Genetic Improvement of Middle-American Climbing Beans for Guatemala (SO1.A1)

Lead U.S. Principal Investigator and University

Juan M. Osorno, North Dakota State University

Collaborating Host Country and U.S. PIs and Institutions

Phil McClean, North Dakota State University
Julio C. Villatoro, ICTA–Guatemala
Fernando Aldana, ICTA–Guatemala
Karla Ponciano, ICTA–Guatemala
Julio Martinez, ICTA–Guatemala
Edgardo Carrillo, ICTA–Guatemala

I. Abstract of Research and Capacity Strengthening Achievements

This is a brand new project within the Legume Innovation Lab, with the addition of a new partner institution (NDSU) and a well-known host country institution (ICTA) with a long history of participation and activity within this project, funded by USAID over several decades. This breeding project is focused on the genetic improvement of climbing beans for the highlands of Guatemala. Historically, climbing beans have received less attention and breeding efforts compared with the bush type. The project has four main objectives:

i) the development of improved climbing bean varieties (the most important effort)

ii) an analysis of the genetic diversity of this unique group of germplasm

iii) a socioeconomic study to gather detailed information about the current status of climbing bean production

iv) capacity building through training and equipment

During the first year of this project, we have been able to do on-farm field testing and validation across 14 locations of nine breeding lines with potential to be released in the near future, and extensive on-farm testing and validation of Bolonillo-Texel across 18 locations. We have done an initial molecular characterization of 25 climbing bean accessions and six breeding lines, and successfully recruited two female students for formal training (M.S. in Plant Sciences) at NDSU, to start in FY2015. In addition, new collaborations have been established with the project *Impact Assessment of Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination for Improved Program Effectiveness* (SO4-1) and MASFRIJOL to augment the success of the breeding efforts of this project.

II. Project Problem Statement and Justification

With approximately 11 million habitants, Guatemala is mostly a rural country, with 60 percent of the population living on farms and 50 percent of the population indigenous. Maize and beans are the main staple food in most households, with a per capita consumption of 9.4 kg per year. Since few other sources of protein are available, this amount is not enough to ensure an acceptable nutritional quality, especially within poor households. As expected, the lack of protein intake has reduced the nutritional quality in many households, significantly affecting children.

Beans are grown on 31 percent of the agricultural land and mostly in the low - to mid-altitude regions (0–1500 masl) in a monoculture system. Contrastingly, intercropping (locally known as milpa) is the main production system in the highlands, where maize–bean is the most common crop association. Unfortunately, on-farm productivity of these climbing beans is approximately one-third of their genetic yield potential mostly due to the lack of improved cultivars that are able to withstand biotic and abiotic stresses. Fungal and bacterial diseases and pests are the main cause for yield reductions. In addition, production is made with almost no inputs of fertilizers and/or other chemicals. Historically, climbing beans worldwide have received less attention and breeding efforts in comparison to the bush-type beans commonly grown in the lowlands, as shown by the significant yield gap between regions. In addition, there are genetic and environmental interactions among species (maize, bean, squash, etc.) not well understood within the intercropping system that may affect crop performance and, hence, seed yield. The legume Innovation Lab has been involved in collaborative bean breeding research targeting lowland agroecologies in Central America, but research for the highland bean production systems is still lacking.

There is an existing collection of approximately 600 accessions of climbing beans collected from across all bean production regions in Guatemala. This collection is kept by ICTA and has been characterized morphologically, agronomically, and with few molecular markers (six SSR primers). Initial results suggest that half of the collection consists of duplicates. In addition, some initial crosses among climbing beans and selections have been made by the ICTA group. These lines will be used intensively in this study.

III. Technical Research Progress

Objective 1: Development of germplasm with improved disease resistance and agronomic performance.

Collaborators

Juan M. Osorno and Phil McClean, North Dakota State University
Julio Cesar Villatoro and Fernando Aldana, ICTA

1A. Field testing of 10 selected lines (ICTA)

A total of 10 climbing bean breeding lines that are at advanced breeding stages were selected to be part of field trials:

1. Bolonillo Altense
2. Bolonillo Hunapu

3. Bolonillo-Texel
4. Bolonillo Anita
5. Bolonillo LOV
6. Bolonillo Martin
7. Bolonillo ICTA Santa Lucia
8. Voluble GUATE 1120
9. Voluble GUATE 1026
10. Local check from the grower (different among farms)

Most of these breeding lines are the product of initial crosses made five to six years ago and subsequent composite mass selection and testing made by Dr. Fernando Aldana at the ICTA–Quetzaltenango station. Any superior line or lines could be released as varieties in the near future while a breeding pipeline is established. The trials were planted around May and grown both at the ICTA–Quetzaltenango station and at farmers' fields in 14 locations (Table 1).

Most locations were tested under the common intercropping system (milpa) and few under monoculture. Depending on space and resources at each location, the 10-entry trials were planted using a Randomized Complete Block Design (RCBD) with two or three replications. Farmers' trials included the local varieties/landraces used by the farmer as the local check to make side-by-side comparisons for these growers. Harvest of these field trials is under way at the time this report is being written and should be finished by early December 2014. All this extensive testing is coordinated by the field validation unit at ICTA (Julio Franco, coordinator), which is the final step before official variety release under ICTA standards. Results will be shown in the next report.

The following agronomic data were collected across most locations:

- Aggressiveness of growth
- Disease symptoms, if present (natural pressure)
- Days to maturity
- Seed yield
- 100-seed weight
- In-station trials also tried to collect the following information:
    - Days to emergence
    - Vigor
    - Early disease symptoms
    - Days to Flowering
    - Pod distribution
    - Aggressiveness of growth
    - Disease symptoms (natural pressure)
    - Days to maturity
    - Seed yield
    - 100-seed weight

1B: Genetic purification of selected material (ICTA)

As explained in the Technical Project Description, phenotypic variation has been detected within accessions. Therefore, individual plant selections were made within the breeding lines during the 2013 growing season and planted again as plant-rows at Quetzaltenango. Selections were made based on potential yield and quality, absence of disease symptoms, and other agronomic traits. Evaluation/selection of promising genetic material will be made at the time of harvest and

selected rows will be sent to the ICTA–San Jeronimo station for winter increase, if possible. This will allow for detection of additional genetic heterogeneity while increasing seed.

1C: Field evaluation of Bolonillo-TEXEL (ICTA)

One of the improved lines selected by Dr. Fernando Aldana at advanced breeding stages (known as Bolonillo-Texel) was also tested at growers' fields. Side-by-side milpa on-farm strip trials of the local's farmer variety/landrace and Bolonillo-Texel were grown (using the same maize material and agronomic practices) in the 18 locations mentioned in Table 1 as on-farm strip trials. Bolonillo-Texel is one of the most promising breeding lines based on preliminary data previously collected by Dr. Fernando Aldana, ICTA–Quetzaltenango. Since these trials are mostly managed by growers, data collection is mostly focused on seed yield, agronomic performance, and personal feedback from each grower. Technical assistance from ICTA agronomists and crop extension personnel from the Ministry of Agriculture have been crucial for finding these growers and locations.

Seed yield and other traits will be compared with common varieties and landraces grown in the vicinity of the testing fields. Results from these field trials will be available once all trials are harvested (November 2014) and data are analyzed. If Bolonillo-Texel has good acceptability it could be released sooner, which would allow for a significant impact of this project earlier than planned by releasing an improved variety of climbing bean thanks to the previous efforts made by the ICTA bean breeding project. Therefore, to be proactive, it has been decided to do a seed increase of Bolonillo-Texel at the ICTA–San Jeronimo station during this winter in collaboration with the MASFRIJOL project. This will allow the project to distribute Bolonillo-Texel seed next year.

<u>Objective 2</u>: Characterization of the genetic diversity of this unique set of germplasm

Collaborators

Juan M. Osorno and Phil McClean, North Dakota State University
Karla Ponciano, Julio Cesar Villatoro, and Fernando Aldana, ICTA

2A: Evaluation of core collection with the 6k SNP chip (NDSU)

As explained in the milestones, this activity had to be postponed because the seed available from the germplasm collection stored at ICTA–Chimaltenango was in bad condition and would not pass phytosanitary inspection in order to be shipped to NDSU. Seed was severely affected by bruchids (mostly *Acanthoscelides* spp.). ICTA doesn't have adequate long-term seed storage infrastructure and it is something that needs to be addressed in the future. Another option would be to have a backup set of this collection with USDA–GRIN. It also appears that CIAT has most of the accessions from this climbing bean collection but this is something that needs to be revised.

To solve this issue with seed quality, it was decided to plant a new field increase of all the germplasm collection at the ICTA–Chimaltenango station to produce fresh seed to be shipped to NDSU for DNA analysis. Germplasm accessions were planted in 2 m individual rows under a trellis system in June 2014 and will be harvested at the end of December 2014. This is also a good opportunity for the PI to phenotypically evaluate the entire collection in the field one more time and to identify genetic material with interesting traits for future use on the breeding process. Once seed is cleaned and conditioned, a sample from each accession will be prepared and sent to

the Ministry of Agriculture for phytosanitary inspection and, subsequently, shipped to NDSU for DNA extraction and molecular analyses using the 5k SNP chip. Preliminary results about the organization of the genetic diversity of this collection and how it is related to other races and gene pools will be ready for the next report.

In spite of the delays with the seed of the entire collection, a group of 25 superior accessions previously selected by the ICTA bean breeding program and six breeding lines from Dr. Aldana's program (and also part of the field testing mentioned in objective 1A), were grown in 2013, and fresh seed was sent to NDSU for initial molecular screening with some InDel markers (Moghaddam et al., 2014). Figure 1 shows polymorphisms for only one of the InDel markers across all the 31 genotypes. However, more InDel markers are currently being screened to provide a better picture of the genetic variability of this subset of germplasm. McClean's lab at NDSU has a collection of approximately 500 InDel markers that could give some initial insights into the genetic diversity at the DNA level of this germplasm. There is no other previous study that has attempted to go into depth within this group of germplasm, since most studies have used just a handful (five to 10) of Guatemalan climbing bean accessions. Preliminary results on this initial screening will be available in the near future and will give us a better idea of how to plan for the actual screening of the whole collection once the seed arrives.

2B: Assessment of the intra-accession variability (NDSU)

Because of the reasons shown in the previous section, this activity had to be postponed. A genetic assessment of variation within the 10 selected lines used in objective 1A will be made to account for the heterogeneity not only among but within accessions and possibly, extrapolated to the rest of the accessions. Preliminary phenotypic observations in the field suggest that there is a high amount of genetic heterogeneity (heterozygosity) within accessions. Therefore, 20 plants from each of the 10 selected accessions will be planted in the greenhouse at NDSU, and DNA will be extracted, for a total of 200 DNA samples/individuals. These genotypes will be also screened with a subset of InDel markers developed in the NDSU bean molecular genetics lab (Moghaddam et al., 2014). The InDel markers were developed from polymorphic SNPs, but their advantage is that they can be easily reproduced by PCR and visualized in an agarose gel. Since the main goal is to assess intra-accession variability, this will be easily detected by looking at the band polymorphisms in the gels. Polymorphic Information Content (PIC) and other genetic parameters will be estimated. This information will allow a better understanding of the organization of the genetic diversity within this core collection for future use and research.

<u>Objective 3:</u> A better understanding of the current socioeconomic status and needs of bean production within the context of intercropping systems in the region

Collaborators

Juan M. Osorno, NDSU; Julio Martinez, Julio Cesar Villatoro, Fernando Aldana, ICTA

New Collaborators

Mywish Maredia and Byron Reyes from Project SO4-1, *Impact Assessment of Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination for Improved Program Effectiveness*.

Growers' surveys

A search for previous socioeconomic information about production and consumption of beans in the Guatemalan highlands allowed the project team to conclude that apart from the agricultural census made in 2003, no other information is available. Nonetheless, the census information has been very helpful in determining which departments and municipalities should be the focus of our surveys and the sample size that may be needed to obtain reliable and useful information. Given this information, the project decided to focus on the following departments: Quiche, San Marcos, Huehuetenango, Totonicapán, and Quetzaltenango, which represent most of the climbing bean production areas.

We are very excited to report a new collaboration in these activities for objective three with the project lead by Mywish Maredia and Byron Reyes, *Impact Assessment of Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination for Improved Program Effectiveness*. Their expertise in this area will be very useful for the success of these surveys. Several conference calls were made between the group members (Julio Martinez, Byron Reyes, Mywish Maredia, and Juan M. Osorno) to design the survey instrument, discuss the questions and arrange all the other important parameters for this activity. This collaboration among both Legume Innovation Lab projects will also include help and training during the actual surveys.

The survey instrument is at the final stages of design and will be submitted to the NDSU–IRB (Internal Research Board) for final approval, given that we are using humans to collect data. A sample of the survey instrument can be provided under request. The plan is to conduct the surveys during January or February 2016, once the harvest season has been finalized across the entire region. In this way, growers will not only have time to talk with the surveyors but also will have a fresh memory of the events in the recently finished growing season. The survey will include questions about cultivation methods, preferred seed types, household consumption, and marketing of harvested beans, among other things. Results of this survey will be shared not only within the project but with other projects currently working in Guatemala (e.g. MASFRIJOL) and interested government agencies.

<u>Objective 4:</u> Capacity building: training the next generation of plant breeders for Guatemala and establishing a long-term breeding plan to increase the productivity of climbing bean in the region.

The PI of this project visited Guatemala in June 2014 and interviewed potential candidates for M.S. degree training at NDSU. We met with four young ICTA employees who are part of an early career program at ICTA, called CAPA, designed to identify outstanding individuals for future employment with ICTA. These young individuals are currently working at ICTA in different areas besides bean breeding. Gabriela Tobar has excellent English skills and already achieved a TOEFL score of 90 and a GRE score of 151. She's applying to NDSU already. Gabriela expressed some interest in breeding and biotechnology. Our plan is to take advantage of Gabriela's expertise in food science to study the nutritional and cooking quality aspects of these germplasm and their genetic components. The other three individuals (Carlos Maldonado, Jessica Moscoso, and Luis Huimac) need to improve their English before they can start the application process, but they mentioned they are already

studying on their personal time. All of them expressed interest in plant breeding, plant pathology and/or biotechnology.

We also met with another potential student, Luz de Maria Montejo. Juan Carlos Rosas (also of the Legume Innovation Lab) gave her an excellent recommendation since she's a graduate from Zamorano and worked under his supervision. She's from Hueuetenango in the Guatemalan highlands and her father is an agronomist. She is the only candidate interviewed with experience in bean breeding, and her knowledge about disease-resistant genes and molecular markers in beans was outstanding. She is very confident and asked a lot of questions. In addition, she did an internship with Jim Steadman (another member of the Legume Innovation Lab.), working with white mold of beans and sunflower. I asked Jim his impressions of Luz and he recommended her without reservation. She was rated very highly by Steadman's research technicians, as well. In my personal opinion, she is the best candidate we've met during our visit. Julio C. Villatoro didn't know her and he was also very impressed. Given the great potential we all saw in Luz, she was transferred from her previous employment with the Ministry of Agriculture into the bean breeding program at ICTA, thanks to the direct involvement and prompt action of the Minister of Agriculture (Elmer Lopez) and ICTA director (Elias Raymundo). Luz is currently in the applications process at NDSU, and we hope to have her starting in the fall 2016 or earlier, if possible.

Research topics will be directly related to the research objectives described above. We foresee research projects focused on the analyses of genetic diversity, genetic resistance to diseases, and production systems, nutritional and cooking quality, among others. The graduate students will be provided a broad range of training in conventional and molecular plant breeding techniques, so that they can assume leadership roles in bean research programs in target countries.

IV. Major Achievements

1. On-farm field testing and validation across 14 locations of nine breeding lines with potential to be released in the near future
2. Extensive on-farm testing and validation of Bolonillo-Texel across 18 locations
3. Initial molecular characterization of 25 climbing bean accessions and six breeding lines
4. Recruitment of two female students for formal training (M.S. in Plant Sciences) at NDSU
5. New collaborations established with project SO4-1 and MASFRIJOL will augment the success of the breeding efforts of this project.

V. Research Capacity Strengthening

Our project was fortunate to receive one of the capacity strengthening grants provided by the Legume Innovation Lab this year for the purchase of a new thermal cycler. The biotechnology lab at ICTA had a 12-year-old thermal cycler that broke down at the beginning of 2013. ICTA tried to repair it but, being too old, no parts are available anymore and it would be more expensive than buying a new one. ICTA is currently in the process of purchasing this new piece of equipment so they can restart all the PCR reactions that have been stalled for months. This new piece of

equipment will not only benefit the bean breeding program but also other programs working on other crops within ICTA that also need to run some PCR reactions. Therefore, the impact of this purchase is at the institutional level.

VI. Human Resource and Institutional Capacity Development

Short-Term Training

Nothing to report for FY2014.

Degree Training

Nothing to report for FY2014. However, two women have been recruited to start formal training (M.S. in Plant Sciences) at NDSU sometime during FY2015.

VII. Achievement of Gender Equity Goals

The thermal cycler obtained through the capacity strengthening award will be mainly used by women in the biotechnology lab at ICTA. In addition, two women ICTA employees have been recruited for formal training (M.S. in Plant Sciences) at NDSU.

VIII. Explanation for Changes

Objective 2. Due to the lack of appropriate seed storage facilities at ICTA, the seed from the germplasm collection had a lot of issues (poor germination, insect damage, etc.). Therefore, it was decided to do a field increase at the Chimaltenango station during FY2014 to have fresh seed that would pass phytosanitary inspection so it could be shipped to NDSU for molecular marker work. This will be completed in FY2015.

Objective 3. The survey has been scaled up thanks to a new collaboration established with project SO.4.1. The new survey instrument will have more questions and will try to increase the sample size across the region. Therefore, the survey instrument is in the final stages of development and pending IRB approval at NDSU. The goal is to deploy the survey in January or February 2015 right after all harvest has been finished. We expect to have results by the end of FY2015.

Objective 4. Even though recruiting efforts were made during FY2014, degree training was postponed due to delays in identifying suitable candidates for training. Two female candidates have been identified to start their M.S. degrees in FY2015 and they are currently in the application process to NDSU Graduate School.

IX. Self-Evaluation and Lessons Learned

The project has had a great start considering it is a brand new project within the Legume Innovation Lab. The genetic material previously developed by Dr. Aldana at ICTA–Quetzaltenango allowed having breeding material ready to be tested in farmers' fields. This will ensure this program has significant impact in the short- to medium-term while a new breeding pipeline is

established (long-term). So far, we are impressed with the capabilities and passion that ICTA personnel put into this project. ICTA has proven success with the long-term program supported by the Legume Innovation Lab for bush type beans for the lowlands along with the University of Puerto Rico. This new partnership with NDSU will create a steady breeding pipeline of climbing beans for the Guatemalan highlands. We don't see major limitations or problems regarding the breeding efforts. There is great support from ICTA administration, more specifically from the director Elias Raymundo.

Student recruiting has been a bit more challenging because of the lack of good English skills among the potential candidates. Nonetheless, two outstanding candidates have been identified and it is our best hope to provide them with the best training possible so they can come back to ICTA and keep improving the breeding programs and hence, the productivity and food security of the region. The challenge here, besides the English skills, is the approval process for the students through TraiNet. Nonetheless, a lot of help has been received by the main office and Michigan State University (MSU) in helping the PI and potential students with the process.

X. Scholarly Accomplishments (Project member in bold)

Moghaddam, S.M., S. Mamidi, Q. Song, **J.M. Osorno**, R. Lee, P. Cregan, and **P.E. McClean**. 2013. Developing marker-class specific indel markers from next generation sequence data in *Phaseolus vulgaris*. *Frontiers in Plant Genetics and Genomics* 5:185.

Vandemark, G.J., M.A. Brick, **J.M. Osorno**, **J.D. Kelly**, and C.A. Urrea. 2014. Yield gains in edible grain legumes. In J. Specht, B. Diers, B. Carver, and S. Smith (eds.) *Genetic Gains of Major U.S. Field Crops*. CSSA Press, Madison, WI.

Osorno, J.M., and P.E. McClean. 2014. Common bean genomics and its applications in breeding programs. In S. Gupta, N. Nadarajan, and D.S. Gupta. *Legumes in the Omic Era* (pp. 185–206). Springer, New York, NY.

Schmutz J, **McClean** P, Mamidi S, Wu GA, Cannon SB, Grimwood J, Jenkins J, Shu S, Song Q, Chavarro C, Torres-Torres M, Geffroy V, Moghaddam S M, Gao D, Abernathy B, Barry K, Blair M, Brick MA, Chovatia M, Gepts P, Goodstein DM, Gonzales M, Hellsten U, Hyten DL, Jia G, Kelly JD, Kudma,D , Lee R, Richard MMS, Miklas PN, **Osorno JM**, Rodrigues J, Thareau V, Urrea CA, Want M, Yu Y, Zhang M, Wing RA, Cregan PB, Rokhsar DS, Jackson SA (2014) A reference genome for common bean and genome-wide analysis of dual domestications. *Nature Genetics* 46:707–713.

XI. Progress in Implementing Impact Pathway Action Plan

After the first year of this new project, we are confident that our activities have been in accordance with our impact pathway plan, with the exception of our grower survey and formal training efforts. Specific plans are in place for FY2015 to ensure we meet the established pathways by the end of next funding cycle. Please refer to the Impact Pathway Plan document for more details.

XII. Annexes

Annex 1. Tables, Figures, and Photos Cited in the Report

Table 1. List of climbing bean trials made during the 2014 growing season in the Guatemalan highlands.

Department	Municipality	Community	Type of Trial
Totonicapán	Paxtocá	Xecoshon	10-entry replicated trial
	Totonicapán	Chuisuc	10-entry replicated trial
	San Francisco el Alto	San Antonio Sija, Paraje Chipuerta	10-entry replicated trial
	Sta. María Chiquimula	Xesená, paraje Pachun	10-entry replicated trial
	Sta. Lucía la Reforma	Aldea Gualtux, paraje Xequelaj	10-entry replicated trial
	Paxtocá	Xecoshon	On-farm strip trials
	Paxtocá	Xecoshon	On-farm strip trials
	San Antonio Sija	Paraje Chipuerta	On-farm strip trials
	Momostenango	Pachawacán	On-farm strip trials
	Momostenango	Pancá	On-farm strip trials
	Sta. Lucía la Reforma	Gualtux	On-farm strip trials
	San Andrés Xecul	San Felipe Xejuyup, sector III	On-farm strip trials
Quetzaltenango	San Juan Ostuncalco	Las Victorias, Caserio Los Escobar	On-farm strip trials
	San Juan Ostuncalco	Caserío Los López	On-farm strip trials
	Olintepeque	La Cumbre	On-farm strip trials
	Olintepeque	La libertad	On-farm strip trials
	Cabricán	La Loma	On-farm strip trials
	Quetzaltenango	Aldea Choquí Alto, zona 6	10-entry replicated trial
	San Juan Ostuncalco		10-entry replicated trial
	Olintepeque	Barrio Pila Vieja, 3ra calle zona 1	10-entry replicated trial
Chimaltenango	Santa Apolonia	Xeabaj	10-entry replicated trial
	Tecpan	Chirijuyu	10-entry replicated trial
	San Juan Comalapa	Panabajal	10-entry replicated trial

Department	Municipality	Community	Type of Trial
	Sta. Cruz Balanya	Chuicapulin	10-entry replicated trial
	Zaragoza	Puerta Abajo	10-entry replicated trial
	San Miguel El Tejar	San Miguel El Tejar	10-entry replicated trial
	Tecpan	Chirijuyu	On-farm strip trials
	Parramos	Chirijuyu	On-farm strip trials
	Sta. Apolonia	Chuaparral 1	On-farm strip trials
	Zaragoza	Puerta Abajo	On-farm strip trials
	Chimaltenango	El Socobal	On-farm strip trials
	Balanya	Chuicapulin	On-farm strip trials

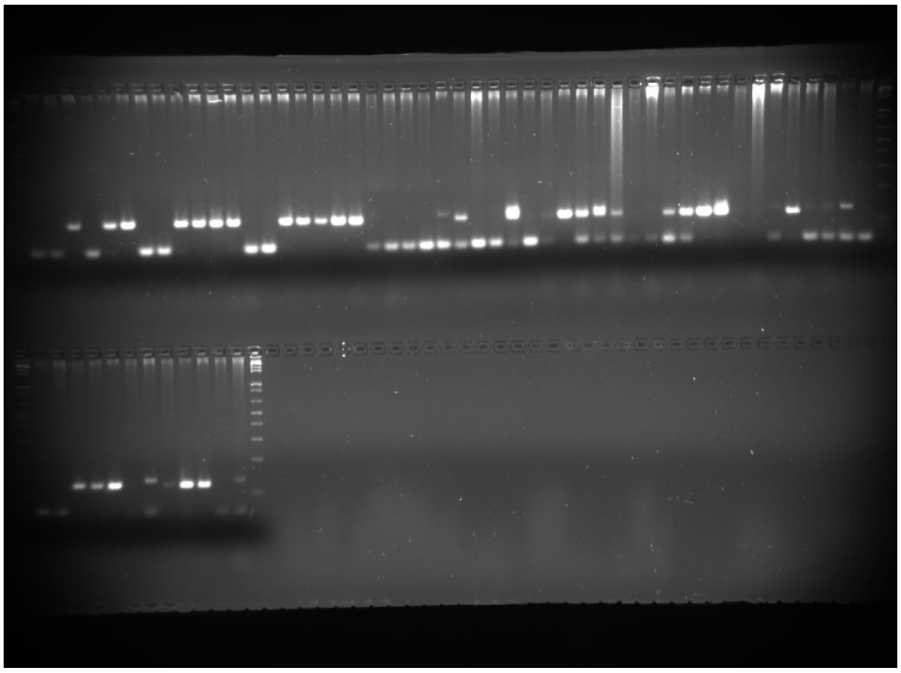

Figure 1. Example of polymorphisms among accessions as revealed by InDel marker 04-07-4908 screened in 25 germplasm accessions (upper lanes, each accession repeated twice), and six breeding lines from Dr. Aldana's initial crosses (lower lanes, each breeding line repeated twice).

XIII. Milestones

Feed the Future Innovation Lab for Collaborative Research on Grain Legumes

Report on the Achievement of "Milestones of Progress"

(For the Period: April 1, 2014 -- September 30, 2014)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2014

Project Title: SO1.A1 Genetic improvement of Middle American climbing beans for Guatemala

	Abbreviated name of institutions																	
	NDSU			ICTA			Institution 3			Institution 4			Institution 5			Institution 6		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Milestones by Objectives	**10/1/14**	**Y**	**N***	**10/1/14**	**Y**	**N***	**10/1/14**	**Y**	**N***	**10/1/14**	**Y**	**N***	**10/1/14**	**Y**	**N***	**10/1/14**	**Y**	**N***
	(Tick mark the Yes or No column for identified milestones by institution)																	
Objective 1																		
1.1 Evaluation of Bolonillo-Texel in farmer fields				**X**	**X**													
1.2 Evaluation of Selected 10 accessions				**X**	**X**													
1.3 Individual plant selections for homozygocity				**X**	**X**													
1.4																		
1.5																		
Objective 2:																		
2.1 Analysis of genetic diversity of core 3	**X**		**X**															
2.2 Analysis of within-accesion variation	**X**		**X**															
2.3 Field evaluation of selected accessions				**X**	**X**													
2.4																		
2.5																		

Milestones, continued

Objective 3:																		
3.1 Search of historic information				X	X													
3.2 First grower survey				X		X												
3.3																		
3.4																		
3.5																		
Objective 4:																		
4.1 Recruitment of potential graduate stu	X	X		X	X													
4.2 First student admitted at NDSU	X		X															
4.3																		
4.4																		
4.5																		

Name of the PI reporting on Milestons by institution						

Name of the U.S. Lead PI submitting this report to the MO	

Signature **Date**

** Please provide an explanation for not achieving the milestones on a separate sheet.*

XIV. Performance Indicators

Feed the Future Innovation Lab for Collaborative Research on Grain Legumes
PERFORMANCE INDICATORS / TARGETS SPREADSHEET for FY 14, FY 15, FY 16 and FY 17

Project Name: **SO1.A1 Genetic improvement of Middle American climbing beans for Guatemala**

Summary of all institutions

Indic. numbe	Output Indicators	FY 14 Target (October 1, 2013 - September 30, 2014)	FY 14 Revised	FY 14 Actual	FY 15 Target (October 1, 2014 - September 30, 2015)	FY 15 Revised	FY 15 Actual
1	4.5.2(6) Degree Training: Number of individuals who have received degree tra	2	1	0	2	0	0
	Number of women	1	1	0	2	0	0
	Number of men	1	0	0	0	0	0
2	4.5.2(7) Short-term Training: Number of individuals who have received short-term training						
	Total number	20	14	75	65	0	0
	Number of women	5	4	55	20	0	0
	Number of men	15	10	20	45	0	0
	Numbers by Type of individual	20	14	75	65	0	0
	Producers	15	10	9	40	0	0
	People in government	5	4	7	20	0	0
	People in private sector firms	0	0	50	5	0	0
	People in civil society	0	0	9	0	0	0
3	4.5.2(13) Beneficiaries: (numbers of households)						
	New/Continuing (total)	0	0	36	10	0	0
	New	0	0	18	10	0	0
	Continuing	0	0	18	0	0	0
	Gendered Household Type	0	0	36	10	0	0
	Adult Female no Adult Male (FNM)	0	0	26	3	0	0
	Adult Male no Adult Female (MNF)	0	0	10	0	0	0
	Male and Female Adults (M&F)	0	0	0	7	0	0
	Child No Adults (CNA)	0	0	0	0	0	0
4	4.5.2(11) Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and community-based organizations (CBOs) receiving USG assistance						
	Type of organization	0	0	0	5	0	0
	Private enterprises (for profit)	0	0	0	0	0	0
	Producers organizations	0	0	0	5	0	0
	Water users associations	0	0	0	0	0	0
	Women's groups	0	0	0	0	0	0
	Trade and business associations	0	0	0	0	0	0
	Community-based organizations (CBOs)	0	0	0	0	0	0
	New/Continuing (total)	0	0	0	5	0	0
	New	0	0	0	5	0	0
	Continuing	0	0	0	0	0	0
5	4.5.2(12) Number of public-private partnerships formed as a result of CRSP assistance						
	Number by type of partnership (total)	0	0	0	0	0	0
	Agricultural production	0	0	0	0		0
	Agricultural post harvest transformation	0	0	0	0		0
	Nutrition	0	0	0	0	0	0
	Multi-focus	0	0	0	0	0	0

Performance Indicators, continued

4.5.2(2) Developmental outcomes:						
Number of additional hectares under improved technologies or management practices						
Number under specific technology types (total)	10	10	10	10	0	0
crop genetics	10	10	10	10	0	0
pest management	0	0	0	0	0	0
disease management	0	0	0	0	0	0
soil-related	0	0	0	0	0	0
irrigation	0	0	0	0	0	0
water management	0	0	0	0	0	0
climate mitigation or adaptation	0	0	0	0	0	0
other	0	0	0	0	0	0
total w/one or more improved technology	10	10	10	10	0	0
New/Continuing hectares	10	10	10	10	0	0
New	10	10	10	10	0	0
Continuing	0	0	0	0	0	0
Sex of person managing hectare	10	10	10	10	0	0
Male	8	8	9	8	0	0
Female	2	2	1	2	0	0
Association-applied	0	0	0	0	0	0
4.5.2(39) Number of new technologies or management practices in one of the following phases of development: (Phase I/II/III)	0	0	0	20	0	0
Phase 1: Number of new technologies or management practices under research as a result of USG assistance	0	0	0	10	0	0
Phase 2: Number of new technologies or management practices under field testing as a result of USG assistance	0	0	0	10	0	0
Phase 3: Number of new technologies or management practices made available for transfer as a result of USG assistance	0	0	0	0	0	0
4.5.1(24) Numbers of Policies/Regulations/Administrative Procedures in each of the following stages of development as a result of USG assistance in each case: (Stage 1/2/3/4/5)						
Sector (total)	0	0	0	0	0	0
Inputs	0	0	0	0	0	0
Outputs	0	0	0	0	0	0
Macroeconomic	0	0	0	0	0	0
Agricultural sector-wide	0	0	0	0	0	0
Research, extension, information, and other public service	0	0	0	0	0	0
Food security/vulnerable	0	0	0	0	0	0
Climate change adaptation or natural resource management (NRM) (ag-related)	0	0	0	0	0	0
Stages of development						
Stage 1 of 5: Number of policies / regulations / administrative procedures analyzed	0	0	0	0	0	0
Stage 2 of 5: Number of policies / regulations / administrative procedures drafted and presented for public/stakeholder consultation	0	0	0	0	0	0
Stage 3 of 5 : Number of policies / regulations / administrative procedures presented for legislation/decree	0	0	0	0	0	0
Stage 4 of 5 Number of policies / regulations / administrative procedures prepared with USG assistance passed/approved	0	0	0	0	0	0
Stage 5 of 5: Number of policies / regulations / administrative procedures passed for which implementation has begun	0	0	0	0	0	0
Notes:						

Notes:

Make sure to complete each section of disaggregates and that the total under each set of disaggrgetations corresponds to total under other disaggregations. Eg. Ind.6: Total has. by gender is same as total has by New/Continuing.
This table corresponds to the Feed the Future Performance Indicators data collection sheet under the FTFMS system. Where an indicator does not apply to the type of work done under the project, leave it blank.
Please follow the indications in the Legume Innovation Lab Indicators Handbook that will be provided to you by the Management Office. Contact Mywish Maredia (maredia@anr.msu.edu) for further information.
There is additional guidance on the USAID website http://feedthefuture.gov/sites/default/files/resource/files/ftf_handbookindicators_apr2012.pdf