- **Vietnam–African Swine Fever Vaccine Development (page 61)**
- **Georgia – Genotypes and Population Structures of Salmonella (page 63)**
- **Kazakhstan– Genes Associated with Grain Quality (page 65)**
- **Turkey– Weaken Wheat Phenylalanine Ammonia-lyase (PAL) Gene Promotor (page 67)**
- **Turkey – Stem Rust Resistance Genes (page 70)**

- **Turkey– Apomixis in Gene Level (page 72)**

PLACE OF PERFORMANCE

- The applicant is expected to host participants at a research facility on their campus in the United States.
- The Participant is expected to spend two to three days at the USDA in Washington DC at the commencement and at the end of their fellowship program to brief and debrief with key USDA officers. The mentor or PI will be expected to make all necessary travel arrangements as well as accompany the Participant during both trips.
- The mentor is expected to make a reciprocal visit of up to two weeks to the participant's home institution, which may be in a developing country.

Issued By
Foreign Agricultural Service, Global Program, Fellowship Program

Catalog of Federal Domestic Assistance (CFDA) Number and Title
10.777 Norman E. Borlaug Exchanges International Science and Technology Fellowship Program

Notice of Funding Opportunity Title
2020 Norman E. Borlaug International Agricultural Science and Technology Fellowship

NOFO Number
USDA-FAS-10777-0700-10.-20-0008

Authorizing Authority for Program
The legislative authority for the Scientific Exchanges Program is provided in Sec. 7139 of the Food, Conservation, and Energy Act of 2008 (7 USC 3319j), as amended.

Appropriation Authority for Program
Further Consolidated Appropriations Act, 2020 (PL 116-94)

Announcement Type
New

B. Federal Award Information

Award Amounts, Important Dates, and Extensions

Available Funding for the NOFO:	up to $1,700,000 total with individual awards being up to $60,000 each.
Projected Number of Awards:	up to 28

Period of Performance: 24 months

Projected Period of Performance Start Date(s): September 1, 2020.

Projected Period of Performance End Date(s): August 31, 2022.
The award period of performance will begin approximately September 1, 2020. However, the implementor has up to 12 months from the beginning of the award to ensure the Fellow begins his or her fellowship. The Fellow will have up to 3 months to complete the assigned work. Extensions, with or without cost, may be considered; please see Section H.

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

Funding Instrument
USDA will enter into a cost-reimbursable agreement under 7 USC § 3319a with selected recipients. Program staff will maintain involvement in the administration of the Scientific Exchanges Program.

C. Eligibility Information

Eligible Applicants
State cooperative institutions or other colleges and universities in the United States

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

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

Maintenance of Effort (MOE)
MOE is not allowable.

D. Application and Submission Information

Key Dates and Times

Application Start Date: June 16, 2020

NOFO Posted Date: June 16, 2020

Application Submission Deadline: August 7, 2020 at 11:59PM EDT

Anticipated Funding Selection Date: August 21, 2020

Anticipated Award Date: September 1, 2020

Address to Request Application Package
This NOFO represents the full application information.

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

Content and Form of Application Submission

- Required forms and certifications, including:
- SF-424 version, signed by the applicant
- SF-424A version. This should be accompanied by a detailed budget and a detailed budget narrative (NOTE: A budget narrative must be provided). All line items should be described in sufficient detail that would enable FAS to determine that the costs are reasonable and allowable for the project per federal regulations. The cost categories should be explained in this manner:
    - **Personnel**: Costs of employee salaries and wages. For each staff person, provide the name (if known), title, time commitment to the project as a percentage of a full-time equivalent (FTE), annual salary, and grant funded salary. Do not include the costs of consultants. Consultants are to be included under "Contractual."
    - **Fringe Benefits**: Costs of employee fringe benefits unless treated as part of an approved indirect cost rate. Provide the method used to calculate the proposed rate amount. If a fringe benefit has been negotiated with, or approved by, a cognizant federal agency, attach a copy of the negotiated fringe benefit agreement. If no rate agreement exists, provide a breakdown of the amounts and percentages that comprise fringe benefit costs such as health insurance, FICA, retirement insurance, taxes, etc. Identify the base for allocating these fringe benefit expenses. (Attach the agreement to the application package.)
    - **Travel**: Costs of project-related travel by employees of the applicant organization (do not include costs of sub-contractor or consultant travel). For each proposed trip, provide the purpose, number of travelers, travel origin and destination, number of days, and a breakdown of costs for airfare, lodging, meals, car rental, and incidentals. The basis for the airfare, lodging, meals, car rental, and incidentals must be provided, such as past trips, current quotations, Federal Travel Regulations, etc.
    - **Equipment**: Equipment is not permitted for this award. Equipment is defined as any article of nonexpendable, tangible personal property having a useful life of more than one year and an acquisition cost which equals or exceeds the lesser of (a) the capitalization level established by the organization for financial statement purposes, or (b) $5000. For each type of equipment requested, provide a description of the equipment, the cost per unit, the number of units, the total cost, and a plan for use on the project, as well as use or disposal of the equipment after the project ends. An applicant organization that uses its own definition for

equipment should provide a copy of its policy or section of its policy which includes the equipment definition.

NOTE 1: Acquisition cost means the net invoice unit price of an item of equipment, including the cost of any modifications, attachments, accessories, calibration and maintenance services, or auxiliary apparatus necessary to make it usable for the purpose for which it is acquired. Ancillary charges, such as taxes, duty, protective in-transit insurance, freight, and installation shall be included in or excluded from acquisition cost in accordance with the organization's regular written accounting practices.

NOTE 2: Prior to the purchase of equipment in the amount of $5000 or more per unit cost, the Recipient must obtain the written approval from FAS, unless the equipment was approved in the initial award. The Recipient shall maintain an annual inventory, which will include a brief description of the item, serial number and amount of purchase for equipment purchased with grant funds, or received under a grant, and having a $5000 or more per unit cost. The inventory must also identify the sub-award under which the equipment was purchased. Maintenance and insurance will be the responsibility of the Recipient. Title of equipment will remain with the Recipient until closeout when disposition will be provided in writing by FAS within 120 days of submission of final reports.

- **Supplies**: Supplies are tangible personal property other than that included in the equipment category if the acquisition cost is less than the lesser of the capitalization level established by the non-Federal entity for financial statement purposes or $5,000, regardless of the length of its useful life. Specify general categories of supplies and their costs. Show computations and provide other information which supports the amount requested. A computing device is a supply.
- **Contractual**: Costs of all contracts for services and goods that further the work of the project. Sub-contractors, sub-awardees, and/or sub-grantees that do not perform technical work (i.e., landscapers, trash collectors, etc.) These costs belong under other cost categories such as equipment, supplies, construction, other, etc. Include third party evaluation contracts (if applicable) and contracts with secondary recipient organizations.
- Demonstrate that all procurement transactions will be conducted in a manner to provide, to the maximum extent practical, open and free competition. Identify proposed sub-contractor work and the cost of each sub-contractor. Provide a detailed budget for each sub-contractor that is expected to perform work estimated to be $25,000 or more, or 50% of the total work effort, whichever is less.

- Identify each planned subcontractor and its total proposed budget. Each subcontractor's budget and supporting detail should be included as part of the applicant's budget narrative.
- Provide the following information for each planned subcontract: a brief description of the work to be subcontracted; the number of quotes solicited and received, if applicable; the cost or price analysis performed by the applicant; names and addresses of the subcontractors tentatively selected and the basis for their selection; e.g., unique capabilities (for sole source subcontracts), low bidder, delivery schedule, technical competence; type of contract and estimated cost and fee or profit; and, affiliation with the applicant, if any.
- All required flow down provisions in the award must be included in any subcontract.
- In this section also include subgrantees. Provide information for each planned subgrant. Identify each planned subawardee and its total proposed budget. Include a brief description of the work to be performed

  - **Other Direct Costs**: Any other items proposed as direct costs. Provide an itemized list with costs and state the basis for each proposed item.
  - **Indirect Costs**: This will be a cost reimbursable agreement issued under 7 USC § 3319a. University indirect costs for cost reimbursable agreements are limited to 10% of modified total direct costs (MTDC).
- If applicable, complete and submit the SF-LLL Disclosure of Lobbying.
- A project narrative that includes the following elements:
  - Indicate the name of the institution applying to host the Fellow;
  - Indicate the training topic;
  - Provide a tentative training plan based on the training interests listed in the statement of work, including topics to be covered, possible field visits and other activities;
  - Please include a narrative description of the proposed training, 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 Participants in the applicable topic(s);
  - Briefly describe the expertise and international experience of the recipient in the group's field of interest and various countries;
  - Demonstrate understanding of cultural context and needs of the trainees;
  - Identify the expected skills or knowledge to be acquired by the Participants at the end of the program;
  - Briefly demonstrate flexibility in training plan to account for potential program changes and the ability to respond to unforeseen circumstances;
  - Include a quality assurance plan. This should include information on how unforeseen problems that can arise will be addressed.

The SF-424 and SF-424A can be completed within the ezFedGrants platform. However, the other required forms must be downloaded from the Forms sections on Grants.gov or will be sent to you upon request to the program officer(s) named in Section G.

Please be aware that OMB Memorandum 18-24: Strategies to Reduce Grant Recipient Reporting Burden has been approved. Various required forms needed to apply for Federal Financial Assistance no longer need to be completed individually at time of application. They are covered in the Financial Assistance Certifications Report.

Effective January 1, 2020, the Financial Assistance Certifications are a common set of certifications and representations required by Federal statutes or regulations in accordance with the grant's guidance under Title 2 of the Code of Federal Regulations (2 CFR 200.208 Certifications and Representations). Those non-Federal entities who intend to apply for, or are already recipients of Federal grants or agreements, must read and agree to the corresponding certifications and representations. Registrants who reply yes to the following question are required to keep these certifications and representations current, accurate, and complete as part of their entity registration.

FAS will verify in SAM.gov that the proper certifications are completed, and if they have not been, you will be contacted and directed to do so. Your award will not be issued until the proper forms are completed within the SAM.gov portal.

Unique Entity Identifier and System for Award Management (SAM)
Each applicant is required to:

(i) Be registered in SAM (https://www.sam.gov) before submitting its application;
(ii) Provide a valid DUNS number in its application; and
(iii) 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.

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

FAS is using ezFedGrants, which is an electronic grants management system. Applicant(s) with electronic access are required to submit their applications electronically through the ezFedGrants portal. Before you can apply, you must have a DUNS number, be registered in SAM, and have access to the ezFedGrants website at https://grants.fms.usda.gov

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.

ezFedGrants System Access and Electronic Signature

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

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

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

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

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

Intergovernmental Review
For state or local entities in the United States, an intergovernmental review may be required for U.S. domestic entities only. Applicant(s) must contact their State's Single Point of Contact (SPOC) to comply with the State's process under Executive Order 12372 (see https://www.archives.gov/federal-register/codification/executive-order/12372.html) Name and addresses of the SPOCs are maintained at the Office of Management and Budget's home page at:

https://www.whitehouse.gov/wp-content/uploads/2019/02/SPOC-February-2019.pdf

Funding Restrictions
Generally, funds may not be used in any manner that is prohibited by 2 CFR Part 200 and 2 CFR Part 400 or this funding opportunity notice.

Compensation for personal services (whether classified as personnel, contractual services, or any other form) may not exceed the pro-rated equivalent of Step III of the Executive Schedule. For calendar year 2019, this is $176,900 per year; $680.38 per day; or $85.05 per hour. Non-monetized fringe benefits are generally excluded from this ceiling, however, a federally-negotiated fringe benefits rate agreement may be required if fringe benefits appear to be unusually high.

FAS agreement funds may only be used for the purpose set forth in the award and must be consistent with the statutory authority for the award. Agreement funds and non-monetary support may not be used for matching contributions for other federal grants or cooperative agreements, lobbying, or intervention in federal regulatory or adjudicatory proceedings. Federal employees are prohibited from serving in any capacity (paid or unpaid) on any proposal submitted under this program. Federal employees may not receive funds under this award. In addition, federal funds may not be used to sue the Federal Government or any other government entity.

In addition, this will be a cost reimbursable agreement issued under 7 U.S.C. 3319a; therefore, University indirect costs are limited to 10% of the direct costs.

These funds cannot be used for construction purposes, general purpose equipment (no particular scientific, technical, or programmatic purpose), scientific equipment exceeding $5,000 or more, entertainment, capital improvements, thank you gifts, or other expenses not directly related to the project

Management and Administration (M&A) Costs:
M&A costs are not allowable.

Indirect Facilities & Administrative (F&A) Costs
Indirect F&A costs means those costs incurred for a common or joint purpose benefiting more than one cost objective and not readily assignable to the cost objectives specifically benefited without effort disproportionate to the results achieved. By statute, indirect costs for cost reimbursable agreements cannot exceed 10% of direct costs.

Other Submission Requirements
All applications must be submitted electronically as indicated above.

E. Application Review Information

Application Evaluation Criteria

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

findings from audits; and (5) ability to effectively implement statutory, regulatory, or other requirements.

Technical Expertise and Experience (40 points)
The host research institution and mentor must have the 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 Participant's country or a similar location will be considered as appropriate. The recipient'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 stated objectives and background. The program plan should be thorough, and it should also help achieve the desired post-program deliverables and the Participant's research goals and objectives. Relevant agricultural practices within the region of the university will be considered as appropriate. Relevant university resources should be identified. Additional resources/organizations should be identified as appropriate. Site visits and meetings should be meaningful to the content of the program, if included.

Budget (25 points)
The proposed budget should be appropriate for the number of Participants and length of the program. The budget should include appropriate cost savings where available and narrative should accompany each line item.

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

FAS conducts a two-part application review process. The Agency conducts an initial review of applications to determine the responsiveness of the application. If an applicant is determined to be ineligible (see Section C. Eligibility Information) or an application is determined to be non-responsive, FAS will notify the applicant. All responsive and eligible applications will be reviewed as described below:

1. FAS will assemble reviewers which may include both federal and non-federal reviewers to review the eligible applications. Reviews of submitted applications will be conducted either on site or by remote review.

2. Technical reviewers will review each eligible application against the evaluation criteria. The reviewers will assign a score and provide summary comments based on the evaluation criteria identified above. Evaluation Criteria: the evaluation criteria must be directly related to key aspects of the project. The criteria must be measurable with an associated point range. It is a best practice, but not required, that the entire review

criteria score range should be out of 100. From the scoring process, a recommendation list will be composed and sent to the selecting official, a minimum score of 70 is required to receive funding.

3. An application may be selected for a post-review quality control and possible rescoring if it received significantly diverging scores and comments from reviewers.

4. If necessary, a secondary application review process includes an internal review panel consisting of FAS staff, and the selecting official reviewing the recommendation list which will display the highest ranked applications. From this list this internal review panel will make final funding recommendations. The internal review panel may take applications out of rank order in consideration of strategic program priorities, which are identified below:

a. Geographic distribution
b. Incorporation of minority-serving institutions
c. Institutional capability to host foreign Fellows
d. Pre-existing relationships between the Fellow and an institution

5. FAS will perform an additional review of the applicant organization which may include reviewing any and/or its key personnel. This review will include reviewing audit reports, publicly available materials and/or government databases and may have a bearing on award outcome. FAS may request additional materials from the applicant as part of this review, including:

a. The summary letter from the applicant's most recent audit report; and
b. Documentation of previous grant award completion that includes the name of the grantor, amount awarded, and whether the grant recipient sufficiently completed the requirements of the grant award (e.g., a final close-out report, certification of grant award completion, etc.)

6.After the technical review and before making final funding decisions, FAS may contact the highest-ranking applicants to seek clarification and to negotiate technical and programmatic aspects of the application. If an application includes a sub-awardee, FAS may request to speak with all parties included in the application to ensure sufficient planning and coordination has taken place prior to making an award.

Confidentiality and Conflict of Interest

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

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

F. Federal Award Administration Information

Notice of Award

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

Administrative and National Policy Requirements

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

https://www.fas.usda.gov/grants-and-cooperative-agreements-administrative-general-terms-and-conditions

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 unless explicitly stated otherwise in subsequent mutually-agreed amendments to the award.

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

Federal Financial Reporting Requirements

The Federal Financial Reporting Form (FFR), as known as the SF-425, must be submitted semi-annually, within 30 days after the end of each reporting period, and a final report within 90 days of the end of the agreement. The required form is available online at: https://www.gsa.gov/portal/forms/download/149786

Program Performance Reporting Requirements

Performance Progress Reporting must be filed semi-annually, within 30 days after the end of each reporting period, and a final report must be filed within 90 days of the end of the agreement and should include details the activities undertaken and progress made.

Performance Expectations

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

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

(2) Assignment of a Mentor

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

- The mentor will establish a professional relationship providing guidance and training in the Participant's research and studies.
- The mentor will work with the Participant before arrival to discuss appropriate work plan, site visits, and other arrangements.
- The mentor will provide the agreed upon 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 Participant during the program.
- The mentor will continue communicating with the Participant beyond the end of the program in the U.S. through the mentor visit.
- Mentor will submit semi-annual progress reports that indicate all program activities are conducted.
- The mentor may assign other faculty members to assist with Participant's training and research activities.
- The mentor may not be assigned to multiple Participants during the same time frame.
- The mentor should include a leadership component to the training curricula; training course, workshop, or other suitable activity that provides leadership training to the Fellow.

(3) Mentor Follow-up Visit

- The mentor visit is a required component of the Borlaug Fellowship Program.
- The mentor will work with the Participant to plan a follow-up visit to the Participant's home country. The trip should occur within 6 months to 1 year after the program ends and no sooner than 3 months before the end of the agreement.
- The mentor will follow up with the Participant for an additional year after their visit to assess the impact of the exchange program.
- The PI will provide USDA/FAS with an agenda for mentor's reciprocal visit, including goals and objectives, three weeks prior to the trip. The mentor's travel information must be provided for emergency contact purposes and country clearance (if required by the cognizant FAS Overseas Office).
- The mentor will provide a trip report highlighting the trip's activities and results through the PI to USDA/FAS within 30 days after the visit.
- The mentor should plan to meet with the USDA/FAS Attaché or staff from the U.S. Embassy while they are traveling, if feasible. USDA/FAS can assist with coordination prior to the trip.

(4) 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 Participant's home to Washington, D.C., and to the university.
- The host institution is responsible for arranging and purchasing all domestic travel related to the Participant's training program.
- The host institution will provide housing for the Participant 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 Participant 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.
- Necessities, such as sheets, towels, and cleaning supplies, will be provided for Participant's use. The Participant 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 Participant with a bus pass or proper allowance for transportation expenses.
- When planning lodging options, the host institution should check with the Participant and account for any special dietary restrictions or preferences.

(5) Meals and Incidentals (M&IE)

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

(6) **Emergency Health Insurance**

- The host institution will purchase emergency health insurance for the Participant for the duration of stay, as required for all J-1 Visa holders (22 CFR 62.14). Dates of coverage must include date of departure from home country to the university until date of arrival in home country from the university.
- The Participant will not be required to purchase his or her health insurance and then be reimbursed.
- The host institution will educate the Participant as to what is covered under health insurance policy, especially highlighting that pre-existing medical conditions are not covered.
- The host institution will immediately alert USDA/FAS staff if any health/medical conditions arise during the program.

(7) Communication

- The host institution will initiate contact with the Participant 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 Participant's physical arrival and departure from the U.S. to comply with U.S. Department of Homeland Security requirements.
- The host institution will provide USDA/FAS with the Participant'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 Participant can be reached in the event of an emergency.

(8) Program

- The host institution will provide educational materials and supplies to each Participant necessary for their full participation in the program.
- The host institution will pay for all fees related to the Participant's training program, such as (but not limited to) technology fees, administrative fees, laboratory fees, etc.
- The host institution will arrange relevant field visits as applicable to the Participant's training program.
- The host institution will ensure the Participant submits an interim and final report (2-3 pages each) to USDA/FAS before the Participant leaves the United States. Reports should include the following:
    - Summary of activities, accomplishments, and any problems encountered or overcome
    - Photographs, when possible
- The mentor ensures that the Participant completes the Program Evaluation.

(9) Orientation

- The PI/Training Coordinator will communicate directly with the Participant 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 Participant's arrival to acquaint them with campus and community resources, such as:
    - Explanation and demonstration of local bus/transportation options

    - Explanation of cultural and legal expectations
- USDA will provide a welcome and orientation packet for mentors

GOVERNMENT FURNISHED ITEMS: USDA FAS will provide Participants with a DS-2019 for the Participant to request and obtain a J-1 visa.

Monitoring
FAS through its authorized representatives, has the right, at all reasonable times, to make site visits to review project accomplishments and management control systems and to provide such technical assistance as may be required. During site visits, FAS will review recipients' files related to the funded program.

As part of any monitoring and program evaluation activities, recipients must permit FAS, upon reasonable notice, to review related records and to interview the organization's staff and clients regarding the program, and to respond in a timely and accurate manner to FAS requests for information relating to their program.

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.

Acceptance of final reports by the agency constitutes a closeout of the award with no further notice or obligation to either party. This acceptance will indicate the period of performance has expired, and any remaining funds will be deobligated. Records must be retained for a minimum of three years after the final reports are submitted, as described in 2 CFR 200.333

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

G. Awarding Agency Contact Information

Contact and Resource Information
For all general questions, contact:
Nicola Sakhleh; Director, Scientific Exchanges Branch
Hours of operation: 8:00 AM – 4:30 PM Eastern Standard Time
Telephone: (202) 690-2484
E-mail address: BolaugFellowships@usda.gov
1400 Independence Ave, SW, Room 3231-S; Stop 1031
Washington, DC 20250-1031

H. Additional Information

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

2. Pre-Award Costs
The Recipient shall not, without prior approval from FAS, incur costs pertaining to the operation of the project, program, or activities prior to the approved project period.

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

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

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

4. Post-award program income
In the event program income becomes available to the recipient post-award, it is the recipient's responsibility to notify the FAS Program Manager to explain how that development occurred, as part of their request for guidance and/or approval. The Program Manager will review approval requests for program income on a case-by-case basis; approval is not automatic. Consistent with the policy and processes outlined in 2 C.F.R. Part 200, pertinent guidance and options, as determined by the type of recipient and circumstances involved, may be approved by the Grant Officer. If approval is granted, an award modification will be issued with an explanatory note in the remarks section of the face page concerning guidance and/or options pertaining to the recipient's approved request. All instances of program income shall be listed in the progress and financial reports.

Appendix

Borlaug Fellowship Program - Algeria – Animal Disease Eradication – Fellow # 1

Scope of Work
Fellow #1: Algeria, Female, Veterinary Inspector, Ministry of Agriculture, M.S., Food Quality and Chemistry of Natural Products

Goal
The goal of the fellow's research is to study the eradication of animal diseases in the country of Algeria and the role of government and disease impact on social-economic issues.

Fellow's Learning Objectives
- Have a world free from animal diseases
- Reduce the risk of developing zoonoses

Research Background
Living in a disease-free world is the responsibility of everyone, especially doctors and veterinarians. Zoonoses are the common diseases between animals and humans and the importance of combating them falls to government, because they were always behind successful eradication of diseases. Mismanagement and non-compliance with hygiene rules and breeding conditions are the major reasons for contamination by pathogens, and having healthy breeding is very important for the rural development and the economy of the country in a way to assure the self-consumption and to encourage trade.

Expected Accomplishments
The fellow hopes to build a good strategy for government standards to follow to eradicate animal diseases. The fellow wishes to better understand animal disease management to allow Algeria to be free of animal diseases and become a better trading partner, especially with exporting countries such as the United States. The fellow's training and experience opportunity in a country with developed agriculture like the United States will positively influence rural development in Algeria by following the same steps to increase productivity and trade.

Contributions to Algerian Agriculture Sector
The fellows project will build a good course of action to eradicate diseases that can be supported by the government in order to improve the economy of the country. The fellow is always trying to do their best for the wellbeing of the animal and therefore the wellbeing of the humans. The fellow hopes to ensure food safety and protect consumer health and fight against anomalies preventing rural development through government action.

Suggested Schedule
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Algeria – Leishmaniasis Risk Assessment – Fellow # 2

Scope of Work
Fellow #2: Algeria, Female, Veterinary Doctor, National Veterinary Medicine Institute, M.S., Biology Science

Goal
The fellow's goal is to identify the reality of the leishmaniasis epidemiological situation in Algeria.

Fellow's Learning Objectives
- Learn the seroprevalence of leishmaniasis in farm animals across the entire Algerian steppe and identify its distribution across these different sub-regions
- List the risk factors for epidemics and current spread of leishmaniasis from rural to suburban disease with increased risks of human transmission
- Find out if there are new animal reservoirs (other than wild dogs and rodents) in domestic livestock allowing the sustainability and extension of this anthropozoonosis, which could spread further
- Identify if there are other arthropods than the sandfly which could also be a vector of leishmaniasis

Research Background
Leishmaniasis is one of the neglected tropical diseases; it is a parasitic disease of the reticulohistiocytic system belonging to the family of Trypanosomidae, genus Leishmania, transmissible by the bite of a female sandfly insect; it can be anthroponoic or zoonotic depending on whether man or animal constitutes the natural reservoir of the parasite endemic in all regions of WHO, it has been estimated that worldwide, 14 million people are infected and each year between 700,000 and 2 million approximately new cases and between 20,000 and 30,000 deaths are registered (WHO 2019). Leishmaniasis in Algeria, with its potential impact on human health and its medical seriousness, is prevalent throughout the eastern Mediterranean region. This area is part of around three-quarters (148,450 cases) of all cases of cutaneous leishmaniasis (study 2016; WHO 2018).

Expected Accomplishments
Leishmaniasis remains a serious threat to public health, aggravated by its wide distribution over the territory and the diversity of parasite species. The epidemics are barely controlled, new outbreaks emerging in the country in endemic areas and others despite the various information, awareness and prevention companions, which greatly worries the health officials who considers a real public health problem their all the more worrying as they cause heavy economic and social losses On the other hand, there was a need to update the national data concerning the distribution of leishmania species in the steppe region and assessment of the climatic impact and environmental changes on the disease transmission system thus allowing strengthening and multiplying prophylactic measures and establishing multidisciplinary collaboration to make the leishmaniasis control program a success, working with a mentor in the United States will help the fellow by orienting themselves on the most recent techniques in the field of identification of leishmania species as well as possible subspecies or zymodeme emerging in the region on the

other hand, cotutelle will help the fellow to deepen their entomological studies since in Algeria there are no specialties in the matter.

The identification of new foci of leishmaniasis in farm animals makes it possible to strengthen the programs for combating vector-borne diseases transmissible to humans and thereby improve the productivity of farms and human profitability in the agricultural sector, on the other hand it allows to save the expenses intended for the treatments of the patients and the epidemiological struggles and to use it to reinforce the agricultural development of these regions in Algeria since they constitute a first agricultural source for the country (meat and cereals).

Contributions to Algerian Agriculture Sector

The identification of new foci of leishmaniasis in farm animals makes it possible to strengthen the programs for combating vector-borne diseases transmissible to humans and thereby improve the productivity of farms and human profitability in the agricultural sector, on the other hand it allows to save the expenses intended for the treatments of the patients and the epidemiological struggles and to use it to reinforce the agricultural development of these regions in Algeria since they constitute a first agricultural source for the country (meat and cereals). This research will attract the government's attention to give more importance to the agricultural sector by mobilizing more funds to carry out more detailed studies.

Suggested Schedule

The applicant should propose a 12 week fellowship schedule that reflects the researcher’s goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Algeria – Indigenous Plant use as Bio-Insecticide – Fellow # 3

Scope of Work

Fellow #3: Algeria, Female, Associate Professor, Larbi Tebessi University, PhD, Animal Biology

Goal

The fellow's goal is to develop the use of indigenous aromatic plants as a bio-insecticide in the management of plant insect pest.

Fellow's Learning Objectives

- Development of the use of aromatic plants as bio-insecticide that could put an end to the invasive insect pests that damage the crops
- Focus on integrated pest management for Fall Armyworm

Research Background

Algeria is considered a rich country in phytogenetic resources with varied flora and more than 600 species of aromatic plants that could serve as bio-insecticides. Chemically, aromatic plants are composed, among others, of secondary metabolites, volatile compounds, secreted as a chemical defense against the insect pests. Plants set up defense systems developed in response to phytophagous attacks. Once attacked, plant cells trigger a whole series of chemical reactions resulting in the synthesis then in the release of volatile compounds of terpene nature. These diffuse into the atmosphere and attract the parasitoids which will kill the insect pest present in the plant. Based on this principle, plant extracts could be employed as they have traditionally been used as repellent, attractant and/or toxic to insect pests. Their chemical components could be analyzed and identified to determine the attractant components to paraitoids and/or the repellent and the toxic components to phytophagous larvae, adult and eggs. Moreover, active ingredient compounds of different plant extract could be identified for a possible development of oil new mixture that could have a synergistic effect.

Expected Accomplishments

The fellow hopes to accomplish the usefulness of aromatic plants as bio-insecticide in the control of insect pests of crops, the fall armyworm. The fellow's working field is insect pests of cereal crops, their biology, physiology and plant host. They have experience in the rearing of lepidoptera (Ephestiakuehniella, insect pest of stored grains), assuring favorable conditions for development, reproduction and egg collection, the assessment of damage and the evaluation of post-harvest grains treatment using essential oils as bio insecticide, but they have never worked on the employment of plant extract to crops. During the training course the fellow expects to be introduced to the general principles of the management of insect pests of crops, the application methods and the economic threshold. They will have the opportunity to get information about conditions of treatment, the moment of application (day/night, time of application required before harvesting) and the exact time when the treatments are necessary for managing pests. This work will be established by a professional mentor where the program interest, the research focus, the goal, the quality of the work, the disposition for working in a team and the scientific spirit between the applicant and the mentor will make a reliable and effective research. This work will

be accomplished by the help given by the mentor and the fellow is convinced that they will learn more during this program.

Contributions to Algerian Agriculture Sector

Agriculture is an important element of rural development in Algeria and is considered one of the major components of the national economy. However, insect pests can have major negative impacts on agricultural production, crops and post-harvest as well and causing enormous economic losses. The contribution of this program could have a positive impact on the food security, as well as the economic development, by sharing new knowledge, new experiments and new aptitude in the field of plant health. After accomplishment of the fellow's research topic, the experience acquired and the relevant solution in the management of insect pests of crops will bring a help for agriculture development and economy. The government of the home country is in the research of new strategies, efficient and economic pesticides to promote agricultural production and the economy diversification of Algeria. They can use this knowledge to develop science-based pest management programs in my country that are economically and environmentally sustainable and socially appropriate, protect human health and the environment by reducing risks caused by synthetic insecticide; establish the progressive methods in the pest management practices in order to protect crops from the pests in Algeria; increase economy with an increase in agriculture production.

Suggested Schedule

The applicant should propose a12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Egypt – Food Contact Material Assessment – Fellow #1

Scope of Work
Fellow #1: Egypt, Female, Food Safety Inspector, National Food Safety Authority, B.S., Chemical Engineering

Goal
The goal of the fellow's research is to make a comparison, based on overall migration limit and specific migration limit risk analysis, between (plastic and bioplastic) being used as food contact material.

Fellow's Learning Objectives
- Compare plastic and bio-plastic being used as food contact material, using risk based analysis (using its pillar "Risk Assessment")

Research Background
The fellow's research will be based on comparing the migration limits between bioplastic and plastic. The Overall Migration limit (OML) applies to the sum of all substances that can migrate from the food contact material to the food (or food simulant). The overall migration limit is a measure for the inertness of the material. A Specific Migration Limit (SML) applies to an individual substance and is based on toxicological studies. Analytical techniques are used to identify the presence of these substances in food (and food simulants). Bioplastic is material produced from renewable biomass source like oils, corn starch, straw, recycled food materials.

Expected Accomplishments
The fellow hopes to get a valid result out of this comparison to be able to start applying it in their country in small scale, then on an industrial scale. As the fellow is a chemical engineer (their graduation project was " Gasification of Biomass to produce Hydrogen"), they volunteered and worked in a campaign that aimed to develop one of the Egyptian villages by developing a recycling project in the village (Abo-seer village). The fellow's previous job before working for NFSA was as an environmental researcher (They researched topics related to plastics and recycled plastics). Working with a mentor will help the fellow in several aspects, including access to a whole new technology that does not exist in their country accompanied by gaining experience – as they are considered fresh in this area - from a leading country such as the United States.

Contributions to Egyptian Agriculture Sector
This fellowship will help the fellow contribute to the enhancement of economic development by making their country pay more attention to the importance of "Food Contact Material" field and how much it affects public health. This will encourage the manufacturer of food contact materials in Egypt to improve their facilities/products and will encourage other entities to start investing in food contact materials which will directly and indirectly affect the economic development.

Egypt nowadays tends to reduce using plastics generally and being eco-friendly, and the government started applying that already in the Red Sea area by prohibiting the use of plastic

bags; due to the death of several creatures, so when the research shows that bioplastic is healthier with less minimum effect on human health, this will encourage the government to start applying this decision all over the country. As a food safety inspector, the fellow's fellowship will play a role in changing their own perspective while conducting inspection for food contact material facilities and developing new regulations and guidelines. For their organization, as they are a certified trainer by IFPTI, the fellow will conduct lectures to present a full brief about the fellowship.

Suggested Schedule

The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Egypt – Food Additives and Regulations – Fellow #2

Scope of Work
Fellow #2: Egypt, Male, Food Safety Inspector, National Food Safety Authority, PhD, Food Science

Goal
The goal of the fellow's research is to assess the impact of food additive mixtures on public health.

Fellow's Learning Objectives
- Evaluation of the mutagenic activity of mixtures of some food additives
- Assessing the effect of these food additives` mixtures on gut flora

Research Background
Most studies on the effects of food additives have focused on studying them individually, whereas in reality these food additives are used in a combined form, especially because different food categories may contain preservatives along with coloring agents, artificial sweeteners, emulsifiers, anti-caking, acidulantn, etc. Due to consuming these food additives together, these permitted food additives may be unsafe due to the presence of additive-additive interaction. Hence the fellow's research will assess the combination effect of various food additive mixtures on food safety.

Expected Accomplishments
The mutagenic activity of food additives will be evaluated in reverse mutation assays in Salmonella typhimurium (strains TA1535, TA1537, TA98, and TA100) and Escherichia coli (WP2uvrA) performed according to (OECD, 1997; Gordon, 2011) using the plate incorporation method. The effect of these food additives` mixtures on gut flora will be assessed as their effect on the growth of lactic acid bacteria. The results of this research may make an alert that we need to reassess -globally- the safety of some food additives.

Contributions to Egyptian Agriculture Sector
If the codex and international agencies reassessed the safety of some food additives, it will be updated in Egypt. By expanding the country of Egypt's knowledge, and teaching the fellows colleagues what they learn through the fellowship.

Suggested Schedule
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Jordan – Genetically Engineered Regulations – Fellow #1

Scope of Work
Fellow #1: Jordan, Head of Molecular Biology Depart, National Agricultural Research Center, M.S., Agricultural Biotechnology

Goal
The goal of the fellow's research is to assess Jordan's Genetically Engineered product regulations.

Fellow's Learning Objectives
- Enforcing feed and food law, animal health and animal welfare rules and monitoring and verifying that the relevant requirements thereof are fulfilled by business operators at all stages of production, processing, and distribution
- Increase public awareness of genetically engineered products

Research Background
Biosafety studies focused on preventing, minimizing and eliminating risks associated with research, production, teaching, use, technology development and services related to genetically modified organisms (GMOs) with the aims of protecting human and animal health and environmental preservation are high-cost and long-term studies, especially those related to risk assessment of genes used in genetic modification we need to study these organisms and assess their impact on human health and the environment.

All the results showed that there was no significant difference between modified and unmodified crops affecting human health and the environment. Given the limited agricultural area and the difficulty of buffer zones areas for isolation on one hand, and the importance of biodiversity and local plant genetic resources on the other, it is necessary to emphasize local regulation and legislation of dealing with genetically modified crops to preserve the genetic materials' biodiversity and origins and ease the global trade markets.

Expected Accomplishments
Hoping by the end of this training course, the fellow will be well qualified in scientific-based global regulation and concerns of dealing with GMOs and get a clear vision which ones more suited our country. Also, they hope to set up a fast easy regular framework for conducting tests and following up procedures of GMOs as a biotechnology researcher at the governmental agricultural research center. Learn the appropriate coordination procedures that are in place and effectively implemented and how to carry out official controls delegation from the central level to a regional or local level.

Contributions to Jordanian Agriculture Sector
Increasing the capacity building in advanced techniques for researchers in developing countries is a critical issue in best utilizing available resources and monitoring of research to succeed in achieving high productivity and food security. Borlaug had opened this chance for many countries to achieve their sustainability goals by funding such programs. Jordan is rich in its genetic resources but the area of plating is becoming smaller and smaller so there is an important

demand to plant these GM crops that can save land and money cost of agricultural practices. GM crops help in achieving green growth, increasing productivity and achieving food security. Setting up local regulation will facilitate the deal with these crops and open the trade markets, this issue is very important at our country as we are importing most of our seeds and byproducts from outside markets.

As an agricultural governmental research body, establishing at Community level a harmonized framework of general rules for the organization, the implementation and the reporting of results of official controls, is going directly to policy changes within our home government. The fellow is the head of the Molecular biology department at their institute for two years. They also are a team leader of many committees at their institute and focal point of GMC in Jordan from the National Agricultural Research Center. Upon personal characters, the fellow is a self-dependent, hard worker and social person all these things gave them the power in life to go on forward always and never giving up.

Suggested Schedule

The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – South Africa – Foodborne Illnesses Regulations – Fellow #1

Scope of Work
Fellow #1: South Africa, Female, Researcher, Agricultural Research Council – Animal Production, M.S., Agricultural Biotechnology

Goal
The goal of the fellow's research is to reduce the risk of foodborne illnesses at the consumer level, with specific reference to Ready-to-Eat (RTE meat products).

Fellow's Learning Objectives
- Assessing consumer's knowledge on RTE meat products and related foodborne pathogens
- Assessing consumers level of food safety knowledge, handling and practices of RTE meat products
- Assessing consumers behaviors and attitudes which affect the safety of food (with special reference to RTE Meats)
- Determining the consumer's awareness and sources of information relating to foodborne outbreaks

Research Background
South Africa was hit by listeriosis outbreak in 2017-2018. Listeriosis is serious infection caused by the bacterium Listeria monocytogenes. People usually become ill with listeriosis after eating contaminated food. According to world health organization (2018), listeriosis outbreak in South Africa was the world's largest documented outbreak of its kind. The source of the outbreak was identified as RTE meat products. It was traced back from two major brands factories manufacturing polony, a ready-to-eat meat product. Approximately 190 food processing facilities that manufacture processed RTE meat products were implicated in the listerias outbreak. National Institute for Communicable Diseases (NICD)'s latest report indicated a total of 1 060 cases with 216 deaths. Food poisoning cases that threaten public health globally occur as a result of the contamination of foods in any stage, from production to consumption. In the food supply chain, consumers are the last point of contact to food, where the existence and level of the dangers caused by foods are of chief concerns. Existing research suggests that a substantial proportion of foodborne illness is attributable to improper food handling, preparation, and consumption practices by consumers. Improper practices include, but are not limited to, inadequate cooking, inadequate cooling and storage of foods, cross contamination of raw and cooked foods, inadequate personal hygiene such as hand washing, and consumption of raw, undercooked, or unsafe foods. It is, therefore, important for the consumers to know and practice safe food-handling behaviors to help reduce the risk of getting sick from contaminated food since food-related diseases can be serious, or even fatal.

Expected Accomplishments
The fellow hopes to come up with effective intervention strategies to raise awareness (at consumer level) of foodborne outbreaks in South Africa. A communication strategy which aims to influence consumer behaviors using tailored food safety messaging which is targeted to the population groups based on their particular risk, behavioral and demographic profiles. The fellow

is currently reviewing literature relating to South African consumer's perceptions towards Ready-to-Eat meat products after 2017-2018 listeriosis outbreak and their implications, thereof, to marketing. This will help both the consumer and the meat processors. Working with a mentor in the U.S. is very important since most of the consumer education studies have been carried out in the U.S. Collaborative working will form a strong pillar of the fellow's work, and the relationships which will be key in ensuring that the project can be delivered effectively.

Contributions to South African Agriculture Sector

Food security and safety in South Africa is at risk. A brief exposure to international experts, facilities and methods will be inspiring and will open new horizons for the fellow. These kind of contacts are critical for sustainability and success of the project. The knowledge gained during the fellowship will be implemented in the food safety systems interventions and mobilize consumer education in food safety. If the project can be effectively implemented it will allow the policy makers to recognize the role that the consumer plays in ensuring food safety which in turn reduce the risk of foodborne illness and make a positive impact on public health outcome. The fellow is already a project leader of a funded project (which is towards completion) in their department. Leading another project will help to improve the fellow's leadership skills, and that will increase their recognition level in their organization and in their field at large.

Suggested Schedule

The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program - Tunisia – Conservation of Tunisian Olives– Fellow #1

Scope of Work
Fellow #1: Tunisia, Male, Researcher, Ministry of Agriculture/IRESA/Olive Institute, PhD, Agronomy

Goal
The goal of the fellow's research is to study the conservation of Tunisian olives genetic resources and enhance the quality of olive oil by the use of molecular markers.

Fellow's Learning Objectives
- Use molecular markers methods (microsatellites, SNPs, etc.) on the Tunisian olive breeding programs

Research Background
Tunisia is the most important olive-growing country of the southern Mediterranean region. Tunisia's olive resources are estimated at over 90 million olive trees, grown on 1,900,000 hectares of land. Olive cultivation plays a vital role in the social and economic life of Tunisia and accounts for nearly 15% of the total value of final agricultural production. In semi-arid regions, periods with water restrictions as a result of both the increase in domestic use and also climatic changes are frequent and problems of drought (due to non-irrigation) can appear. For these reasons, the use of biotechnology and especially molecular markers are interesting to find new genotypes resistant to drought stress and showing good quality of olive oil.

Expected Accomplishments
The fellow hopes to enhance their knowledge of cultivated olives during their American fellowship experience. In the USA, there are experienced institutions like the National Clonal Germplasm Repository, Davis, and National Arid Land Plant Genetic Resources Unit, Parlier, which are repute in studying tree fruit and nut crops. Among fruit trees, olive is founded in the germplasm repository and research is conducted to study the genetic diversity and the adaptation of olives in United States of America.

The fellow will be able to exchange innovative practices concerning promising strategies of food security and agriculture development. The training will offer the possibility to enhance their knowledge and skills on the use of new technologies in the field of agricultural policy and research. The training goal is to establish a long-term collaboration between and among trainees and between institutions, which are doing front activities in different fields of agriculture biotechnology use, agriculture safe products and food security. The course will help the Tunisian candidate from the Olive Institute to have access to a new approaches related to the use of safe biotechnology in agriculture.

Contributions to Tunisian Agriculture Sector
The fellow will put new skills and knowledge to work for their employing organization. To reach this goal, the output of this training will be directly used in their institute. Furthermore, this course will offer the possibility to the fellow to provide new strategies and methodologies which will be directly used for growers and for future research at the Olive Institute.

Suggested Schedule
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Bangladesh–Highly Pathogenic Avian Influenza
Bioinformatics - Fellow # 1

Scope of Work
Fellow #1: Bangladesh, Male, Scientific Officer, National Reference Laboratory for Avian Influenza. M.S. in Microbiology

Goal
To improve provide food security and public health through controlling highly pathogenic avian influenza virus infections in poultry in Bangladesh.

Fellow's Learning Objective
- To sequence the whole genomes of Bangladesh highly pathogenic avian influenza viruses by next generation sequencing
- To be able to apply bioinformatics to compare the sequences to determine molecular evolution and reassortment of Bangladesh highly pathogenic avian influenza viruses by time-scaled Bayesian phylogenetic model
- Perform antigenic cartography on Bangladesh highly pathogenic avian influenza viruses to determine antigenic evolution and select a vaccine candidate from circulating stains.
- Develop new reagents and tests for specifically detecting highly pathogenic avian influenza virus infections in Bangladesh poultry

Research Background
A total of 556 outbreaks of Highly Pathogenic Avian Influenza Viruses (HPAIV) in poultry and wild birds have been reported in Bangladesh since 2007. In addition, eight human cases and one human fatality caused by infection with H5N1 have been reported in Bangladesh since 2008. Control measures applied to HPAIV outbreaks in Bangladesh poultry include quarantine, movement restrictions and culling of infected birds without compensation. These measures result in significant reductions in both income and food supply for poultry owners. Since 2012, H5 vaccines have been imported and used in commercial poultry to control infections, however no testing of the two imported commercial vaccines has been done to verify their efficacy against the circulating field viruses. Preparing a vaccine from a local H5 virus would reduce Bangladesh's dependence on imported vaccines and reduce the costs to Bangladeshi poultry farmers.

Expected Accomplishments
Establish next generation sequencing technology in our national reference laboratory and in applying updated bioinformatics tools for genetic characterization and monitoring evolution of avian influenza in Bangladesh. Develop the ability to select potential vaccine candidate virus from local virus isolates and monitoring the antigenicity of circulating virus for evaluation of vaccines. The ability to monitor the genetic and antigenic evolution of Avian Influenza Vaccines, improved diagnostic tests, and locally produced vaccines will contribute to institutional capability to diagnose and control outbreaks of HPAI, which will result in reduced vaccine costs to poultry farmers and less birds being culled.

Contributions to Bangladeshi Agriculture Sector
Increase capacity for monitoring genetic evolution and to produce vaccines for HPAIVs from circulating strains will be established, which will help in reducing the prevalence of AIV in Bangladesh. It also is helpful to develop an appropriate farm biosecurity model for future prevention of AIV. National food security will be strengthened by protecting the productivity of safe animal protein and economic development. Moreover, the knowledge acquired from the fellowship can be applied to other diseases, with the hope of protecting other livestock sectors. The fellowship would also contribute to the capacity building for molecular characterization of current circulating strains of HPAIVs and will be helpful for predicting the threat of new emerging AIVs from mutation and reassortment of circulating viruses. The current Bangladesh government policy is to control HPAI outbreaks by culling infected birds without compensating the owner and to import vaccines from international vaccine manufacturers. Improved diagnostic tests will allow farms to be tested more quickly and then be cleared of infection. The availability of vaccine produced from a local virus strain will significantly improve protection of vaccinated birds and reduce the costs to poultry producers.

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Bangladesh – Newcastle Disease Vaccine - Fellow # 2

Scope of Work
Fellow #2: Bangladesh, Male, Assistant Professor, Bangladesh Agricultural University. PhD in Immunology

Goal
To develop an improved vaccine against Newcastle disease virus (NDV) circulating in Bangladesh using a reverse genetics approach.

Fellow's Learning Objective
- Generate a genotype-matched, live attenuated vaccine from circulating virulent NDV strains in Bangladesh
- Generate of a recombinant NDV vaccine candidate by a reverse genetics' technique using genotype XIII backbone and an avirulent F protein cleavage site (FPCS)
- Study the genetic stability of the recombinant vaccine virus on serial back passage in chickens, the in vitro replication and pathogenicity of the recombinant vaccine virus, and the immunogenicity and protective efficacy of the recombinant vaccine virus against challenge with homologous virulent NDV strains

Research Background
Newcastle disease (ND) is a highly contagious and often fatal disease affecting wide varieties of domestic and wild birds worldwide. It is caused by Newcastle disease virus (NDV) which is a non-segmented single stranded negative sense RNA virus. The F protein cleavage site (FPCS) is the critical sequence responsible for major changes in the virulence. In Bangladesh, ND prevention is focused on biosecurity and vaccination of poultry with live and inactivated ND vaccines. Today, the strains of NDV used in locally produced or imported ND vaccines in Bangladesh, such as BCRDV, RDV, LaSota and B1, belonged to genotype II and are phylogenetically divergent from virulent virus circulating in the field. For effective control of ND in Bangladesh, a genotype-matched vaccine is required using field NDV strains. Several recent studies showed the promise of reverse genetics technique to generate live attenuated NDV vaccine by replacing the F protein cleavage site of virulent viruses with F protein cleavage site of avirulent strains.

Expected Accomplishments
Upon successful completion of the project, a genotype-matched, live attenuated NDV vaccine will be generated from local virulent strains. Most of the vaccines that are being used in Bangladesh were developed using conventional techniques. An innovative approach, such as reverse genetics, to develop genotype matched vaccine within short time would provide better protection for poultry flocks. The skill of reverse genetics technique can be applied to generate other vaccines against infectious diseases such as avian influenza and Gumboro disease in Bangladesh.

Contributions to Bangladeshi Agriculture Sector
Infectious diseases are major threat towards successful poultry industry in Bangladesh. Besides avian influenza, ND is number one killer of commercial and backyard poultry in Bangladesh.

Most of the vaccines that are being used in Bangladesh are imported and genotypically different from field viruses. This project will be used to develop an improved, genotype matched reverse genetics vaccine which will help the poultry industry to fight against deadly NDV infection. In return, the poultry farming which is a major provider of meat will be sustainable leading to enhanced food security in Bangladesh.

Proposed Schedule

The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Cambodia–Vapor Heat Treatment of Fruit Fly- Fellow #1

Scope of Work
Fellow #1: Cambodia, Male, Plant Quarantine Officer, Cambodia Department of Plant Protection. M.S. in Integrated Crop Management

Goal
Enhance technical knowledge of how fruit flies affect production and export of fresh fruits, to reduce damage caused by fruit flies, and to remove quarantine constraints on the export of produce from Cambodia using Vapor Heat Treatment.

Fellow's Learning Objective
- To carry out fruit fly surveillance and rear test in laboratory; establish a Vapor Heat Treatment (VHT) for fruit fly R&D management for testing and training counterparts
- To create public awareness campaign on fruit fly management for quality tropical fruits production and exports

Research Background
Fruit flies have long been regarded as major pests to mango, whether grown for domestic consumption or for export. They are a major constraint to food security and trade.
Tropical fruit production in Cambodia, many of which are of high export quality, has expanded significantly in recent years. Besides domestic consumption, only a small amount of annual harvest is being exported to neighboring countries. With limited domestic processing capacity and external market access, prices of fresh fruits are subject to high fluctuations. To address an increasing harvest, there is an urgent need for Cambodia to diversify its export destinations for fresh fruits. In order to meet this goal, improvements need to be made across the whole production/market continuum to enable Cambodia to compete at international level. One of the key drivers for this is to meet phytosanitary requirements of the importing countries. Fruits are vulnerable to attack by several types of fruit flies which are regarded as quarantine pests of concern to most importing countries.

Expected Accomplishments
Develop an appropriate database on the occurrence, distribution of various fruit flies in Cambodia, and their host range and economic significance and their management is Developed. Develop effective survey and monitoring protocols for detection of fruit flies; increase the capacity of plant protection professionals to rear test fruit flies successfully in laboratory; increase the capacity of plant protection professionals to disinfest test fruit flies by VHT; develop a data system to store test data and perform analysis; implement a public awareness campaign on fruit fly management for quality fruit production and exports.

Contributions to Cambodian Agriculture Sector
The overall goal of this research is to enhance technical knowledge of how fruit flies affect production and export of fresh fruits, to reduce damage caused by fruit flies, and to remove quarantine constraints on the export of produce from Cambodia. This research will establish disinfestations techniques against fruit flies on selected key fruit commodities, including mango,

dragon fruits, and mangosteen by building capacity of technical officers on rearing test fruit flies in laboratory, disinfestations techniques by vapor heat treatment (VHT).

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Costa Rica–Banana Fusarium Wilt- Fellow # 1

Scope of Work
Fellow #1: Costa Rica, Female, Researcher, National Institute of Research and Innovation. M.S. Genetics and Molecular Biology

Goal
To characterize through proteomics and metabolomics analysis, the proteins and metabolites involved during confrontation assays of a Trichoderma spp. strain against Fusarium oxysporum f. sp. Cubense tropical race 1 (foc TR1).

Fellow's Learning Objective
- To perform dual confrontation assays of a Trichoderma spp. strain against foc TR1
- To identify the proteins involved during confrontation assays between a Trichoderma spp. strain and foc TR1 through proteomics
- To analyze the metabolites involved during confrontation assays between a Trichoderma spp. strain and foc TR1 through metabolomics

Research Background
The plant-pathogenic Foc is the causal agent of fusarium wilt of banana (Musa spp.), which is one of the most devasting diseases on banana plantations. It can be divided into four physiological races, race 1, 2, 3 and 4. Race 1, 2 and 4 infect Musa species, but race 4 has a broad host range infecting almost all cultivars. In 2019, Foc tropical race 4 (Foc TR4) was confirmed in Colombia therefore Latin American countries with banana production are making efforts to prevent the income of the pathogen. Foc chlamydospores can persist in soil for a long time. Traditional options for managing this pathogen, are complicated because fungicides are largely ineffective. One of the options that has been tested is the use of biological control agents. Some Trichoderma spp. strains have the capability of being parasites of other fungi. In Costa Rica, INTA, Corbana and others, have explored the potential use of Trichoderma spp. to control Fusarium species. INTA preserved a mycoteca and hope to use the Trichoderma spp. strains to characterize proteins and metabolites with potential to use them in a future as biofungicides.

Expected Accomplishments
Identify proteins and/or metabolites with potential to use them as control options for foc TR1 infections in banana plantations, gain experience in proteomics and metabolomics analysis, and create a scientific relationship with a mentor's group to develop future collaborations, research projects and publications.

Contributions to Costa Rican Agriculture Sector
Costa Rica has a long history of using pesticides as an exclusive option for plant disease control, although this is environmentally dangerous and a risk for public health. This project will contribute to the international effort to protect all the banana production around the world from foc TR4. This research topic offers a sustainable option to support disease control strategies that the government uses for foc RT1 and the results can be used to strengthen the sanitary policies that are followed to prevent foc RT4 from entering Costa Rica as well as control foc RT1.

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Guatemala–Medfly Gene Editing- Fellow # 1

Scope of Work
Fellow #1: Guatemala, Female, Technology Transfer Advisor, Universidad del Valle de Guatemala. M.A. in Project Management

Goal
To identify pro-longevity gene orthologues in Medfly and test the effects of overexpression on the Medfly longevity and sterilization process.

Fellow's Learning Objective
- Design target-specific sgRNA and Cas9 nuclease expression plasmids and synthesize single guide RNAs
- Evaluate the fertility and longevity of the new strains

Research Background
The Sterile Insect Technique (SIT) is widely accepted to reduce insect pest populations. It employs X rays or gamma radiation to sterilize males that later are released into the wild population to mate with wild type females and reduce the pest population. Today, SIT is used to control the dissemination of pests such as: Ceratitis capitata, Anastrepha sp. and Bactrocera sp. A technical limitation of the SIT process is the development of specific strains with classic induced mutagenesis. This technique, although unpredictable and time consuming, allows the SIT programs to develop fly strains with favorable characteristics. The release of transgenic organisms is highly regulated or prohibited in many countries, but some studies are proposing the use of the tool CRISPR-Cas9 toolbox, which is classified in some regions as a non-Genetically Modified (GM) tool, to create non-GM fly strains with favorable characteristics for the SIT process. This project proposes to use CRISPR/Cas to overexpress potential pro-longevity genes in testis and evaluate the effect on fertility and longevity of medfly. This will allow identification of pro-longevity genes that would not affect the Medfly sterilization process. These results will be the first step to engineer non-GM, longer-lived fly strains as a novel technology in the region.

Expected Accomplishments
The sterile medfly life span is directly proportional to its impact in wild-fertile population decrease, therefore fruit productivity will be enhanced by the degree of control achieved by a new long-lived strain. This project will develop methods to increase the production efficiency of the SIT process by silencing sexual differentiation genes in Anastrepha ludens, to create male-only progeny to create the first CRISPR-Cas medfly strain for SIT use in Guatemala.

Contributions to Guatemalan Agriculture Sector
The Borlaug Fellowship will allow Guatemalan scientists to locally design and develop a novel strain with gene editing technology. Moreover, this fellowship will be a step forward in setting up the first CRISPR laboratory in Central America, which will give the region the opportunity to apply this technique to tackle different problems ranging from pest and vector control to human diseases. The implementation of a new medfly strain in the SIT program Moscamed, will be Guatemala's first example of the new technical manual that classifies CRISPR organisms as non-

genetically modified. The project will initiate a gene editing laboratory at UVG's Center of Innovation and Technology (CIT), hub of maker spaces dedicated to designing prototypes in collaboration with industry, regional entrepreneurs, students, faculty, and researchers. The laboratory will be part of the B-HIVE, a cluster of bio-based maker spaces for the development of new biotechnological solutions. The goal is to be able to turn this cluster into a biotechnology benchmark in the region that will introduce and popularize CRISPR-Cas tool and its potential throughout Guatemala.

Proposed Schedule

The applicant should propose a 10-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Honduras–Aflatoxins and Mycotoxins in Food Grains- Fellow # 1

Scope of Work
Fellow #1: Honduras, Male, Associate Professor, Zamorano University. PhD in Food Science

Goal
To evaluate and quantify chemical components of importance in food safety and quality (i.e. mycotoxins), determine a post-harvest corn management system that can reduce the incidence of mycotoxins in grains in Honduras, and evaluate the effect of processing on the mycotoxins levels of grain-based food products.

Fellow's Learning Objective
- Develop and/or validate analytical methods to evaluate the physical properties and mycotoxins levels in corn and grain-based food products
- Develop agricultural practices and/or storage strategies to reduce post-harvest loss for small producers, and gather scientific data to develop a draft of a national policy or norm to control and prevent the incidence of mycotoxins in grains and grain-based products

Research Background
In Honduras, the main source of carbohydrates in the daily diet is corn, accompanied by beans as a protein source, which is why these are the most important grains in national production. The conditions of field production, harvest and post-harvest handling of corn, make it a grain prone to be contaminated with fungi that produce toxins and due to the high consumption of this grain nationwide, it becomes a safety and food security problem, since mycotoxins are harmful to consumer´s health. In Honduras, small producers harvest corn with a high moisture content, which favors the incidence of fungi that damage the structure of the grains, making it unfit for human consumption or to produce feed for animals. There are no controls or regulations that specify the post-harvest management of the grains; therefore, one of the objectives of this proposal is to determine a post-harvest system that reduces the incidence of fungi that produce mycotoxins.

Expected Accomplishments
Determine different effective methodologies that can be used to measure mycotoxins levels (i.e. aflatoxins, fumonisins, etc.) in corn and other important grains for human and animal consumption. Determine good agricultural practices that can be used to prevent and control the incidence of mycotoxins and transmit this knowledge to producers in different areas of Honduras. Develop technical teaching material that can be shared with grain producers to help them prevent or control harvest loss due to mycotoxins. Start developing a draft of a policy that can orient policymakers on this issue.

Contributions to Honduran Agriculture Sector
Authorities in Honduras do not have an idea of the impact that mycotoxins have over the health of the population. More importantly, the government does not have an idea about the presence or levels of mycotoxins in food products. Helping producers, including those that only

harvest for subsistence, will be beneficial for the food security in Honduras. In addition, if the country develops a national policy or norm about mycotoxins, it will encourage industries to improve their storage systems and this will benefit all the consumers by reducing the risk of long-term effect produced by these toxins.

Proposed Schedule

The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Mongolia– Pathogens in Pork and Poultry - Fellow #1

Scope of Work
Fellow #1: Mongolia, Male, Infectious Diseases Department Head, Mongolian University of Life Sciences. PhD Veterinary Medicine

Goal
Develop a better understanding of genomics and molecular epidemiology research methods, including next-generation sequencing, for detection and identification of pathogens in pork and poultry products for the improvement of food safety/security and veterinary service in Mongolia

Fellow's Learning Objective
- Detect and analyze genome sequences and evolutionary dynamics of pathogens in pork and poultry products including bacterial hazards
- Detection and identification of bacterial pathogens including but not limited to campylobacter and salmonella by microbiological culture and traditional molecular biology methods such as PCR for viral pathogens in poultry products
- Detect and identify viral pathogens including but not limited to avian influenza virus by egg inoculation, cell culture, and traditional molecular biology methods such as PCR in poultry products for genomics and molecular epidemiology
- Determine protocols for different types of NGS platforms for samples of bacterial and viral cultures, in pork and poultry products

Research Background
Agriculture especially livestock is a traditional and special sector of the national economy and an important source of employment in Mongolia. Although traditional livestock production is central to Mongolia's economy, the intensive livestock production (exotic stock such as pig and poultry) is increasing due to economic development, food culture changes, tourism, migrations and it is challenging for the diagnostic capacity and research experiences on poultry and pig products safety and diseases. Also, food poisoning incidents sporadically occurred in poultry or pork products and it is the lead government to periodically ban the import of pork, chicken, egg, and feed and/or suspend the food market and restaurants due to lack of research-based evidence and/or risk assessment for the policymakers. African Swine Fever (ASF) is a deadly viral disease of swine that has significant economic consequences in food security. ASF has become endemic among the domestic swine population in Asian countries, including Mongolia, where outbreaks associated with transmission are linked movement of pigs and pig products. Research investigating of pathogens in Mongolia has primarily focused on large food animals, and poultry and pig pathogens have largely been neglected. Current diagnostic methods such as isolation, culture, and genotyping although useful for pathogen identification, have limitations since it includes cost, the necessary skill set, and is time consuming. Mongolia needs to develop more accurate methods such as NGS that allow single test to screen of its identification of biological hazards in pig and poultry products.

Expected Accomplishments
Gain a better understanding of genomics and molecular epidemiology research methods including next-generation sequencing for detection and identification of emerging and high consequence pathogens in pig and poultry products for improvement to the food safety and veterinary service in Mongolia.

Contributions to Mongolian Agriculture Sector
Well-defined pathogens and phylogeny based on whole-genome sequencing could be a valuable forensic tool to isolate geo-origin or source attribution of accidental or deliberate incursions into Mongolia and to provide data support to local policymakers for the evidence-based decision. Develop a genomics and molecular epidemiology laboratory focused on a wide range of diseases include pig and poultry pathogens.

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Philippines– African Swine Fever Detection- Fellow #1

Scope of Work
Fellow #1: Philippines, Male, Assistant Professor, Central Luzon State University. DVM in Veterinary Medicine

Goal
Develop a Nanotech based, low-cost, and portable detection kits for African Swine Fever virus.

Fellow's Learning Objective
- Produce a tangible product, which is the lateral flow colorimetric assay test kit, that can be used by veterinarians to detect the presence of viruses
- Determine the sensitivity, specificity, and rapidness of detection both at the lab and at the farm level

Research Background
African Swine Fever is presently haunting the swine industry around the globe. Currently, there is no vaccine against the virus. Present detection methods require samples to be submitted at the lab for confirmation (with the use of Polymerase Chain Reaction, DNA-based detection method which is too complicated and costly). Delays in detection can cause wide dissemination of the deadly pig disease. Nanotechnology works on the principle of antigen-antibody reaction. Usually, gold nanoparticles (AuNP) are used to label an antibody. The antigen, which is the ASF virus, if present from the sample, will react with the antibody which is usually visually seen as a color change reaction. The reaction between the antigen and the antibody can be easily seen because of the gold nanoparticles.

Expected Accomplishments
Explore the possibility of using gold nanoparticles as a detection method since the principle is easy even for local swine farmers. Develop a Low-cost, portable, Nanotech-based, rapid disease detection kit for African swine fever.

Contributions to Philippine Agriculture Sector
The Philippines is a pork-eating nation. It needs to sustain and help the swine industry since there is no cure for ASF at present. This kit can be used by the government lead-agency Bureau of Animal Industry in the early detection of ASF from the ASF-free islands and thus can limit the spread of the virus throughout the Philippines. The kit can be used by the government veterinarians for surveillance study which can be basis of the government for policy making decisions towards the protection of the swine industry and the public health as well.

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Sri Lanka– Rice Biotechnology- Fellow # 1

Scope of Work
Fellow #1: Sri Lanka, Female, Director of Agricultural Biotechnology Centre, University of Peradeniya. PhD in Plant Biology and Biotechnology

Goal
The goal is to develop a rice blast (caused by fungus Magnaporthe oryzae) resistant Sri Lankan rice variety-using gene editing by a non-transgenic approach.

Fellow's Learning Objective
- Explore direct delivery of purified CRISPR/Cas9 ribonucleoproteins (RNPs) to the protoplast of Sri Lankan rice variety BG94-1 known to be highly susceptible for rice blast disease caused by Magnaporthe oryzae
- Check for efficient targeted mutagenesis of selected gene - ERF transcription factor, OsERF922 in microcalli/early-stage cultures of BG94-1
- Regeneration of plantlets from effectively edited protoplasts, multiplication and rooting
- Greenhouse and field-testing for rice blast, agronomic and quality traits with resistance and susceptible check varieties

Research Background
Rice blast, caused by the fungal pathogen Magnaporthe grisea, is a serious disease affecting rice cultivation in Sri Lanka (SL) and over 85 other countries in the world. It is considered as the most destructive disease of rice due to its widespread distribution and potential to cause up to 50% yield loss. The fungus causes lesions on leaves, stems, panicles, seeds, and roots from seedlings to mature rice. It is controlled by spaying fungicides, which increases production cost and environmental pollution. Enhancing the genetic resistance has been shown to be the most economical and effective approach for controlling rice blast. A recent study done in Sri Lanka evaluated 34 rice varieties including Sri Lankan varieties and International Rice Research Institute (IRRI) recommended varieties for blast resistance. With conventional breeding, it takes more than a decade to pyramid multiple blast resistance genes into a rice variety via crossing and backcrossing, while the high pathogenic variability in M. oryzae often leads to the rapid breakdown of resistance. Since most of the parental lines are susceptible and the phenotypic screening is highly influenced by the environment, new breeding strategies are essential.

Pathogen-associated molecular patterns (PAMPs)-triggered immunity (PTI) is an effective approach for the development of broad-spectrum resistance to rice blast. The PTI-breeding strategy applied using RNAi-based down-regulation of rice transcription factor expression has enhanced blast resistance. However, crops derived by RNAi-technology are considered as genetically modified (GM). Sri Lanka is still developing biosafety laws and regulations and the general public is not positive about GM crops. Sri Lanka, on the other hand, promotes mutation breeding especially when the required germplasm is not available. Therefore, developing and releasing a blast-resistant rice variety through an approach similar to mutation breeding would be acceptable. The proposal is to develop a non-transgenic approach, by direct delivery of purified CRISPR/Cas9-RNPs for OsERF922 to the protoplast of a local susceptible rice variety Bg94-1 and regeneration of resistant plants from the efficiently edited protoplasts.

Expected Accomplishments
The fellow wants to explore the direct delivery of purified CRISPR/Cas9 ribonucleoproteins (RNPs) to the protoplast of Sri Lankan rice variety BG94-1 known to be highly susceptible for rice blast disease caused by Magnaporthe oryzae. This will include checking for efficient targeted mutagenesis of selected gene - ERF transcription factor, OsERF922 in 18 / 25 microcalli/early-stage cultures of BG94-1, regeneration of plantlets from effectively edited protoplasts, multiplication and rooting, and greenhouse and field-testing for rice blast, agronomic and quality traits with resistance and susceptible check varieties.

Contributions to Sri Lankan Agriculture Sector
Rice blast is a serious problem in Sri Lanka. The government tries to reduce agrochemical usage and to enhance productivity at the same time. Developing high-yielding resistant varieties would be the best possible way to achieve such goals. The applicant would like to develop a blast-resistant local rice variety in a shorter time period. The same approach can be used for developing resistant varieties against other biotic and abiotic stresses in rice and other crops. Since the Sri Lankan government is still in the process of developing biosafety laws and regulations, and there are no exemptions for gene editing in the draft documents, a blast-resistant rice variety with an approach similar to mutation breeding will be a groundbreaking point in changing biosafety policy in Sri Lanka.

Proposed Schedule from Applicant Proposal
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Sri Lanka–Rice Biotechnology - Fellow # 2

Scope of Work
Fellow #2: Sri Lanka, Female, Senior Lecturer, University of Peradeniya. PhD in Molecular Plant Breeding

Goal
To identify of novel mechanisms, gene candidates, and superior alleles for saline tolerance by RNA-Seq analysis of Sri Lankan rice germplasm to broaden the genetic base for salinity tolerance.

Fellow's Learning Objective
- Analyze leaf, sheath and root tissue Na+ and K+ concentrations in three Sri Lankan rice cultivars (saline tolerant: Bw400, At354 and saline susceptible: BG352), under variable salinity stress conditions
- Construct RNA-Seq transcriptome of roots of the three cultivars under salinity stress
- Identify deferentially expressed genes (DEGs), transcript structures and co-expression networks
- Characterize the molecular functions and pathways in which the DEGs are involved (functional profiling)

Research Background
Salinity is a major constraint in local crop production and the net income loss due to salinity ranges between 22-43% in local irrigated rice farmlands. Pokkali is a salinity tolerant land variety widely used in breeding. Most salinity tolerant local cultivars have Pokkali introgressed in their genetic background. This project will study contrasting responses to salinity stress expressed in three local cultivars by comparative physiological and transcriptome analysis and will identify DEGs and co-expression networks. These include Bg352, a saline sensitive local cultivar with wide adaptability, high grain quality and farmer acceptance, and the two salinity-tolerant local cultivars, At354, derived from the Pokkali background and Bw400, with a distant genetic background. The fully annotated genomes of rice and other closely related cereals and the extensive literature available on salinity tolerance mechanisms enable efficient functional annotation of the candidate genes. The project will discover novel mechanisms, associated genes and alleles that can be effectively used in crop breeding for salinity tolerance.

Expected Accomplishments
The project has four objectives: (1) to analyze leaf, sheath, and root tissue Na+ and K+ concentrations in three Sri Lankan rice cultivars (saline tolerant: Bw400, At354 and saline susceptible: BG352), under variable salinity stress conditions, (2) to construct RNA-Seq transcriptome of roots of the three cultivars under salinity stress, (3) to identify deferentially expressed genes (DEGs), transcript structures and co-expression networks and (4) to characterize the molecular functions and pathways in which the DEGs are involved (functional profiling).

Contributions to Sri Lankan Agriculture Sector
Sri Lanka records the highest caloric deficits in South Asia. Although, 98% of the farmers grow improved rice cultivars national average yield is 3.7 t/ha which is 50% of the genetic potential

indicating, tremendous possibility for improvement. Over 92% of rice farmers are small holders, who contribute to 80% of the production. They own lands >2 ha. Fragmented land use and the inherent diversity in agro-climates, farming systems and socio-economies are major challenges in improving the local rice sector. Employing over 30% of the labor force and using 46% of the harvested land, rice sector has significant impact on the local economy. With more than 45,000 hectares of agricultural land are affected, salinity is a major constrain in local agriculture production. Even moderate salinity (EC 4-8 dS m−1) reduce yield by 50–80% in glycophytic crops. This project makes use of a promising, high-throughput technology and local underutilized (genetic) resources to broaden the genetic base for salinity tolerance that will lead to development of cultivars for saline affected soils.

Proposed Schedule

The applicant should propose 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Sri Lanka– CRISPR/CAS9 System to Control Leaf Curl Diseases - Fellow #3

Scope of Work
Fellow #3: Sri Lanka, Female, Senior Lecturer, University of Peradeniya. PhD Plant Genetics

Goal
Develop a CRISPR/CAS9 based system to control leaf curl diseases caused by begomoviruses in Sri Lanka.

Fellow's Learning Objective
- Design and generate multiplexed gRNA-Cas9 constructs targeting both coding and noncoding regions in the begomovirus genome
- Using the model plant, Nicotiana benthamiana, and a transient expression assay, screen the constructs from Objective 1 for their ability to suppress or attenuate virus replication and disease development

Research Background
Chili (Capsicum annuum L) is a very important condiment in Sri Lanka and other South Asian countries. Although there is a yield potential of about 3 t/ ha, the average dry chili yield in Sri Lanka is 1.0 t/ ha and these low yields are mainly attributed to diseases prevalent in all agro-ecological zones where chili is grown. All of the popular chili varieties are found to be susceptible to leaf curl disease. Significant yield losses are attributed to leaf curl disease of chili (LCDC) with disease incidence being recorded from all the major chili growing areas in Sri Lanka. The main reasons for LCDC are pest infestation such as by thrips and mite, and more importantly, due to begomoviruses transmitted by whitefly vector. The most popular chili varieties in Sri Lanka are MI-1, MI-2, Arunalu and MI-hot. None of these are resistant to LCDC. These are transmitted exclusively by the whitefly Bemisia tabaci. In Sri Lanka, the most widespread method to control the spread of LCDC is by using a range of insecticides to control the whitefly vector. Uprooting of infected crops and burning is the most commonly used cultural practice that is prevalent among farmers of all scale. Due to the detrimental effects such as acquired resistance by the target pest, destruction of non-target species, and the potential environmental impact, the chemical control is far from ideal. Novel biotechnological measures such as producing resistant varieties through transgenic or RNA silencing are other possible approaches that have obtained wide attention but are in their infancy in Sri Lanka. In the last few years, the use of CRISPR-Cas9 editing technology in the management of viruses has been reported extensively. The focus of this proposal is to use a novel, genome editing-based strategy to reduce the impact of a destructive begomoviral pathogen, Leaf curl disease of chili (LCDC), affecting the sustainability of an economically important cash crop, chili, in Sri Lanka.

Expected Accomplishments
To design and generate multiplexed gRNA-Cas9 constructs targeting both coding and noncoding regions in the begomovirus genome. Then, using the model plant, Nicotiana benthamiana, and a transient expression assay, screen the constructs for their ability to suppress or attenuate virus replication and disease development.

Contributions to Sri Lankan Agriculture Sector

Chili is one of the major cash crops in Sri Lanka and is very popular among the dry zone farmers due to its less susceptibility to large pests such as wild elephants and monkeys. According to statistics, Sri Lanka reaches only 1/3 of the chili yield potential. The proposed research will utilize new approaches to generate resistance to the viral disease LCDC with desirable outcomes: high level of virus suppression, durable resistance with minimal or no escape mutants. Knowledge gained from this proposed research will be applicable to the control of LCDC disease in Sri Lanka and to develop genome-editing protocols to control plant diseases caused by begomoviruses in other crops in general. Sri Lanka is lagging with regards to the utilization of molecular tools in crop improvement, mainly attributed to the lack of a biosafety framework in place. The genome-editing technique will be an attractive alternative to developing environmentally sound and durable control options for economically important diseases. The outcome of this research will be able to convince the policy makers, the significance of biotechnological approaches in crop improvement and the research need government's support.

Proposed Schedule from Applicant Proposal

The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Sri Lanka–Blister Blight Disease in Tea- Fellow # 4

Scope of Work
Fellow #4: Sri Lanka, Female, Principal Research Officer, Tea Research Institute of Sri Lanka. PhD in Plant Pathology

Goal
Identify and characterize candidate resistance genes against blister blight disease in tea (Camellia sinensis).

Fellow's Learning Objective
- Aligning the data against reference genome of tea plant
- Identifying disease resistant genes associated with blister blight and other diseases
- Cloning and functional characterization of disease resistant genes

Research Background
Tea is a non-alcoholic beverage produced from tea plant (Camellia sinensis). Sri Lanka is the world's fourth tea producer and world's third tea exporter. Tea contributes about 40% of the country's agricultural export earnings and 0.7% to the GDP. Tea disease are one of the threats to tea production. Blister blight (BB) caused by Exobasidium vexans, is the major leaf disease directly attack the harvestable shoots and young emerging shoots. Crop loss has been estimated to 40%. As the demand for pesticide free tea has been increasing; use of agrochemicals is discouraged. Therefore, breeding for BB resistance is one of the objectives of tea breeding programs. Conventionally, resistant plants are developed by crossing resistant parents, followed by phenotypic selection of plants. However, limited information on genetic basis of BB resistance in tea and pathogenicity of E. vexans is available. So far, none of the genes are cloned and functionally related to BB resistance. The genome sequence can serve as a vital resource for studying the genetic bases of disease resistance for genetic modifications. The major step in the development of disease-resistant varieties is to identify the candidate disease-resistance genes (R). Presently, more than 100 candidate R genes are identified by their structure, function, and characterized in different plant species. It is aimed at identifying R genes in tea using bioinformatics tools and characterize their function/s in relation to BB resistance.

Expected Accomplishments
Development of BB resistance tea cultivars with introgression of R genes in future. A similar approach could be extended to other important diseases (stem cankers) with generated information. Disease resistant plants would minimize crop loss and expenses thus increasing tea production. Identifying disease resistant genes associated with blister blight and other fungal diseases.

Contributions to Sri Lankan Agriculture Sector
Tea is the highest foreign exchange earner and number one agricultural crop. Therefore, it has direct influence on agricultural productivity, and foreign earning and income of tea small holders leading to economic development of the country. Genetically engineered (GE) crops or Genetically Modified Organisms (GMO) are not produced and importation is not allowed in Sri

Lanka. Due to recent climate change, growing demand for food, and associated issues, the need of GE is felt. Some GE research is carried out at the laboratory level. National Biotechnology Policy, the National Biosafety Framework, and others focus on GE. In the absence of strong regulatory frameworks, advanced knowledge, and infrastructure, the proposed study will bring new knowledge, experience, and scientific data to help introducing proper legal framework to ensure that the quality of the imported and domestically produced GE products to the human health and biodiversity of Sri Lanka while enhancing agricultural productivity.

Proposed Schedule from Applicant Proposal

The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Vietnam–Tilapia Aquaculture - Fellow # 1

Scope of Work
Fellow #1: Vietnam, Male, Vice Dean, Vietnam National University of Agriculture.
PhD Aquaculture

Goal
To establish effective management for sustainable development of Tilapia farming industry in Vietnam.

Fellow's Learning Objective
- Detect new emerging bacterial diseases in Tilapia that have appeared and caused massive mortality in Vietnam in recent years
- Establish methods for the diagnosis of infections caused by new emerging bacterial diseases in Tilapia for laboratories in Vietnam
- Establish effective prevention and treatment through trials for practical application in tilapia farming

Research Background
Tilapia is a crucial cultured species of Vietnam's seafood industry and has been designated as the main farming species, facilitating the expansion of scale and increasing production to serve processing needs and exportation by the Vietnamese Government and the Ministry of Agriculture and Rural Development. However, in recent years, new diseases of Tilapia have been occurring, causing massive mortality for Tilapia, causing economic losses and affecting the productivity and sustainable development of the tilapia industry. Due to the lack of investment for research, the causative pathogens have not been detected and diagnosed correctly, the methods of disease prevention and treatment are based on judgment. Hence, the effectiveness is not good enough. It is urgently requested to determine the new emerging diseases on Tilapia, establish diagnostic procedure, the effective prevention and treatment to minimize economic losses due to the disease outbreaks, improve production efficiency, and enable sustainable development for the tilapia industry.

Expected Accomplishments
Detect new emerging bacterial diseases in Tilapia that have appeared and caused massive mortality in Vietnam in recent years.
Establish methods for the diagnosis of infections caused by new emerging bacterial diseases in Tilapia for laboratories in Vietnam.
Establish effective prevention and treatment through trials for practical application in tilapia farming.

Contributions to Vietnamese Agriculture Sector
In recent years, the government and the Ministry of Agriculture and Rural Development targeted that Tilapia will be the main culture species for domestic use and exportation. Thus, Tilapia has been widely cultured and expanded in Vietnam with many models such as culturing in earth ponds, and cage culture in rivers and hydroelectric lakes. However, the biosecurity to protect fish

and sustainable tilapia farming is poorly practiced by farmer and community. Consequently, the outbreaks of diseases have been appearing frequently and cause severe economic loses. Reduction of the overuse of antibiotics and chemicals in aquaculture that assists in increasing quality of products for exportation, increases the value of products. The project will help to reduce the side effect of antibiotic use in aquaculture, especially occurring resistance antibiotic bacteria strains and antibiotic residual in meat. All subsequently could be enhanced aquaculture productivity, economic development for farmers, improve food biosecurity and enable for sustainable aquaculture and tilapia farming in Vietnam. Tilapia farming was changed from traditional culture species only for domestic use to the main culture species for exportation is one of the policy changes in 2019 in Vietnam Aquaculture, but the disease outbreaks become the most challenging. Therefore, research on management for the disease outbreaks is a key factor playing a vital role in the success of this policy changes.

Proposed Schedule from Applicant Proposal

The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Vietnam–Soybean Biotechnology- Fellow # 2

Scope of Work
Fellow #2: Vietnam, Female, Lecturer, Vietnam National University of Agriculture.
PhD in Crop Science and Plant Biotechnology

Goal
Determine the efficiency of the CRISPR/Cas9 system in editing soybean drought tolerance genes.

Fellow's Learning Objective
- Design single-guided RNAs for drought tolerance genes of soybean
- Construct CRISPR/Cas9 expression vector
- Evaluate mutation efficiency of the CRISPR/Cas9 system for drought tolerance genes of soybean

Research Background
Soybean is an important legume crop with great economic and environmental values. Soybean provides protein and oil for food production and animal forage. However, soybean production is currently affected by abiotic stresses. Drought, an important abiotic factor of frequent occurrence limits plant growth and yield in many areas on the earth that is increasingly topical because of climate change and water shortages. Traditional breeding is constrained due to narrow genetic bases of soybean. In addition, breeders must repeatedly introgress the mutations into elite soybean cultivars by conducting genetic crosses and selection over generations and years. This is a long and labor-intensive process, which delays delivery of soybean varieties to cope with a continuously changing agriculture environment. Genome editing technologies provide new opportunities for crop improvement by employing precision genome engineering for targeted crop traits. Among three genome editing techniques, zinc-finger nucleases (ZFNs), transcription activator-like nucleases (TALENs) and clustered regularly interspaced short palindromic repeat (CRISPR)/CRISPR-associated protein (Cas) system, CRISPR-Cas system is simpler, faster and more efficient. Application of CRISPR/Cas9 for crop improvement is through modification a target crop plant's genome in very precise ways, provided availability of the plant's genomic sequence and the genes that code for, or allow production of, specific proteins with known functions. However, primary application of this tool has been the generation of gene knock-outs so far. CRISPR/Cas9 system has not been employed for studying abiotic stress responses as of now. Soybean is among crops that its genomic resources has been well studied. However, there has been little focus on use of CRISPR/Cas9 for adaptation studies including drought tolerance in soybean.

Expected Accomplishments
Design single-guided RNAs for drought tolerance genes of soybean, construct CRISPR/Cas9 expression vector, and evaluate mutation efficiency of the CRISPR/Cas9 system for drought tolerance genes of soybean.

Contributions to Vietnamese Agriculture Sector
Vietnam is ranked among five countries affected severely by climate changes which currently cause serious drought and salinity conditions. Consequently, many areas are not cultivatable, and farmers are becoming poorer. Therefore, the Ministry of Agricultural and Rural Development's (MARD) efforts have been channelized towards development of varieties adaptable to stresses. Thus, scientists need to focus on applying advanced biotechnology tools, such as genome editing and genetic engineering for development of new crop varieties, including soybean. The research will provide evidence on the effectiveness of genome editing techniques for soybean improvement of targeted traits, such as drought tolerance. This will increase the awareness about efficient application of biotechnology in crop breeding in Vietnam.

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Vietnam–African Swine Fever Vaccine Development-Fellow #3

Scope of Work
Fellow #3: Vietnam, Female, Vice Head of Pathology, Vietnam National University of Agriculture. PhD in Veterinary Sciences

Goal
Develop a system for assessing an African Swine Fever (ASF) vaccine and a vaccination strategy to be used in Vietnam

Fellow's Learning Objective
- Develop criteria for choosing an animal model and experimental design for comparing ASF vaccine safety, efficacy, immune responses, clinical, and pathological responses
- Conduct an experiment to validate the chosen animal model and experimental design for an ASF vaccine

Research Background
Since the Ministry of Agriculture and Rural Development (MARD) confirmed its first ASF outbreak on 19 February 2019, all 63 provinces/cities reported outbreaks. More than six million pigs have been culled leading to considerable economic loses. cost-effective ASF prevention strategies such as vaccination became a priority for the Vietnamese government. The university expects to provide cost-effective strategy for ASF prevention and control in Vietnam using vaccines. One of the main reasons there is no effective ASF vaccine is the lack of detail in understanding of the pathogenesis and immune responses. Pigs are of great importance in Vietnam because of their contribution to human nutrition, their role in agricultural production systems and their economic function. ASF in Vietnam has led to the death and culling of more than six million pigs or approximately 22 percent of the total pig population in the country. Having an effective ASF vaccine and vaccination strategy would minimize the risk and the economic impact of ASF on Vietnam pig industry thus preserving Vietnamese farmers livelihood and food security.

Expected Accomplishments
Improve the competitiveness of the livestock industry based on timely application of advanced science and technology. The project will contribute directly to improving government capacity to generate necessary evidence to support animal disease prevention and control policy. Especially for high impact animal diseases such as ASF. This capacity can also be applied to other future emerging threats as well.

Contributions to Vietnamese Agriculture Sector
Vietnam will gain the ability to assess which African swine fever vaccines should be used and the fellow will be able to provide recommendations on how to vaccinate pigs in Viet Nam. This study will increase Vietnam's understanding of ASF virus and host interaction including mechanism of protective immunity, approach for vaccine development and assessment.
ASF is a relatively new disease in Vietnam. So far, there is neither safe infrastructure nor validated protocols to assess an ASF vaccine for used in Vietnam.

Proposed Schedule
The applicant should propose a 12-week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post-award.

Borlaug Fellowship Program – Georgia – Genotypes and Population Structures of Salmonella – Fellow #1

Scope of Work
Fellow #1: Georgia, Female, Specialist, LEPL Scientific Research Center of Agriculture/ Risk Assessment Division. PhD Life Science

Goal
The goal of the research is to gain preliminary but important insights into the genotypes and population structures of Salmonella enterica isolated from locally produced and imported poultry products in Georgia, using the WGS and phylogenetic analysis.

Fellow's Learning Objective
- Isolation and identification of Salmonella from locally produced and imported retail poultry carcasses, poultry meat products and eggs
- Gain knowledge how to monitor the occurrence of Salmonella in retail poultry products
- Determining genotypes and population structures of Salmonella, using the WGS, which will generate important data for assessing the risks associated with foodborne salmonellosis

Research Background
Salmonella is an important foodborne pathogen worldwide. In Georgia, the salmonellosis infections demonstrate the increasing trend (https://www.ncdc.ge). It is highly important to indicate that the sources underlying the emergence and spread of these infections remain largely unknown and need to be urgently determined. The information on the occurrence of Salmonella across different food clusters has been solely based on the very limited date obtained from the Food Safety State Control Program. Besides, these occurrence data (exhibited in incompliances varying from 0.5% to 4.6% of Salmonella occurrences in food in 2014-2018 clearly are not enough to gain insights into and explain the increasing trend of human salmonellosis incidence rates. This is coupled with a complete absence of the genotypic data for Salmonella from food and human infections in Georgia.

The solution to this problem is generating more data not only on the occurrence of Salmonella across different food matrices with poultry products being suggested as a main source of Salmonellosis, but also on the Salmonella genotypes circulating in both food and salmonellosis infections. Determining i) the genotypes of Salmonella from these sources using the WGS, and ii) the phylogenetic analyses linking these genotypic data on Salmonella from food and human infections. This will allow the risk managers to design effective preventive strategies to limit and control the salmonellosis infections across the country.

Expected Accomplishments
The Borlaug fellowship would allow the fellow:
- To improve knowledge and laboratory skills of the isolation of bacterial foodborne pathogens (preferably Salmonella)

- Master the WGS technology, the assembly and analysis of bacterial genomes, and the methods of phylogenetic analyses to determine genotypes and population structures of foodborne agents
- To successfully launch research to understand and track the transmission sources of salmonellosis in Georgia

The Borlaug Fellowship will help the fellow become involved in more in-depth studies for determining i) the risk pathways of microbial contamination of different food matrices, and ii) the sources of transmission of foodborne infections. These will allow for designing better strategies and measures for control and prevention of foodborne diseases, and for food safety and security being so essential for the well-being of the population, the economic growth of the country, and the successful international trade of its agricultural products.

Contributions to Georgian Agriculture Sector
According to the Regulation of the Government of Georgia (No. 442/08.29.2018 ["Procedures for the Risk Assessment, Risk Management, and Risk Communication within the Framework of Risk Analysis]), SRCA, with its Risk Assessment Division, it is mandated to perform the food safety risk assessment on a state level in the country. The outcomes of the risk assessment activities of SRCA and the recommendations, for risk managers and other interested parties, frequently contribute to improved or new policies being developed by the Georgian government in the fields of food safety and food security. The food safety risk assessment is a new area reflecting a short history of practices in Georgia. Thus, there has been a great need for the fast-pace development of advanced food safety risk assessment practices in the country, where the agricultural industry is one of its strategic fields for economic growth. The Risk Assessment Division of SRCA has been in a process of research capacity building accompanied by a constant training of its personnel in the fields of food safety, veterinary and phytosanitary risk assessments.

Head of the division, Dr. Mamuka Kotetishvili, who was very recently appointed to this position, is the U.S. trained expert in the area of molecular epidemiology of infectious agents. His research studies have contributed to the better understanding of both epidemiology of foodborne agents and food safety globally. Among other priorities, Dr. Kotetishvili considers a necessity of advanced trainings for the young researchers especially in U.S. universities and other institutions, which provide the state-of-the-art methodologies and practices, as well as an ideal training environment for advanced food safety risk assessments. In addition he has a vision for a growth of expertise of risk assessors via developing collaborative research and establishing close collaborative ties both locally and internationally in the above areas. The knowledge and skills, that the fellow intends to acquire during the training in a U.S. institution, will be beneficial to SRCA striving for establishing very strong risk assessment capabilities in the given fields.

Suggested Schedule
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program– Kazakhstan– Genes Associated with Grain Quality - Fellow #1

Scope of Work
Fellow #1: Kazakhstan, Female, Republican State Enterprise "National Center for Biotechnology" under the Science Committee of Ministry of Education and Science of the Republic of Kazakhstan/ Laboratory of Biotechnology and Plants Breeding. MS Biology

Goal
The goal of this research is to identify new genes associated with grain quality, productivity and disease resistance using new genomic technologies.

Fellow's Learning Objective
- Search for new grain quality genes and study the relationship of traits that determine yield and disease resistance
- Genotyping of wheat lines and varieties using modern DNA-markers
- Determination of the nucleotide sequences of genes, which associated with grain quality of promising lines and varieties of wheat
- Identification of DNA markers associated with grain quality
- Identification associations between target traits/genes and molecular markers, conducting statistics

Research Background
The research is related to obtaining valuable wheat lines that are resistant to adverse abiotic and biotic environmental factors using biotechnological methods, genotyping and identification of plant varieties and forms using molecular-genetic markers and the adaptation of woody test tube plants in the soil, which have been obtained using microclonal propagation. During the research activity, the fellow has published more than 20 regular papers.

One of the main tasks at the present stage is the creation of high-yield, tolerance to environmental harsh conditions, and durable varieties. In previous research works the fellow was able to obtain drought-resistant wheat lines using the in vitro culture method and cell selection. She has also worked under the project "Modern genetic diversity of the flora of the State National Natural parks Bayanaul and Burabay" (Northern Kazakhstan, 2015-2017). As a result of the project, a herbarium of endemic, rare and endangered plant species was studied and collected, plants DNA was isolated and performed comparative analysis of the current status and genetic diversity of plants was carried out using DNA-markers of the nuclear and chloroplast genomes. The task was to determine the nucleotide sequence of ITS and rbcL genes for each plant species under study, which is used to determine belongs to a particular taxon in molecular biology. The presence of the sequence of nucleotides that make up this gene (DNA barcode) opens up wide possibilities for solving many applied and fundamental problems. In addition, we can clarify the position of the species in the existing classification: compare how closely a given taxon is related to neighboring taxonomic units. For genotyping, molecular-genetic methods were used: DNA isolation and purification, polymerase chain reaction, agarose gel-

electrophoresis, determination of nucleotide sequences of nuclear and chloroplast genomes using DNA markers.

The fellow's research is also related to the adaptation of test-tube woody plants, which were obtained using microclonal propagation in the soil in the framework of the project: "Commercialization of the technology of microclonal propagation of woody plants for industrial use in urban greening". This study developed a protocol for adapting test-tube plants to non-sterile conditions.

Expected Accomplishments
Through the fellowship the fellow hopes to gain theoretical knowledge and practical skills to work in accordance with the goal, SNPs analysis, determine the nucleotide sequences of targeted genes, identify targeted traits/genes and provide statistics.

At the moment, their scientific interest is identification of new genes and molecular markers associated with grain quality. The fellowship will expand the fellows horizons and knowledge in wheat genetics and will affect further crop improvement such as, development of genetics and wheat breeding, which is important for food security. The fellow will take into account the experience of a mentor in the USA to conduct similar studies in their home country. This training will serve as a synthesis of practical skills and theoretical knowledge which will be crucial to obtain scientific results.

The Borlaug scholarship will contribute to improving agricultural productivity and food security in Kazakhstan. This will expand theoretical knowledge in wheat genetics and crop improvement. Molecular breeding technologies enable the creation of varieties with high yields, adapted to a wide range of biotic factors, which is important for food security in Kazakhstan.

Contributions to Kazakh Agriculture Sector
The use of modern technologies and the joint work of geneticists and breeders aimed at improving and strengthening breeding programs for the cultivation of high-quality wheat varieties will allow to obtain high productivity, which in the future will not only affect the food security of the country, also will increase wheat export, which will have a beneficial effects on country's economy. Without the application of biotechnology innovations, agricultural production will considerably decrease in the domestic food production sector.

The fellow would like to be considered for this scholarship in order to use opportunities, which will be ensured in the framework of program. The gained knowledge will be introduced into their future research work, such as enhancing my qualification and applying for a PhD program. It can be considered as an excellent opportunity for self-realization as a scientist, self-confidence, and to independently evaluate personal progress and achievements.

Suggested Schedule
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Turkey– Weaken Wheat Phenylalanine Ammonia-lyase (PAL) Gene Promotor - Fellow #1

Scope of Work
Fellow #1: Turkey, Male, Research Assistant, Ankara Üniversitesi. PhD Biology

Goal
The goal of the research is to weaken wheat phenylalanine ammonia-lyase (PAL) gene promotor by Homology Direcred Repair (HDR) CRISPR-Cas9 technology to obtain more economical and effective biofuel production.

Fellow's Learning Objective
- Editing the specific regulatory motifs of PAL gene (The fellow has already identified six possible cis-elements on PAL promoter region including TATA box, and GTAC sequence) via HDR CRISPR-Cas9
- Compare the lignin contents of the CRISPR-Cas9 edited and non-treated wheat (control group) for the validation of the PAL promotor editing. He will also determine the promoter of the wheat PAL gene expression levels in order to validate CRISPR editing
- Test the bioethanol production potentials of CRISPR-Cas9 edited and non-treated wheat straw by simultaneous saccharification and fermentation (SSF)

Research Background
Renewable biofuels are promising alternatives to fossil-based fuels. Among them, bioethanol is considered as one of the most important ones. Bioethanol can reduce the CO2 emissions up to 90% and can be obtained from lignocellulosic agricultural wastes such as corn stover or wheat straw. Lignocellulose is one of the most under-utilized and cheap feedstocks on Earth. Therefore, lignocellulosic bioethanol does not affect the food production chain.

Lignocellulose has three essential elements: Lignin, cellulose and hemicellulose. Cellulose and hemicellulose contain fermentable sugars such as glucose and xylose. On the other hand, lignin which is a phenolic polymer creates a physical barrier to microbial attacks, pretreatment agents or enzymes. Therefore, the structure of lignocellulose is resistant to disruption. To obtain fermentable sugars for bioethanol production, lignocellulose should be pretreated in order to eliminate lignin. However, in bioethanol production, the pretreatment step consists of nearly 60% of total costs. Thus, reducing pretreatment costs is essential for the feasibility of the process.

Phenylalanine ammonia-lyase (PAL) is an enzyme which plays a vital role in the lignin biosynthesis. The enzyme catalyzes a reaction transforming L-phenylalanine to ammonia and trans-cinnamic acid. Since the PAL has a substantial role in the plant life, complete disruption of the PAL gene or PAL promoter region may be mortal for the organisms. However, weakened PAL promotor gene may allow reduced lignin levels in wheat. By this way, cheaper pretreatment can be available and more economical bioethanol can be produced from wheat straw.
Wheat is a substantial nutrient for humans, and wheat straw is the primary residue of wheat processing. United States of America (47,370,880 metric tons in 2017) and Turkey (21.500.000 metric tons in 2017) are two of the biggest wheat producers in the world, and millions of tons

wheat straw are generated in both countries annually. In the literature, there are numerous studies about bioethanol production from wheat straw. Thus, in this research proposal, wheat straw is selected for its commercial availability and common usage.

Because the reasons mentioned above, the goal is to edit PAL gene promoter of the wheat by Homology Directed Repair CRISPR-Cas9 approach and obtain wheat lines which have reduced lignin expression. For editing of the PAL promoter, regulatory motifs on the promoter will be aimed. According to my preliminary researches, PAL promoter different regulatory motifs, including TATA box. For the TATA box is crucial for the expression, the other regulatory motifs will be edited. During the CRISPR experiments, combinatory editing will be carried out. Hence, it will be possible to obtain many different expression patterns. After CRISPR editing, pretreatment susceptibility and bioethanol production potentials of CRISPR edited and non-treated wheat straw will be investigated. The results will provide valuable information about more economical biofuel production.

Expected Accomplishments

During the fellowship, the fellow hopes to obtain CRISPR-Cas9 mediated transgenic wheat lines which have weakened PAL activity and lowered lignin content. This situation will give novel information about the lignin biosynthesis/bioethanol production relationship. This will enhance the fellow's scientific background about metabolic engineering studies which are game changing technologies for agriculture and biofuel productions.

The fellow also hopes to show lowered lignin concentrations will cause cost-effective bioethanol production, as described in the literature previously. His scientific background is renewable biofuel production, and this potential study is suggested more-economical bioethanol production from abundant agricultural waste.

The U.S.A is the leading country in science and one of the biggest agricultural economies of the World. Therefore, both commercial bioethanol production and intensive research is carried out in the U.S.A currently. As a result, working with a mentor in the U.S will benefit the fellow's scientific career greatly.

Bioethanol production of the world is mainly met by edible crops such as wheat, maize or sugarcane. On the other hand, lignocellulosic bioethanol production is a growing industry and commercially available in countries such as USA or Norway. Unfortunately, in Turkey, there is very little attention to lignocellulosic bioethanol production. Furthermore, metabolic engineering is a promising approach for effective biofuel production. By this context, producing new transgenic wheat lines can help the reducing bioethanol prices and Borlaug Fellowship can contribute to the economic development of the bioethanol industry in Turkey.

Contributions to Turkish Agriculture Sector

First, bioethanol is an eco-friendly energy source. Second, bioethanol from lignocellulosic material is renewable. Third, producing cheaper bioethanol from metabolically engineered lignocellulosic feedstocks is possible. Unfortunately, Turkey is a fossil-based fuel importer country. Thus, there is an urgent need for renewable energy sources in Turkey. Therefore,

effective results can be obtained through strong public relations about the study and its conclusions.

In the fellow's organization, biofuel researches and metabolic engineering studies are limited. Therefore, if the Borlaug Fellowship program supports his study, he will get to a chance of work on biofuel production from metabolically engineered lignocellulosic biomass. The fellow can also transfer the acquired knowledge to Turkey and collaborate with the mentor that will be appointed by the fellowship program. Know-how of the such a collaboration can provide the fellow with qualified scientific articles and leadership.

Proposed Schedule from Applicant Proposal
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Turkey –Stem Rust Resistance Genes – Fellow #2

Scope of Work
Fellow #2: Turkey, Female, Senior Research Assistant, Icarda International Center/ Cereal. Pathology, MS Plant Protection/ Pathology/ Virology

Goal

- To be able to characterize resistance (R) genes conferring resistance to stem rust in a set of commercial cultivars and advanced breeding genotypes and use them in marker assisted selection for enhancement of resistance to stem rust in high yielding cultivars from Turkey
- Implementation of molecular diagnostic SNP assay for surveillance and population studies of the wheat stem rust pathogen from CWANA and East Africa

Fellow's Learning Objectives

- Characterize the stem rust resistance genes in the wheat cultivars and advanced breeding lines from national breeding in Turkey using molecular markers which will aid in developing future breeding strategies against the new and emerging races of stem rust
- Enhancement of durability of resistance to stem rust using Marke Assisted Selection approach for incorporating R genes into commercial cultivars and elite lines
- Implementation of the diagnostic SNP assay for the wheat stem rust pathogen will allow for early detection of virulent strains that threaten resistant wheat cultivars, which will aid the stakeholders to take safety measures in time to ensure wheat yield security
- Transfer of advanced molecular technologies in MAS of wheat resistance genes and pathogen population genetics from the USDA CDL, an internationally recognized laboratory, to further build research capacity in Turkey

Research Background
Cereal rust diseases (Stem, Stripe and Leaf) are the most damaging diseases of wheat and barley around the world. Losses of yield can range up to 80-100% depending on the type and severity of the epidemic. The most sustainable solution to this problem is the deployment of cultivars with multiple R genes, which will provide stable resistance. This reduces or eliminates the need to rely on pesticides, which are more, which are economic and environmentally more costly. Development of resistant and stable wheat cultivars requires the "stacking" of multiple R genes through using advance molecular tool (MAS) which greatly enhances the speed the breeding process. A key component of developing a long-term strategy of deployment of resistant cultivars is to understand the pathogen population and to detect new virulent strains before epidemics occur.

Expected Accomplishments
At the end of the fellowship, the fellow will learn molecular marker techniques required to detect the R genes in the wheat populations and be able to transfer desired genes in breeding programs using marker-assisted selection. Furthermore, the fellowship will provide training in wheat stem rust pathogen genotyping with the SNP assay. She has been working on cereal rust diseases for the past seven years. Her research focuses on race typing of rust pathogen samples collected from not only Turkey but also received samples to Regional Cereal Rust Research Center in

Izmir and different regions of the world. The fellow has experience in seedling and adult plant assessment of rust diseases on wheat in glass house and field conditions. In addition to this, she has also been involved in genetics and mapping studies for the identification of novel genomic regions and sources of resistance to rust diseases. Therefore, these research experiences are well in line with the proposal objectives here and it will allow the fellow to grow professionally and develop international future collaborations and projects. Working with a mentor in USDA ARS Cereal Disease Laboratory, one of the leading international research centers in cereal rust research, will provide a perfect learning opportunity for the fellow to realize the objectives of the research.

The Borlaug Fellowship will directly contribute to enhanced agricultural productivity, economic development and food security in Turkey as they work closely with the national breeding programs therefore, identification of viable R genes as well as identification of new sources of resistance and incorporating them into the elite cultivars will ensure enhanced yield stability. The early detection of the disease in the field will allow both plant pathologists and breeders to devise strategies and plans to ensure minimum yield loss and help farmers sustain economic stability. Early detection of changes in pathogen virulence and identification of new R genes is of paramount importance for fighting against cereal rusts and while working closely with the national breeding program and plant pathology department it will bring economic development by ensuring higher and stable yields with minimum economic pressure on the farmers.

Contributions to Turkish Agriculture Sector

The successful completion of the objectives of the research will allow the breeders and pathologists to change their strategies according to the emerging threat which will eventually lead to change in policy. The early detection of the previously present disease or emergence of a new race as well as its likely source of resistance will be vital in making the strategies and policies required to tackle the problem at hand.

The Borlaug fellowship will allow the fellow to grow professionally which will result in more self-confidence and enhance their vision and ambitions. At the successful completion of the fellowship the fellow will be able to train and teach colleagues as well as graduate students from universities in Turkey. These technologies will contribute to the fellows personal leadership and mentorship qualities. The new skillset will promote growth in the fellows organization as well with the newly gained knowledge and techniques. They will be able to devise new research hypotheses leading to novel scientific publications allowing the fellow to elevate herself and organization.

Suggested Schedule

The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.

Borlaug Fellowship Program – Turkey– Apomixis in Gene Level - Fellow #3

Scope of Work
Fellow #3: Turkey, Male, Professor, Canakkale Onsekiz Mart University. PhD, Biotechnology, Field Crops

Goal
The goal of this project is to obtain extensive information about Apomixis (an asexual reproduction system through seed) in gene level using a natural apomict Boechera species and engineer apomixis in sexual crop plants using the model system Arabidopsis thaliana.

Fellow's Learning Objective
- Using Boechera species with autonomous embryo development and produce seeds without meiosis and fertilization (apomixis)
- Analyze apomixis associated genes in natural apomicts using gene deletion and gene introduction methods
- Characterize the structure of the apomixis associated genes (controlling meiosis, parthenogenesis, and endosperm development) in diploid apomict and sexual Boechera spp. using genome and transcriptome data
- Clone the best candidates (gene cloning) obtain mutant Arabidopsis lines (gene deletion) complementation analysis in Arabidopsis mutants (gene introduction)

Research Background
In the sexual production of the angiosperms, one of the well-known process double fertilization where the specialized cell division called meiosis produces haploid gametes combine to form diploid (2n) embryo. In contrast to this, an asexual reproduction system known as apomixis represents an exception since the embryo formation occurs without fertilization of the egg (Koltunow 1993). Previous studies suggest that three elements are commonly observed in apomicts; the generation of a cell capable of forming an embryo without prior meiosis (apomeiosis); the spontaneous, fertilization-independent development of the embryo (parthenogenesis); and the capacity to either produce endosperm autonomously or to use a pseudogamous endosperm derived from fertilization (Bicknell and Koltunow 2004; Koltunow 1993; VielleCalzada et al. 1996). It has been already proposed that apomixis has the potential to change hybrid seed technology by providing a new tool to maintain hybrid vigour in plant breeding since the progeny of apomictic plants are genetically identical to the mother plant (Grimanelli et al. 2001; Koltunow et al. 2001). Until now, the molecular mechanisms underlying apomixis are not known in natural apomicts, there are studies suggest that apomixis may emerge from the sexual system deregulated by epigenetic modifications (Carman 1997; Curtis and Grossniklaus 2008; Grimanelli 2012; Grimanelli et al. 2003; Koltunow and Grossniklaus 2003). Apomixis also is a desirable trait for breeders to maintain hybrid vigor for subsequent generations through seeds that contain genetically identical embryo to the mother plant (Grimanelli et al. 2001; Koltunow et al. 2001). However, several candidate genes triggering specific components of apomixis are known, the function of their proteins is not clear (Albertini et al. 2004), the most important genes, which demonstrate a phenotype inherent in gametophytic apomicts are recently reviewed (Brukhin and Baskar, 2019).

Expected Accomplishments
This research will allow for new collaborations with the experts in the field of innovative plant breeding specialized on gene mapping, gene expression, gene deletion, gene introduction, marker-assisted plant breeding, and DNA mapping. This fund would provide a more international platform with which to release ideas. Taskin lab researches both the molecular biology of apomixis and plant metabolic pathways. They are working with natural apomicts plant species Boechera and optimized an efficient regeneration system and investigated the Agrobacterium-mediated transformation method. The innovative breeding techniques will create new tools to induce apomixis in agriculturally important plants such as rice and maize. Working with a mentor in the U.S. is very important since there are much better facilities and more specialized scientists in the USA.

Plant Biotechnology is perhaps one of the most important areas in Turkey's growth because it is largely an agricultural country. The use of apomixis thus holds great promise for sustainable agricultural production in other developing countries, as well as Turkey. The important applications of this project include:

- Creating newly apomictic crop species all of which can be hybrids, thereby broadening the scope of hybrid technology
- Retaining the maintenance of extreme heterozygosity
- Enabling propagation through seed of crop species currently vegetatively propagated
- Avoiding crop losses due to failures in pollination/fertilization
- Allowing propagation of hybrid seed directly by the farmers

Contributions to Turkish Agriculture Sector
The introduction of apomixis in crops will change the hybrid seed technology through the reduction in cost and time of breeding. Also, apomixis will provide the rapid generation and multiplication of superior forms through seed from novel germplasms and the avoidance of pollinators and cross-compatibility. Although growing genetically modified plants in fields do not allow in Turkey, the government should be aware of the beneficial effects of such technologies. The fellow will organize a workshop about the techniques learned during their visit to conventional plant breeders and researchers from the Ministry of Agriculture.

This fellowship would also further strengthen existing relationships between the two Universities and expand our co-operation in the future. Canakkale Onsekiz Mart University was founded in 1992. The university has expanded rapidly over the last few years and wishes to increase its participation in international research and other projects. With this fellowship, the fellow also stands to benefit considerably from such specialized knowledge, help students and finally assist colleagues in the university.

Suggested Schedule
The applicant should propose a 12 week fellowship schedule that reflects the researcher's goals and objectives as specified under this Scope of Work with a final schedule to be negotiated post award.