



SUSTAINABLE BIOECONOMY FOR ARID REGIONS (SBAR)

Summary Report – Quarter 1, 2020

Information submitted by project partners; synthesized by:
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USDA Cover Page

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ACCOMPLISHMENTS

January 2020 – March 2020

INTRODUCTION AND MANAGEMENT

General Overview: Organization

The Sustainable Bio-economy for Arid Regions (SBAR) Center of Excellence continues to succeed under the tutelage of Dr. Kimberly Ogden, who leads the overall research effort and ensures adequate progress toward meeting goals. The SBAR Project Director (Alix Rogstad) continues to oversee operations and manages all of the day-to-day project administration and business affairs, as well as coordination, communication, and data sharing among partnering organizations and institutions.

A comprehensive project evaluation plan, approved in July 2018, is still effectively capturing detailed progress on the project's defined objectives. As a living document, the evaluation plan will change to reflect revised research questions, project goals and big-picture, overall objectives. The second-year comprehensive review for the project was conducted at the 2019 SBAR Retreat in September, and lessons learned and feedback will be incorporated into year three activities. The next scheduled thorough review and update will be in July 2020.

Advisory Board

No changes were made to the Advisory Board makeup during this quarter (Table 1).

Table 1. SBAR Advisory Board members.

Advisory Board Member	Company/ Representation	Year Joined Board
Chris Cassidy	USDA, Rural Development	2018
Matt Chavez	Independent Grower, NM	2017
Steve Csonka	Commercial Aviation Alternative Fuels Initiative (CAAFI)	2017
Mark DeDecker	Bridgestone Americas, Inc.	2017
Gary Deen	Double D Farms, AZ	2017
William Goldner	USDA, National Institute of Food and Agriculture	2017
John Holladay	Pacific Northwest National Laboratory	2019
Chris Kuzdas	Environmental Defense Fund	2018
Homer Marks	Southwest Indian Agriculture Association, Tohono O'odham Nation	2017
Newt McCarty	NMSU, Extension Educator	2018
Jaroy Moore	Texas A&M Agrilife Research & Extension Center	2017
Alex Muravijov	Guar Resources	2017
Paul "Paco" Ollerton	Tierra Verde Farms, AZ	2019
Matt Payne	West Water Research, Inc.	2018
Bob White	Bridgestone Americas, Inc.	2017

Receiving the signed non-disclosure agreements (NDA) to ensure confidentiality of research data, information, and conclusions for the duration of the project is ongoing. To date 7 NDAs

have been completed and returned, 4 other Advisory Board members are subject to existing project NDA and confidentiality agreements, and the remaining 4 NDAs are pending. Sensitive data is not shared with individuals until a signed NDA is on file.

The Advisory Board meets frequently (4 times/year) so that (1) relevant research updates can be shared; (2) Advisors can drill down into specific Component work as it is underway; and (3) the researchers can solicit comments/suggestions for improving research direction or overcoming challenges. Ultimately, the goal for more frequent meetings is to ensure that SBAR can remain agile in addressing changing priorities and circumstances.

The Advisory Board met in January, where the System Performance & Sustainability Team provided an overview and status update on the research progress. A second meeting was hosted in February, where the Feedstock Development & Production Team provided a detailed description of ongoing field and laboratory research that is addressing a variety of feedstock improvement questions. During both meetings, the Advisory Board members were able to learn more about on-going processes and plans, and they could ask direct questions to the researchers regarding guayule and guar production and genetic research.

Future Advisory Board meetings will be hosted in April and May 2020, and a longer in-person meeting is being planned for July 2020.

Budget and Financial Management

Budget management activities continue to work effectively, and all project expenditures are on track. Rogstad continued to maintain sub-award agreements and develop modifications when necessary, non-disclosure agreements, and work with partners to ensure grant funds are spent according to the project plan and approved scopes of work.

Sub-awards are fully activated with all project partner institutions: Bridgestone Americas, Inc., New Mexico State University (NMSU), Colorado School of Mines (CSM), Colorado State University (CSU), and the USDA-Agricultural Research Service (USDA-ARS). All sub-awards are progressing appropriately.

Component Working Group Meetings

All five SBAR component working groups continued to participate in scheduled online meetings to ensure forward momentum on all project tasks. Smaller focus group meetings were scheduled and facilitated as necessary, including budget meetings and partnership development meetings. During this reporting period, the virtual meeting space (via Zoom) was utilized 42 times for over 46 hours. This quarter showed a marked increase in the number of Zoom participants from previous quarters, with at least 496 individuals accessing meetings. An additional 5 meetings were hosted during the same timeframe that did not require the virtual meeting space.

LEADS Team Meetings

The component leaders and co-leaders (LEADS) continued to meet with Ogden and Rogstad during established twice-monthly meetings held via SBAR's dedicated Zoom online meeting space. The LEADS continue to provide guidance for project decisions, and assist with resolving

internal conflicts that are brought for discussion. This has proven to be an effective way to communicate key issues requiring short turn-around times.

SBAR Annual Retreat

As previous years, the 2020 SBAR Annual Retreat will be hosted at the University of Arizona in Tucson from 27-29 July 2020. The Retreat will include progress updates for each Component, Advisory Board meeting time, and open networking periods. There will also be multiple opportunities for student engagement through dialogue with colleagues and poster presentations. We are tentatively planning for Component-specific sessions following the joint retreat. Preparation and pre-planning for the Annual Retreat is underway; a final agenda will be available by June.

Communication and Reporting

Rogstad continues to be the main point-of-contact for most SBAR communication. Various listservs are maintained that enables quick dissemination of pertinent and critical information. Rogstad also fields questions and liaises among project researchers, Advisors, partners, and students.

Reporting schedules for researchers are established and working well. Quarterly reports submitted are synthesized and made available to the research team and Advisory Board members. Summary reports are also posted to the SBAR website for wider dissemination. Each researcher is required to submit a self-evaluation score/rank with their report, and they are asked to describe all issues that may put them at risk for meeting annual goals (as articulated in annual scopes of work). A Task Tracker Report is provided to the LEADS, which gives a status update for each team member per component. The Task Tracker Report is a proactive management tool that allows the identification of issues before they become risks for overall project completion.

Website and Social Media

The SBAR-specific website (www.sbar.arizona.edu) continues to be regularly updated and maintained, serving as the digital “face” of the SBAR Center. Updates this quarter included highlights from each component, and major changes to the Education page. The Youth Development page is also currently under revision.

The SBAR webpage was visited by people in 40 different states of the USA during this reporting period (Table 2). Since inception, the website has been viewed by people in 44 states.

Table 2. Web traffic to the SBAR Center webpage from within the United States since inception.

State	Time Period				
	Jul – Dec 2018	Jan – Dec 2019	Jan – Mar 2020	Apr – Jun 2020	Jul – Sep 2020
Arizona	X	X	X		
Arkansas		X	X		
California	X	X	X		
Colorado	X	X	X		
Delaware		X	X		

State	Time Period				
	Jul – Dec 2018	Jan – Dec 2019	Jan – Mar 2020	Apr – Jun 2020	Jul – Sep 2020
District of Columbia	X	X	X		
Florida		X	X		
Georgia		X	X		
Hawaii			X		
Idaho		X	X		
Illinois	X	X	X		
Indiana		X	X		
Iowa	X	X	X		
Kansas	X	X	X		
Kentucky		X	X		
Louisiana			X		
Maine			X		
Maryland	X	X	X		
Massachusetts		X	X		
Michigan		X	X		
Minnesota		X	X		
Mississippi		X	X		
Missouri		X	X		
Montana		X	X		
Nebraska		X	X		
Nevada		X	X		
New Mexico	X	X	X		
New York	X	X	X		
North Carolina	X	X	X		
North Dakota		X			
Ohio		X	X		
Oklahoma		X	X		
Oregon		X	X		
Pennsylvania		X	X		
South Carolina	X	X	X		
South Dakota		X			
Tennessee	X	X	X		
Texas	X	X	X		
Utah		X	X		
Virginia		X	X		
Washington	X	X	X		
West Virginia		X			
Wisconsin		X			
Wyoming		X	X		
Total	15	41	40		

There were 811 unique sessions from January – March 2020. Page views occurred in 36 different countries this quarter (top three: USA, India, and Finland), including 9 countries that have not visited the website previously. Even though website visitors are diversifying, visitors

from the USA account for about 92% of site visits overall. This quarter showed a marked increase in website visits from European countries (Austria, Finland, France, The Netherlands, and the United Kingdom), which accounted for another 4% of site visits overall.

There have been 6,127 unique website sessions since July 2018. Since activation, the website has had visitors from 6 continents and 72 different countries around the world (Table 3). The highest visited website pages during this period included those that include SBAR resources (publications, presentations, and accomplishment reports) and pages that describe our team, education/outreach opportunities, and the New Mexico Alternatives Crops conference. Other highly visited pages included those that provide details about ongoing research. The website will continue to be updated regularly as the project unfolds.

Table 3. International web traffic to the SBAR Center webpage since inception.

Country	Time Period				
	Jul – Dec 2018	Jan – Dec 2019	Jan – Mar 2020	Apr – Jun 2020	Jul – Sep 2020
Algeria			X		
Argentina		X			
Australia	X	X	X		
Austria	X	X	X		
Bahrain			X		
Bangladesh		X	X		
Belgium		X			
Brazil		X			
Canada	X	X	X		
Chile		X			
China	X	X	X		
Colombia		X	X		
Congo-Kinshasa		X			
Côte d'Ivoire		X			
Cyprus		X			
Ecuador			X		
Egypt	X				
Estonia		X			
Ethiopia	X				
Finland			X		
France		X	X		
Germany	X	X	X		
Ghana		X	X		
Grenada			X		
Greece			X		
Honduras		X			
Hong Kong	X	X			
Hungary			X		
India	X	X	X		
Indonesia		X			
Iran	X	X	X		
Ireland		X			

Country	Time Period				
	Jul – Dec 2018	Jan – Dec 2019	Jan – Mar 2020	Apr – Jun 2020	Jul – Sep 2020
Israel		X			
Italy	X	X	X		
Japan	X	X	X		
Kenya		X			
Kuwait	X	X			
Lebanon		X			
Malaysia		X			
Mexico	X	X	X		
Morocco		X			
Namibia		X			
Nepal	X	X			
Netherlands		X	X		
New Zealand	X		X		
Nigeria		X	X		
Pakistan	X	X	X		
Paraguay		X			
Peru		X			
Philippines	X	X	X		
Poland		X	X		
Portugal		X			
Qatar		X	X		
Romania			X		
Russia		X			
Saudi Arabia		X	X		
Singapore		X			
South Africa		X			
South Korea		X	X		
Spain		X			
Sri Lanka		X			
Sweden		X			
Switzerland			X		
Taiwan		X			
Thailand	X	X	X		
Turkey	X	X	X		
Ukraine		X			
United Arab Emirates		X			
United Kingdom	X	X	X		
United States	X	X	X		
Vietnam		X			
Zambia		X			
Total	22	60	36		

FEEDSTOCK DEVELOPMENT & PRODUCTION

Project Coordination: The Feedstock Development (FD) Team holds a single joint monthly meeting and periodically meets on an as-needed basis in between monthly meetings. The UA continues to lead these meetings (Dr. Dennis Ray), which are leveraged to ensure all team members are on schedule and research work can seamlessly integrate between components. Questions related to planting or harvesting schedules are generally worked out during these monthly meetings. The FD team members also meet during weekly research team meetings (all-hands) hosted at both the UA and New Mexico State University. These weekly briefings provide an opportunity for open communication regarding on-going experiments, issues/challenges, and results for both guayule and guar research. Quarterly summary reports also provide an opportunity to discuss relevant research topics and questions that may need further exploration.

Issues/Risks:

Abdel-Haleem: Due to global COVID-19 pandemic situation and USDA policies of essential operations and maximum teleworking, dry guayule harvested samples from each plot are stored at -18C to preserve, when situation is relaxed samples will be chipped and ground and final ground samples will be transferred to Eloy station for rubber and resin contents using NIRS models, based on the current situation, it is early to predict if 2020 milestones will be met.

Angadi: Progress of guar research was affected by two things, which will delay our progress by at least one year. First, unusual growing season of 2019 affected all our field trials and we could not summarize results from two seasons, as 2019 guar seed yields were small and treatment responses were different. So, we will repeat trials during 2020 field season. Due to pandemic of COVID-19, university is restricting research work significantly. Each project has to be approved by Vice President Research. Also, it will affect graduate student recruitment and joining. Allowing researchers to carry over funds and give additional time to hire new graduate students will help the success of the project.

Dierig: Bridgestone Agro Operations partially shut down as a result of COVID-19 response. We anticipate to still meet the goals of our SOW. We completed most of the harvesting and processing of shrubs prior to shut-down. The analytics will be slightly delayed.

Grover: Due to the current COVID pandemic, the university was locked down in March interrupting the threshing of guar lines and collecting various data. The work will be resumed as soon as the conditions improve and the situation allows.

McCloskey: The Covid-19 pandemic and UA Arizona responses will only temporarily delay the spring experiments at MAC and Eloy. I do not expect an estimated two-week delay to cause any serious difficulties in meeting the project objective or tasks in spring 2020. However, as noted in the previous quarterly report, the failure of the fall 2019 experiments will cause a delay in generating the data needed for herbicide registrations. Nonetheless, I am optimistic that herbicide registrations can be obtained in 2020.

McMahan: The USDA-ARS-WRRC location of the research was shut down in response to the COVID-19 pandemic on March 17, 2020. Essential operations (preservation of plant and animal

life and safety) continues but all other work has been moved to telework. We are fortunate to have skilled employees (Mariano Resendiz, Grisel Ponciano) supporting preservations of SBAR project plant cultures. However, new transformations, and genotype/phenotype evaluations, have been discontinued. At this point it is uncertain if we may still meet 2020 milestones.

Neilson/Maier: Jessica Ledesma is close to completion of the soil texture analysis of the 108 soils from year 1. We obtained the data on the control soil that was analyzed by Brookside as a QC for her analyses. She was unable to complete the texture analysis due to the COVID lab closure. She will graduate in May, but I have decided to hire her as a technician so she will be able to complete this analysis as soon as the UA allows research to resume. The work should take 2-3 weeks to complete and will be her first priority.

Further, Kyle Brown was not able to complete DNA extractions for the 2019 Eloy and MAC soil samples from the irrigation field trial due to the COVID lab closure. He will resume work on these soils when the UA allows research to resume.

Statistical analysis of amplicon sequencing data from 2018 Eloy soil samples is not complete because Kyle Brown is learning to use the necessary software. His goal is to master the use of this software during the COVID UA closure period.

Amplicon sequencing for bacteria/archaea and fungi will be performed on all 2018 and 2019 soil samples from the MAC and Eloy irrigation field trial when the other amplicon sequencing is complete. This task is delayed due to the COVID lab closure and will not resume until the DNA extractions are complete that the UA Microbiome Core is open for sequencing.

Ogden: COVID19 Issues – BioCrop activities are challenging because we cannot get in touch with BioCrop expert to continue this work. It is hard to predict how long the university will be closed. The experiments are postponed. We will try to catch up once the university is open.

Ray: Due to COVID-19 and the University shutdown in March, all except essential research has been halted. At first, essential was keeping plants alive to continue experiments when restrictions are lifted. As of April 7, we had applied for and been granted essential status to keep plants alive and continue laboratory work. (Appendix 1) We are planning so the resumption of all research activities will go as seamlessly as possible. Part of the rationale for obtaining this was being part of the SBAR Center of Excellence, and aspects of our research partners work at USDA-Albany, CA and Bridgestone are continuing as essential. Full reasoning and description are provided in Attachment 1.

Objective 1. Improve biomass quantity and quality through genetics and traditional breeding.

Task #	Description of Task	Deliverable	Target Completion Date
1 Dierig	Evaluate USDA germplasm lines	Ploidy analysis completed	31 Aug 19 30 Apr 22

		Harvest/Analysis of first growth cycle completed	
2 McMah	Perform plant transformations using all 3 constructs (AP1, SEP3, FT, LEAFY)	Confirmed transformation for invitro plants – 6 lines AP1	31 Aug 20
		Confirmed transformation for invitro plants – 6 lines SEP3	31 Aug 20
		Confirmed transformation for invitro plants – 6 lines FT	31 Aug 20
		Confirmed transformation for invitro plants – 6 lines LEAFY	31 Aug 20
3 McMah	Determine effect of transgenes on rubber content by ASE (tissue culture)	% rubber data obtained for each construct line	31 Aug 20
4 McMah	Transfer plants to greenhouse for flowering phenotype	Transfer at least 2 lines to greenhouse	31 Aug 20
5 Ray	Evaluate growth and rubber/resin content in guayule germplasm lines	Rubber/resin content determined in 21 guayule germplasm lines	30 Jun 20
6 Ray	Compare root growth/architecture and water use in direct-seeded and transplant-established guayule	Plantings established	31 Jan 20
		Compare root growth and top growth for direct-seeded and transplant-established plants	31 May 20
		Compare root growth/top growth/water use	31 Mar 20

Evaluate Germplasm Lines (Variety Trials):

Two trials planted by direct seeding at Eloy, April and May 2018 were harvested in March, 2020. The first trial includes 55 USDA varieties and the second 30 varieties, both with 4 replications. One m² section was harvested from each plot. The same trial was planted in Maricopa, AZ and harvested at the same time. Rubber and resin analysis of both locations is in progress and results will be included along with biomass and rubber yield data in the next quarterly report.

Plant Transformations using AP1, SEP3, and FT Genes:

Our project seeks to enhance natural rubber content in guayule by downregulation of flowering. Previously, four target genes (*APETALA1*, *SEPATTALA3*, *FLOWERING TERMINUS*, *LEAFY*) all transcription factors related to flowering, were identified. Five guayule transformation constructs for downregulation (including one 2-gene version: *pND6 – AP1 – SEP3 (pAS)*) were prepared and plant transformations performed. In 4Q19, we focused on transformations of *pAS* constructs and on recovery of plants from the other 4 constructs.

Table 4. Status of transformed plant recovery April 15, 2020.

Construct	Calli Status	Plants recovered	PCR results
<i>APETALA1</i> AP1	Calli growing under selection pressure.		
<i>SEPATTALA</i> SEP3	Calli growing under selection pressure.	205 plants moved to rooting media.	Plant transformation confirmed by PCR for 6/6 events.

FLOWERING LOCUS T FT2	Calli growing under selection pressure.		
LEAFY	Calli growing and forming leaves under selection pressure.	21 plants moved to rooting media	
pND6 – AP1 – SEP3 (pAS).	Initial calli obtained, transformations continuing.		

Flowering downregulation transformations are still underway for the pAS construct. As of January 2020, we have 200 calli with the Leafy construct and 90 calli with the pAS construct. Figure 1 shows the Leafy construct plants in rooting media.

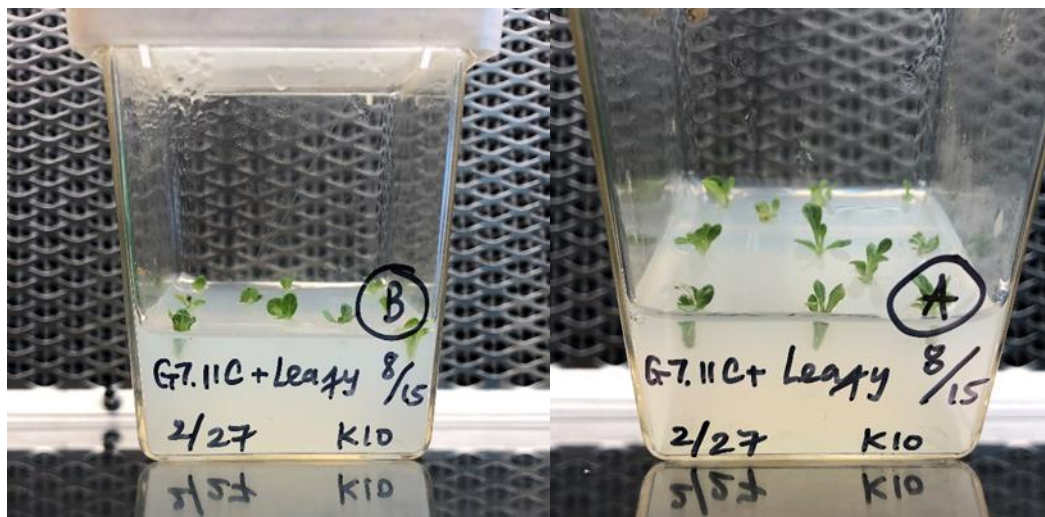


Figure 1. Guayule plants modified to downregulate LEAFY in rooting media.

Effect of transgenes on rubber content by ASE (tissue culture):

Research continues as planned; no data to report.

Transfer plants to greenhouse for flowering phenotype:

Research continues as planned; no data to report.

Growth and Rubber/Resin Content in Guayule Germplasm Lines:

Plant samples that were harvested and processed last quarter were analyzed by Accelerated Solvent Extraction (ASE) for “resin” (acetone extractable compounds) and rubber (cyclohexane extractable compounds) (Table 5). Samples from the same plots were harvested on February 25, with heights measured (Table 6), then weighed, chipped, and dried (Table 7), and will also be analyzed for percent resin and rubber.

Table 5. Mean and standard deviation values for a) % "resin", b) % "rubber"; and c) total % extract from plant samples harvested last quarter (November 2019) as analyzed by ASE. Values followed by the same lower-case letter are not significantly different.

("resin")					compounds ("rubber")				
Level	Number	Mean	Std Dev		Level	Number	Mean	Std Dev	
11604	7	4.57	1.62	a	11604	7	2.10	0.69	a
11701	7	4.24	0.72	ab	11701	7	1.91	0.48	a
PARL803	7	3.19	1.28	b	PARL803	7	2.20	0.83	a
PARL804	7	3.22	1.21	b	PARL804	7	1.97	0.54	a
PARL816	7	3.80	0.77	ab	PARL816	7	2.13	0.46	a
PARL914	7	3.53	0.80	ab	PARL914	7	2.35	0.93	a
R1044	7	3.72	1.28	ab	R1044	7	1.77	0.49	a

c) Percent total extracted compounds				
Level	Number	Mean	Std Dev	
11604	7	6.67	1.50	a
11701	7	6.15	0.72	ab
PARL803	7	5.39	0.65	b
PARL804	7	5.19	1.22	b
PARL816	7	5.93	0.39	ab
PARL914	7	5.88	0.67	ab
R1044	7	5.49	1.16	b

Table 6. Mean heights (cm) of seven guayule germplasm lines measured on 25 February 2020. Values followed by the same letter are not significantly different.

Level	Number	Mean	Std Dev	
11604	14	24.3	5.1	a
11701	14	24.9	8.9	a
PARL803	14	19.4	3.6	a
PARL804	14	21.0	3.9	a
PARL816	14	21.9	7.4	a
PARL914	14	21.9	3.9	a
R1044	14	23.5	6.8	a

Table 7. Mean weights of seven guayule varieties harvested on 25 February 2020. Values followed by the same letter are not significantly different. A. Fresh weight; B. Dry weight.

A. FRESH WT (g)					B. CHIPPED DRY WT (g)				
Level	Number	Mean	Std Dev		Level	Number	Mean	Std Dev	
11604	7	204.9	84.7	a	11604	7	74.3	33.7	a
11701	7	291.8	246.7	a	11701	7	103.3	87.3	a
PARL803	7	169.1	69.4	a	PARL803	7	54.0	27.0	a
PARL804	7	260.2	112.3	a	PARL804	7	96.0	42.3	a
PARL816	7	236.2	140.0	a	PARL816	7	91.9	58.6	a
PARL914	7	283.3	113.9	a	PARL914	7	91.0	49.9	a
R1044	7	265.9	156.8	a	R1044	7	89.9	50.1	a

Root Growth/Architecture Compared to Water Use in Direct Seed and Transplant-Established: Roots that were harvested 9 November (185 DAP) were analyzed for resin and rubber (Table 8).

Table 8. Mean values for "resin" (acetone-extractables) and "rubber" (cyclohexane-extractables) in guayule plant material (AGB=above ground biomass and roots found in the first 20 cm) harvested at 185 days after planting. Values in a column marked with "***" are significantly different.

	RESIN %				RUBBER %			
	AGB		0-20 cm roots		AGB		0-20 cm roots	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
185 DAP								
Direct seeded (n=4)	8.09	0.25	3.93	1.39	2.08	0.18	1.92	2.25
Transplanted (n=4)	7.29	1.57	2.61	0.64	1.85	0.08	1.64	1.04

Other Tasks:

Dormancy in guayule:

In our Dormancy collaborative study (with Julie Neilson, and Diaa El-Shikha/Pete Waller) we continued characterization of plant tissues from irrigation field trials in Maricopa before, during, and after winter dormancy. Most of the data for this study has been generated and analyses are underway. In 1Q20 a series of discussions were held regarding results interpretation and data correlations. The project team met by telecon January 23, 2020.

Factors that correlated with % rubber included:

Positive correlation:

Soil microbiome biomass (DNA)

% Resin

Conc of extracted rubber particles

Negative correlation:

Shrub mass (fresh weight)

NVDI vegetation index

Soil Organic matter

Microbial taxa were identified that correlate positively with rubber and resin content and also some that correlate negatively with shrub mass and NDVI. The next step is to generate an outline and figures for publication.

Objective 2. Develop high-throughput phenotyping to support crop expansion using remote-sensing methods to create interactive databases/tools.

Task #	Description of Task	Deliverable	Target Completion Date
1 Abdel-H	Phenotypic characterization - Guayule	Collect and analyze available phenotypic data; plant stand and establishment, plant height	31 Dec 21

		and width, flowering time, rubber, resin	
		Collect and analyze first set of available high-throughput phenotyping (HTP) parameters: vegetation indices and reflectance	31 Dec 21
		Summary report completed	30 Jun 22
2 Abdel-H.	Phenotypic characterization – Guayule under stress conditions and stability	Field planting – plant and maintain USDA guayule collections	30 Jun 20
		Collect and analyze available phenotypic data: plant ht, plant width, flowering time, rubber, resin	31 Dec 21
		Collect and analyze available high-throughput phenotyping (HTP) parameters: vegetation indexes and reflectance	31 Dec 21
		Summary report completed	30 Jun 22
3 Abdel-H	Guayule leaf waxes	Leaf wax extraction from guayule tissue	31 Jan 21
		Wax class determination	31 Dec 21
		Summary report completed	31 Jan 22
4 Angadi	Guar remote sensing	Seasonal multispectral data from deficit irrigation study	31 Mar 20
5 Dierig	Remote sensing evaluation of USDA germplasm lines	Rate of growth comparison between lines completed	31 Aug 20

Phenotypic characterization – Guayule:

Second year of the field trial containing 48 USDA guayule accessions are maintained at Maricopa, AZ. Plots are maintained by hand weeding as needed and surface irrigation at bi-weekly intervals based on the weather and plant growth stage.

Plant height were recorded for two-year old plants. Analysis of variance of plant height showed significant differences among guayule accessions with CAL3 (diploid) the shortest, while tetraploid improved germplasm such CAL2, CAL1, AZ-2, CAL5, and CAL7, and wild accession R1109 were the longest (Figure 2). There were significant variations among genotypes in relative plant growth as function of plant height. These differences among genotypes, could be independent from plant height, and different mechanisms could control plant height and growth rate.

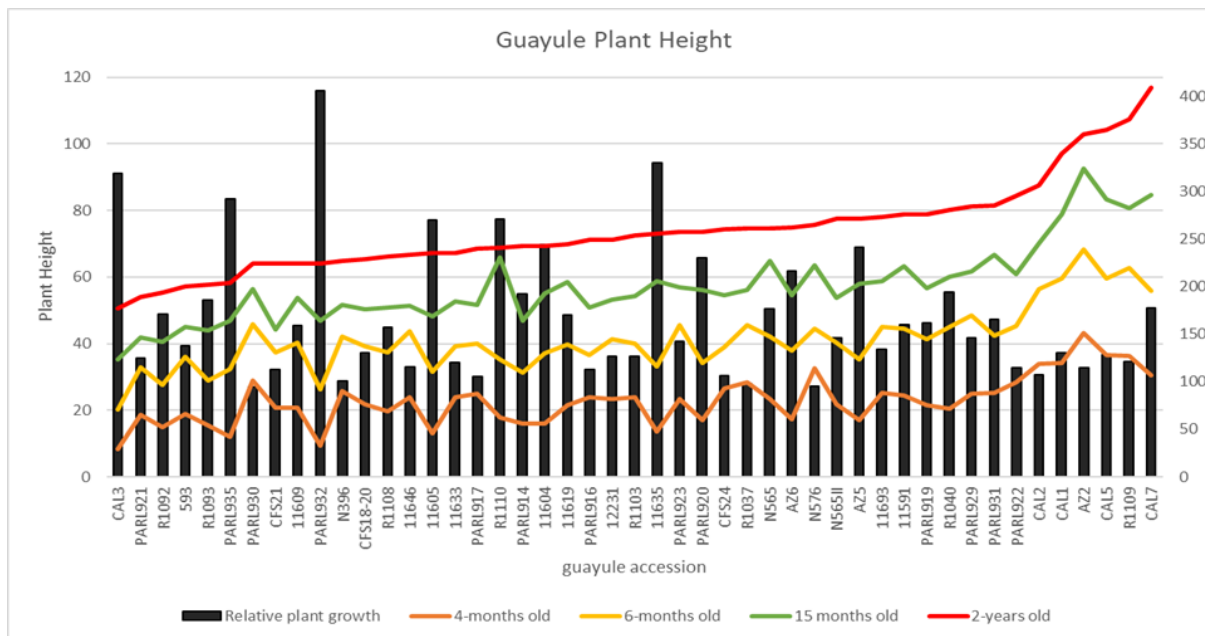


Figure 2. Guayule plant height sampled at Maricopa Agriculture Center, Arizona.

Two-year guayule shrubs were harvested, fresh and dry weight were recorded. ANOVA revealed the significant variations in both fresh and dry biomass among guayule accessions (Figure 3). Data showed that dry biomass increased in all guayule accession, but proportion of increase was genotype dependent. Guayule biomass is important factor in final rubber production determination, phenotypic variations in such traits will allow for selecting high rubber content as well as higher rubber production.

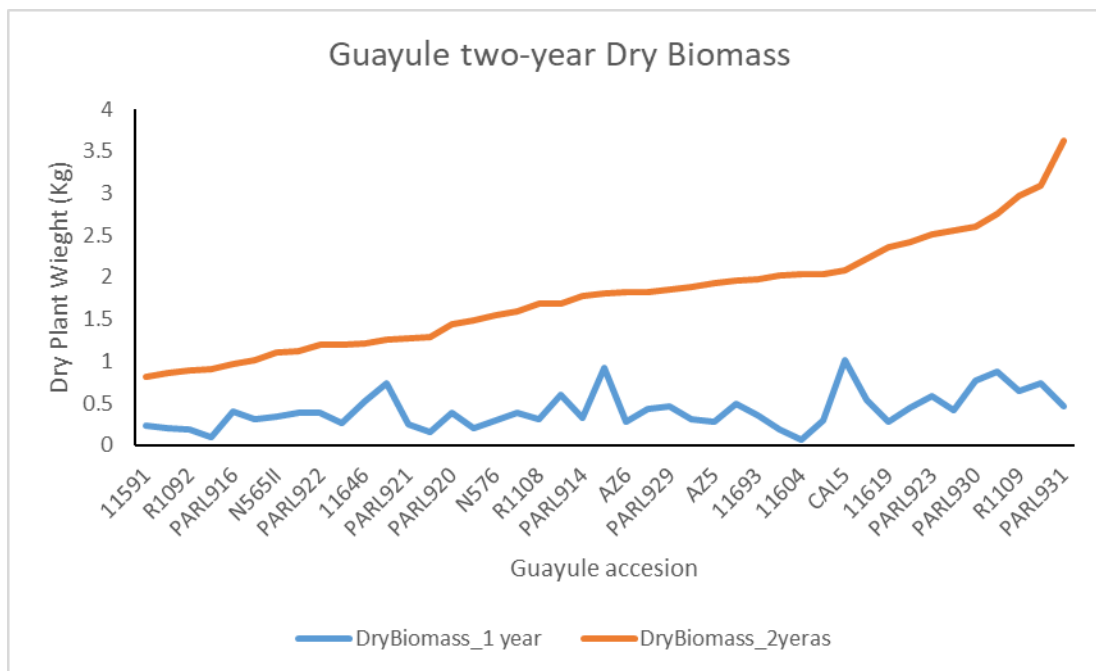


Figure 3. Guayule dry biomass weight over two years.

To estimate the rubber and resin contents of two-year guayule genotypes were dried and stored at -18C. those samples will be chipped and ground. The final ground samples will be transferred to Eloy station for rubber and resin contents using NIRS models.

Phenotypic characterization – Guayule Under Stress Conditions:

A new experiment with 60 guayule genotypes, including new genotypes that will be tested for the first time, and 6 common checks has been initiated at Maricopa, AZ with the target to test guayule genotypes growing under stress and non-stress conditions. Genotypes were transplanted into the field in October 2019, in two trials (stress and no stress treatments will start at spring) in augmented design. At both trials, plots are maintained by hand, weeding as needed, and surface irrigation at bi-weekly interval based on the weather and plant growth stage. Differential irrigation schedules were started at stress and non-stress treatments. At both trials, plots are maintained by hand-weeding as needed.

Guayule Leaf Waxes:

Plans to collect and extract waxes components from guayule genotypes growing under stress and non-stress will start in the coming summer. Research is continuing as planned; no new data to report.

Guar Remote Sensing:

Dr. Diaa El-Shikha and Hadiqa Maqsood have made progress in processing the remote sensing data. To compensate for bad 2020 season, we are thinking of repeating the drone data collection one more year from deficit irrigation trial at Clovis. We will collect essential ground data during the remote data collection.

Remote Sensing Evaluation of USDA Guayule Germplasm Lines:

Research is continuing as planned; no new data to report.

Objective 3. Deploy superior genotypes of guayule and guar to regional growers.

Task #	Description of Task	Deliverable	Target Completion Date
1 Angadi	Evaluate guar germplasm in New Mexico high plains environment	Identify guar germplasm suitable for cooler and northern latitudes	30 Apr 20
		Summarize data after harvest; present at field day in Clovis, NM	31 Dec 19
		Assess available guar cultivars at Clovis, NM	31 Dec 19
2 Angadi	Galactomannan assay	Assess irrigation effect on guar gum content	30 Apr 20
3 Grover	Evaluate guar germplasm lines (increase # of seeds)	Collect data on field performance of guar germplasm lines	31 Aug 20

		Generate report on guar germplasm line field performance	31 Aug 20
4 Ray	Evaluate seed from plants surviving root rot inoculation Determine root rot tolerance per guayule germplasm	Screen 42 guayule germplasm lines for root rot fungus tolerance New germplasm lines screened for the first time Seed from surviving plants screened for trait inheritance	31 Jan 20 30 Nov 20 31 Dec 21
5 Ray	Guayule salt tolerance trials	7 germplasm line's transplants evaluated for sensitivity under 11 saline treatments Initial estimate of lines with most tolerance complete Continue screening germplasm lines Seed from surviving plants collected and planted for 2 nd round evaluation	31 Dec 19 31 Dec 19 31 Aug 20 31 Oct 20
6 Ray	Guar yield trials in Tucson, AZ; Las Cruces, NM; and Clovis, NM	Increase guar seed for yield tests Yield trial protocols established (3 different for comparison) Yield trials planted in 3 locations Yield trials harvested; yields compared	15 Apr 19 1 May 19 30 Jun 20 31 Dec 20
7 Ray	Guar genetic combination trials	Guar seed from crosses of partial male-sterile plants with 2 elite lines collected Genetic diversity evaluated	31 Dec 19 31 Jan 21

Guar Germplasm in New Mexico:

Although 2019 field season was not great, we completed processing all field samples and data analysis. Due to poor growing season, most trials will be repeated to get one more year data. Data from germ plasm evaluation study and currently available guar cultivar study are useful to assess genetic diversity under adverse conditions.

Harvest data from USDA guar germplasm study was shared with Dr. Dennis Ray. Yield levels were lower compared to Tucson. We also had leaf disease issues and poor growth. The trial will be repeated during 2020 season. Guar cultivar assessment was completed. Due to unreliable and very low yields the trial will be repeated.

Guar Galactomannan Assay:

Galactomannan assay was done on 2018 samples from deficit irrigation trial to assess the effect of levels of water availability on galactomannan content of guar seeds. Assay underestimated galactomannan content and repeated attempts to modify protocol and talking to company developing assay did not correct it. We are storing the sample to retry after the problem with assay kit or protocol is addressed. In spite of low gum yields, irrigated guar seeds had higher gum content.

Guar Germplasm Line Multiplication:

Nothing new to report.

Seed Evaluation following Root Inoculation and Root Inoculation per Guayule Germplasm:

Work on new screenings has stopped until new sources of the root rot fungus are obtained.

Guayule Salt Tolerance Trials:

Surviving plants from salt stress experiments are being moved from pots in the greenhouse to the field.

Guar Yield Trials in Tucson, AZ; Las Cruces, NM; and Clovis, NM:

Guar pods threshed and weighed January 9-15; yields calculated (Table 9).

Table 9. Guar yields by variety and flowering.

Variety	N	mean kg/ha	mean lb/a	*	Flowering
Kinman	4	3176.7	2836.3	a	early
Lewis AZ	4	2813.0	2511.6	ab	early
TX 78-3726	4	2798.5	2498.6	ab	early
B-49824	4	2792.0	2492.9	bc	early
PI 263406	4	2771.8	2474.8	abc	late
SANTA C RUZ	4	2727.4	2435.1	abc	mid
NO 10949	4	2716.9	2425.8	abc	late
Lewis TX	4	2707.2	2417.1	abc	early
Matador	4	2610.2	2330.5	abcd	mid
G-05	4	2598.1	2319.7	abcde	mid
PLG 241	4	2588.4	2311.0	abcde	late
B-49819	4	2552.8	2279.3	bcde	early
SURTI	4	2526.1	2255.5	bcde	late
IC-83 NO 3	4	2498.7	2230.9	bcdef	late
WKP-88-43	4	2451.8	2189.1	bcdef	late
TX73-2731	4	2447.7	2185.5	bcdef	early
COL NO K619	4	2421.9	2162.4	bcdef	late
PLG 86	4	2403.3	2145.8	bcdef	mid/late
PLG 482	4	2399.3	2142.2	bcdef	mid
PI 263698	4	2388.8	2132.8	bcdef	late
EC 248A	4	2375.0	2120.5	bcdef	early
NO 10521	4	2361.3	2108.3	bcdef	mid
B-49823	4	2278.9	2034.7	bcdef	early
PI 542608	4	2257.9	2015.9	bcdef	mid
TX71-3292	4	2238.4	1998.6	bcdef	mid
COL NO 36 PUNJAB	4	2221.5	1983.5	bcdef	late
Gawar	4	2193.2	1958.2	cdef	late
SIRSA 56	4	2097.9	1873.1	def	late
PI 186477	4	2002.5	1787.9	ef	early
MULKHANIA	4	1915.2	1710.0	f	mid

*Levels not connected by same letter are significantly different.

[Guar Genetic Combination Trials:](#)
Research for this task is complete.

Objective 4. Deploy agronomic production practices; identify agronomic information for salinity, herbicide, and nutrients to support production; provide irrigation apps using algorithms to growers.

Task #	Description of Task	Deliverable	Target Completion Date
1 Angadi	Conduct guar critical stage-based deficit irrigation trial	Report on growth stage-based irrigation management Present data at regional and national conferences	15 May 20 15 May 20
2 Angadi	Guar germplasm temperature requirement	Identify optimum soil temperature for planting USDA guar germplasm	31 Jul 20
3 Dierig	Density trials in Tucson and Eloy, AZ	Establish trial with different densities in Tucson, AZ Summarize plant growth, yield performance, and traits for density trial with 2 varieties and 5 densities in Eloy, AZ Final harvest and analysis completed for 5 plant densities and 2 varieties in Eloy	31 Dec 20 30 Apr 22 30 Apr 20
4 Dierig	Bi-monthly harvest from irrigation trials	Growth data over seasons from two locations Harvest plots for shrub dry biomass rubber/resin content and yield	31 May 20 30 Apr 20
5 Dierig	Irrigation Timing Study	Plant replicated trial and begin treatments	31 Aug 20
6 Grover	Evaluate guar response to moisture stress	Track and collect research data on moisture stress experiment Generate report/publication from results obtained Present research results at regional/national conferences	31 Aug 20 31 Aug 20 31 Aug 20
7 Grover	Evaluate guar response to planting density	Track and collect research data on guar density experiment Generate report/publication from results obtained	31 Aug 20 31 Aug 20
8 McClos	Conduct guayule herbicide tolerance study, at Eloy and Maricopa, AZ (Fall)	Collect data to support 24c SLN herbicide registrations – (a) topical, postemergence broadleaf herbicide; (b) post-directed herbicide; (c) herbicide application sequence for	28 Feb 20

		chemical weed control from seeding to 6mo old plants	
		Generate research report/publication and Extension bulletin from results obtained	30 Jun 20
9 McClos	Conduct guayule herbicide tolerance studies, at Eloy and Maricopa, AZ (Spring)	Collect data to support 24c SLN preemergence herbicide registrations – (a) topical, postemergence broadleaf herbicide; (b) post-directed herbicide; (c) herbicide application sequence for chemical weed control from seeding to 6mo old plants	30 Jun 20
		Generate research report/publication and Extension bulletin from results obtained	30 Jun 20
10 Ogden	Development and testing of AquaCrop model	Growth model compared to field data	30 Apr 20
11 Ogden	Development of BioCrop model	Preliminary output and evaluation of most important parameters	31 Aug 20
12 Ray	Guayule density trial	Yields for 2 lines, 5 densities, 2 locations, and 2 seasons compared	30 Nov 21
13 Ray	Range of N and P application	Compare N and P utilization and effects of nutrients on biomass, rubber and resin production	30 Nov 20
14 Waller	Install TDR, infrared camera and flowmeter system	Provide data on guayule irrigation experiments	15 Jul 20
		Provide data set that can be used to refine the use of sensors for WINDS crop irrigation mgmt.	15 Jul 20
15 Waller	Integrate python MySQL WINDS model with existing tools	Integrate new python model with WINDS (winds.arizona.edu), and in-situ sensors	15 Jul 20
		Database available to economic modelers	15 Jul 20
16 Waller	Irrigation experiments: Guayule and Guar	Collect data; image collection, neutron probe readings, in-situ sensors, crop coefficient development and destructive plant samples for chemical analysis	15 Jul 20
		Document effects of irrigation treatment on plant growth, soil moisture, plant stress, plant	15 Jul 20

		chemical response, plant vegetative indices, and crop coefficient	
		Generate a publication on guayule irrigation experiments	15 Jul 20
17 Waller	Deficit irrigation study (water stress); Eloy, AZ	Quantify effects of irrigation scheduling strategies on rubber/biomass yield and plant stress	15 Jul 20

Guar Critical Stage-Based Deficit Irrigation Trial:

Data from two years of were statistically analyzed to assess the effect of pre-irrigation and in-season irrigation treatments. A graduate thesis was written with the data. First chapter focused on irrigation management on drought physiology, crop growth and yield formation in two diverse guar genotypes (Table 10).

Table 10. Seed yield, harvest index (HI) and yield components of guar cultivars under different irrigation treatments in 2018-2019.

Treatments	2018					2019				
	Seed yield (kg ha ⁻¹)	Pods plant ⁻¹	Seeds pod ⁻¹	1000 seed weight (g)	HI (%)	Seed yield (kg ha ⁻¹)	Pods plant ⁻¹	Seeds pod ⁻¹	1000 seed weight (g)	HI (%)
Pre-irrigation (P)										
Yes	1024 a [†]	62.9 a	3.6 a	23.4 b	30.8 a	302 a	44.8 a	3.2 a	32.4 a	26.6 b
No	807 b	47.8 a	3.8 a	28.8 a	35.8 a	330 a	46.7 a	3.2 a	29.2 a	33.3 a
Growth Stage-Based (S)										
FI	983 a	64.2 a	3.9 a	25.9 ab	29.1 c	365 a	47.5 a	3.1 a	28.7 b	27.8 b
Vst	811 a	47.7 a	3.5 a	24.1 b	32.3 bc	364 a	49.0 a	3.3 a	31.3 ab	29.8 ab
Rst	977 a	62.3 a	3.8 a	25.6 ab	34.3 ab	290 ab	44.9 a	2.9 a	31.0 ab	30.0 ab
RD	893 a	47.2 a	3.8 a	28.7 a	37.4 a	246 b	41.6 a	3.4 a	32.1 a	32.2 a
Cultivars (C)										
Kinman	956 a	57.5 a	3.5 a	27.7 a	32.0 a	368 a	58.0 a	3.0 a	30.9 a	31.0 a
Monument	876 a	53.2 a	4.0 a	24.5 b	34.6 a	265 b	33.5 b	3.4 a	30.6 a	28.9 a

In a typical year like 2018, pre-irrigation is a good strategy to irrigate guar without competing with main crops during the growing season. However, these differences were not evident in 2019, which was very dry and hot in the beginning and turned wet later in the season. In season irrigation had no significant effect on yield formation and seed yield. Harvest index suggested Guar stressed after flowering reduced seed yield compared to the guar stressed at vegetative growth. Guar is an indeterminate crop and stressing it after flowering reduced unwanted vegetative growth. However, such differences were not observed in 2019. Water extraction due to pre-irrigation showed significant differences to a depth of 1.40 m in 2018 (Figure 4).

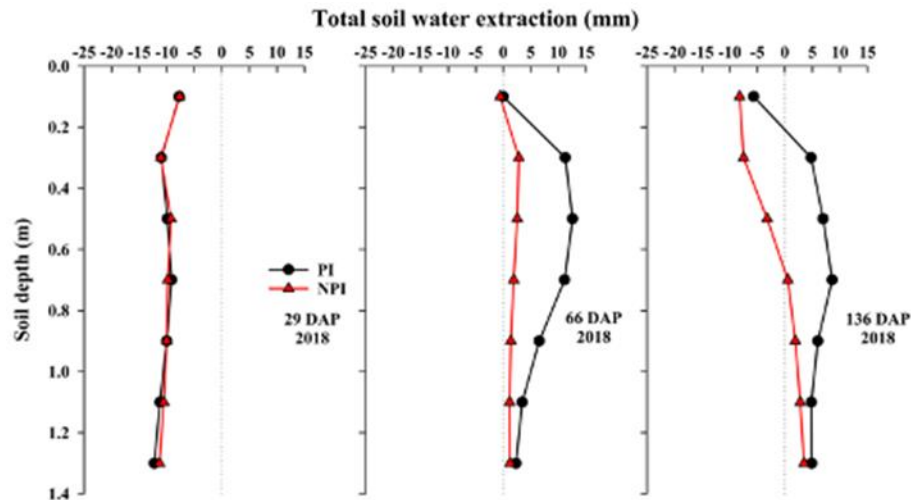


Figure 4. Total soil water extraction from guar soil profile (0.0 to 1.4m) under the pre-irrigation (PI) and no-pre-irrigation (NPI) treatments calculated at 0-29, 0-66, and 0-136 DAP in 2018.

In general, pre-irrigated had more soil water and it extract that water to meet guar crop demand. Treatments those did not receive irrigation during post flowering stage, Rst and RD, extracted more soil water to reduce crop water stress. Water use efficiency was the highest in those Rst and RD treatments. Frequent rain affected deficit irrigation study in 2019. Graduate student wrote master's thesis on the project and defended recently. Although, he has written first draft of two manuscripts, due to unusual second season, we will add one more years data before publishing.

Incubator Study to Understand Temperature and Germination Relationships:

The data from the incubator study, which focused on assessing genetic variation among guar cultivars for temperature and crop establishment relationships, has been written as a manuscript and gone through review. Hope to submit to a journal in a month. The data was also presented as a poster in Alternative Crops Conference at Portales, New Mexico. We wanted to run another trial looking at genetic variation in the available USDA germplasm for cold tolerance. But, due to restrictions imposed by the university in response to state government regulations to reduce spread of COVID-19 pandemic, the trial is delayed.

Density Trials in Tucson and Eloy, AZ:

The densities are 30, 18, 12, 6, 3-inch in-row spacing for density 1, 2, 3, 4, 5. Plots were harvested for year 1.5 at Eloy and year 1 at Tucson in October. Data for Tucson are provided separately by Dr. Ray.

The plant population study with five plant population and two distinctly different guayule lines were planted at Eloy in April 2018 and at Tucson in September 2018. Five in-row spacings (30, 18, 12, 6, and 3 inches) correspond with five targeted plant population, 5227, 8712, 13068, 26136, and 52272 plants/a. The actual plant population after thinning at Eloy are included in the following table.

Table 11. Plant population treatment with targeted and actual plant number for AZ-2 and Sel-1 at Eloy.

Density # in the figure	Targeted in-row spacing (inch)	Targeted plant/m for sampling	Targeted plant population (plant/ac)	Actual plant population for AZ-2 (plant/ac)	Actual plant population for Sel-1 (plant/ac)
1	30	1	5227	3983	3983
2	18	2	8712	7966	7966
3	12	3	13068	13276	14936
4	6	6	26136	34851	19915
5	3	12	52272	44808	31863

In March 2020, the final sampling from the field was conducted but samples are not yet analyzed for rubber and resin. The biomass data showed that AZ-2 had significantly higher biomass compared to Sel-1 (Figure 5). For AZ-2, there were no differences among all five density treatments. For short-stature Sel-1, biomass increased from density 1 and 2, but then stay flat for the rest of density treatments. This is consistent with our observation that AZ-2 is more vigorous and individual plants can fill up space. For varieties with similar height to Sel-1, increasing plant population can increase biomass yield. This should be done by reducing row spacing (not done in this experiment) and in-row spacing. If a short stature variety has significantly higher rubber content, it has the potential to have lower biomass but higher rubber yield compared to the high biomass of AZ-2.

Rubber and resin content will be analyzed and full results including rubber yield will be included next quarterly reporting. The same experiment was planted at Tucson in September 2018. The second harvest will be conducted there later this Spring, 2020, when crop is 1.5-year old.

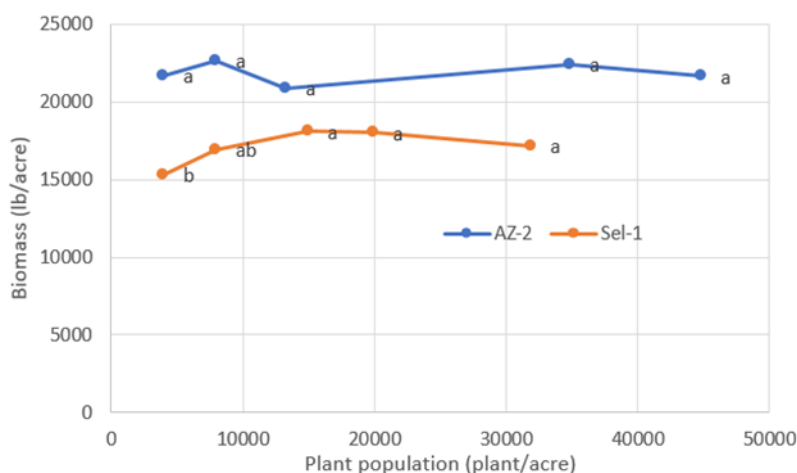


Figure 5. Biomass yield of two guayule genotypes (AZ-2 and Sel-1) affected by plant population at Eloy at 22-months of age.

Bi-Monthly Harvest from Irrigation Trials:

The fields at Eloy and Maricopa were harvested in January and March 2020. These were the final bimonthly harvests, but we will sample regrowth after 6 months. Data is currently being compiled.

Irrigation Timing Study:

Planning for this experiment occurred this quarter. The field has been prepared and planting will occur April 20. There will be 2 germplasm lines (AZ-2 and Sel-1) and 3 replications planted at Eloy with furrow irrigation. There are 8 row plots 250 ft long with a two row buffer.

1. Full Irrigation: Irrigate as determined by the model developed as part of this project.
2. Stress for Harvest: Irrigate as treatment 1 for 1.5 years, then no irrigation.
3. Half Irrigation: Irrigate every other irrigation as determined by the model.
4. Minimum Irrigation: Irrigate three times per year, approximately every growth stage (May/June, September, and February).
5. Minimum Year2: Year 1 irrigate as determined by the model, and Year 2 irrigate three times (February May/June, September).
6. One Irrigation: One irrigation after establishment in the first year, one irrigation in year 2.

Irrigation lines are currently being installed. The field was planted with a cover crop (Barley) to be harvested prior to field preparation and planting. Establishment will be with sprinklers prior to furrow irrigation.

Guar Response to Moisture Stress:

Final plant samples were harvested for threshing and evaluating seed yields and yield attributing characters. The threshing will be started after the pandemic situation allows the work.

Guar Response to Planting Densities:

Nothing new to report.

Guayule Herbicide Tolerance Study, Fall 2019:

None of the experiments started were successful due to a lack of seedling establishment as discussed in the previous quarterly report.

An initial screening study of herbicides post-directed at the base of plants and the soil between rows was completed in the guayule fields planted in spring 2019 for the grass herbicides and Aim postemergence studies.

Table 12. Fall 2019 - Spring 2020 herbicide experiments.

Spray Date	Chemicals Applied	Location/Field	Method of Application	ARM File Name / Data Tables?	Data Collected to Date
1-13-202019	Chateau, Goal Tender, Liberty, Caparol, Karmex, Matrix, Sandea, Rinskor, Butoxone 200	MAC / F1 / B48-49	The herbicides were mixed with the appropriate adjuvants and spray at the bottom 4 inches of canopy and the soil between the crop rows.	Guayule MAC F1B48-49_Winter 2019-2020 PostDirect	Data on plant death and, necrosis of basal leaves was collected. Starting variation in plant heights precluded evaluating stunting but in general no stunting was observed and no plants died.

Guayule Herbicide Tolerance Study, Spring 2020:

Soil samples were collected in four different fields at Maricopa to help choose the best field for the spring 2020 experiments at MAC. Farm Service Agreements for MAC were completed with an experiment start date of March 1. Planning for the experiments at MAC and at Eloy was completed. However, the start of the experiments was delayed due to the Covid-19 pandemic. A waiver for conducting field work at MAC and Eloy was expected during the first week of April. The experiments will be started as soon as possible.

Herbicide Trials – Publication, Extension Bulletin and 24c SLN Applications

A Research Report on the 2018 Aim postemergence experiments was drafted and will be submitted to UArizona Cooperative Extension Manuscript Fastrack site in Q2 2020. A draft research report of 2019 Aim experiments is in progress.

Development and Testing of AquaCrop Model:

Essentially we are obtaining Maricopa data to model and changing growth parameters within the model to reflect how guayule grows, most importantly that guayule grows more linearly in terms of canopy cover in the field instead of exponentially like corn that first is just a stem followed by many leaves, whereas guayule just comes out like a bush from the beginning.

AquaCrop Progress this Quarter

Summary

- AquaCrop OS version has been updated to October 2019 release.
- AquaCrop model exhibits secondary inflection point during first 150 days.
- Growth is very close to linear for every irrigation treatment.
- Canopy coverage exponential function is being replaced by linear fit.
- Simulation output includes CC, root depth, water fluxes, biomass, and yield.
- Temperature is being used to control periods of growth (lower/upper)
- Currently modeling data at MAC; waiting on biomass data for MAC
- Data is current through March 2020

Model Output

Default AquaCrop output for canopy coverage exhibits monotonically increasing behavior, as the canopy is calculated via exponential. Real data exhibits a secondary inflection point and can be well approximated as linear growth for the initial period of canopy expansion. The model error fits the MAC data for D100 (Figure 6).

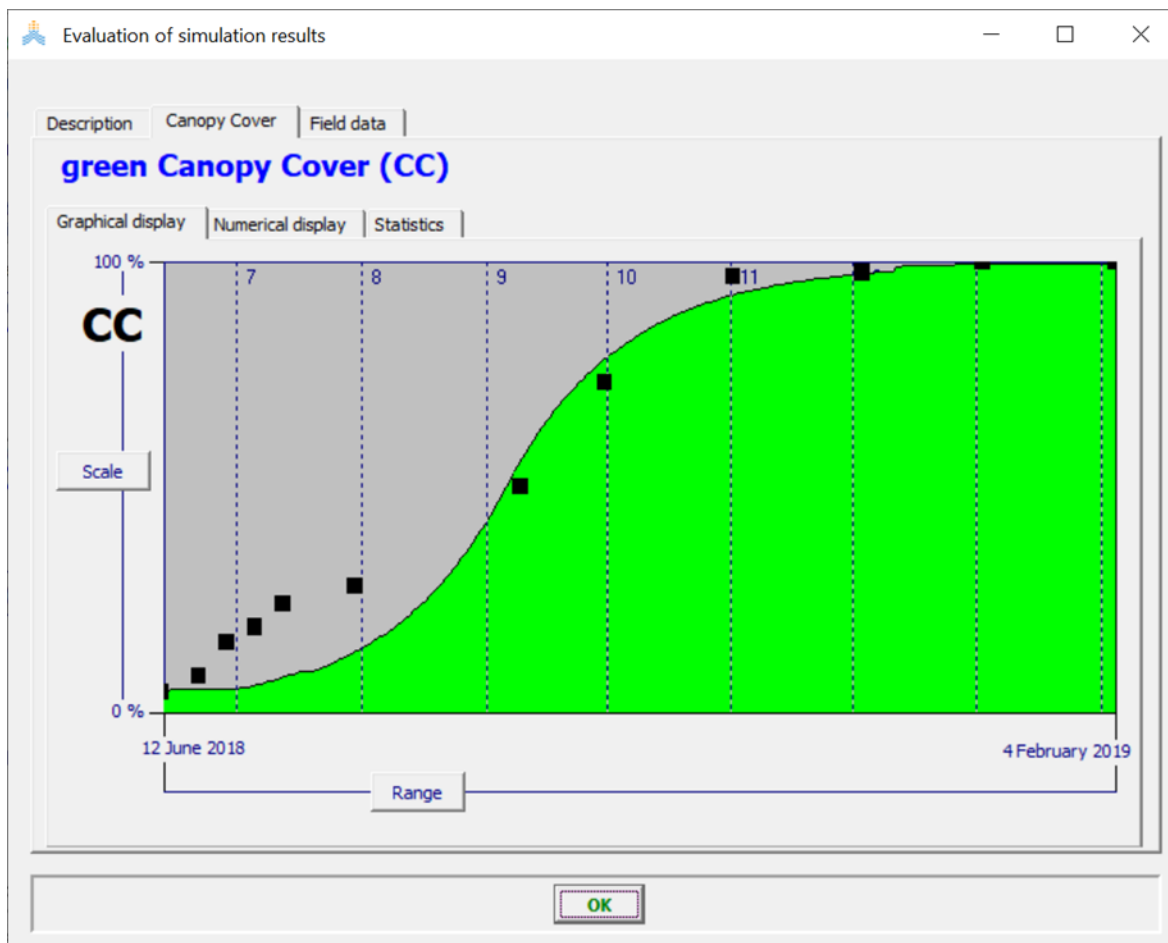


Figure 6. AquaCrop output vs. D100 (black boxes).

AquaCrop predicts the mid-later stages of canopy expansion reasonably well, but the initial period (June-August) exhibits substantial deviation. Adjustments of the canopy expansion can be modified by adjusting the time-to-event for various parts of the plant lifecycle. Time to max emergence, max canopy, senescence, and harvest can be adjusted in order to provide the best fit to % canopy. A screenshot demonstrating this process in the AquaCrop UI is shown in Figure 7.

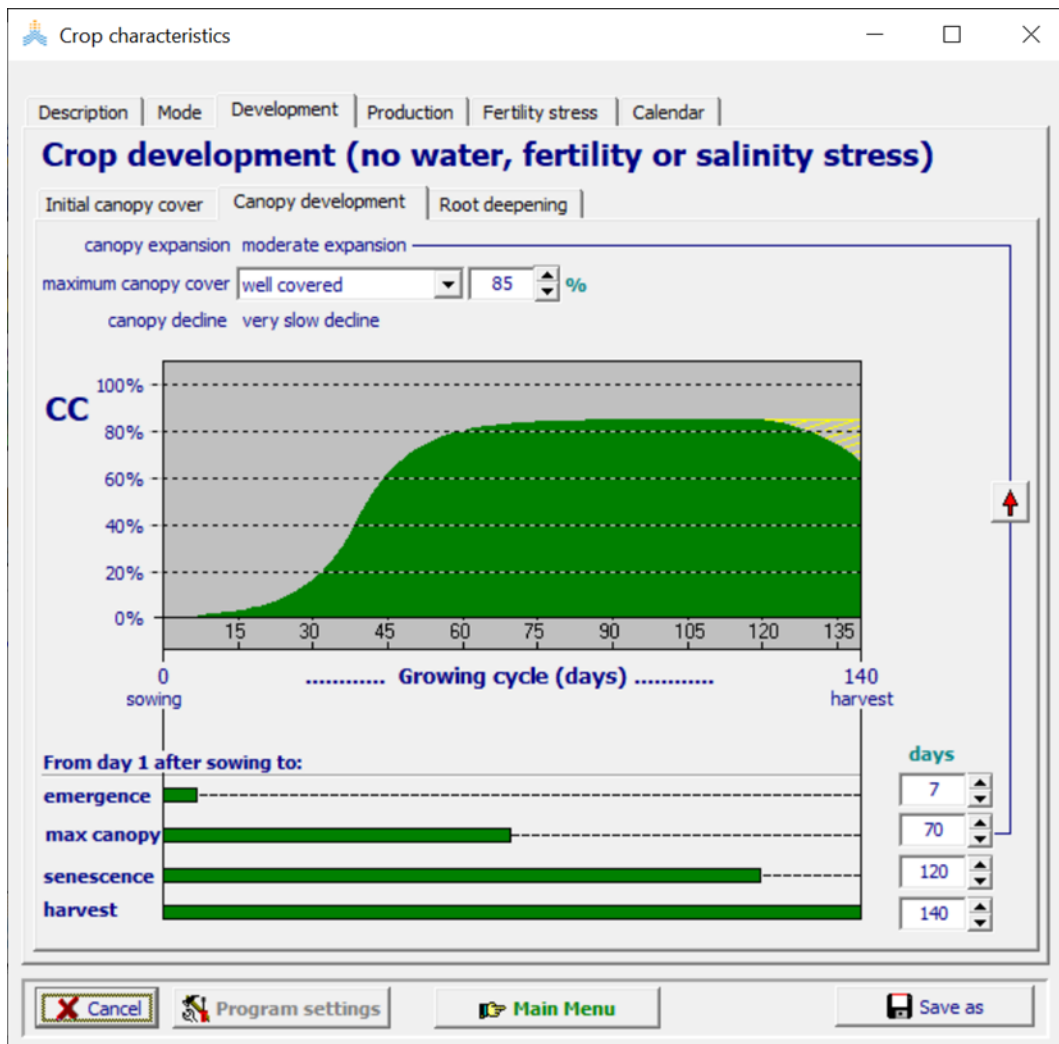


Figure 7. Example of canned AquaCrop output.

AquaCrop OS (MATLAB) does not include any data visualization modules, that is, it cannot display the simulation output. In order to display data, a few different MATLAB scripts were created to create plots of the model output (Figure 8).

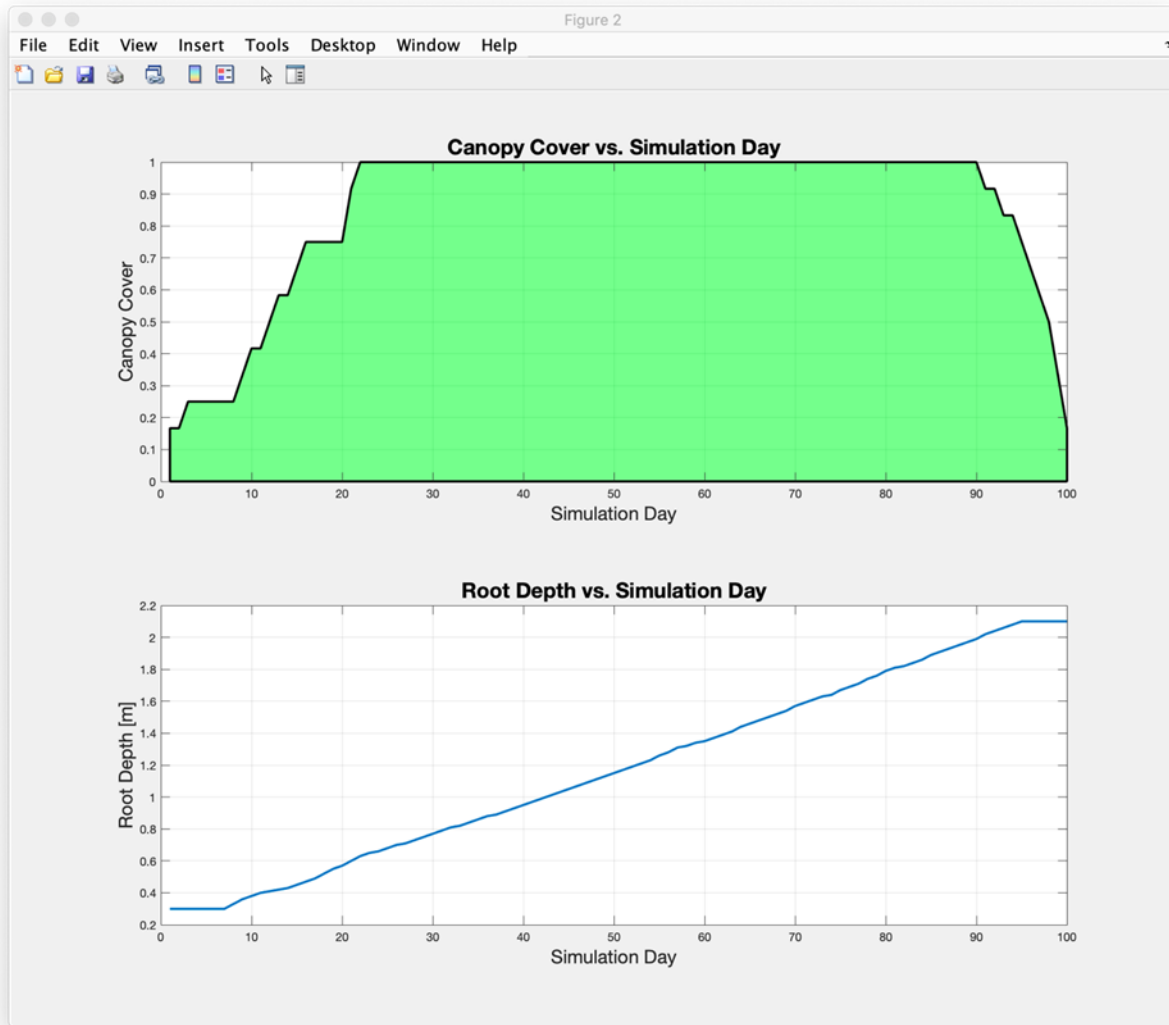


Figure 8. Example of custom MATLAB simulation output.

Linear regression was applied to % canopy coverage data at MAC for all irrigation treatments. Table 13 shows the slope, intercept, and R^2 values for % canopy values for the first 101 and 163 days, respectively. Results are displayed in Figure 9.

Table 13. Data parameters used within the AquaCrop model.

Irrigation Type	Slope_101	Int_101	R ² _101	Slope_163	Int_163	R ² _163
D50	0.4967	-20.1068	0.8225	0.458	-17.478	0.9611
D75	0.4819	-19.4949	0.8127	0.5326	-23.0036	0.9719
D100	0.5194	-21.5471	0.9363	0.5773	-25.896	0.9762
D125	0.5008	-22.2283	0.9298	0.6168	-30.87	0.9511
D150	0.5302	-22.8077	0.8776	0.658	-32.0454	0.9775
F100	0.5304	-21.4118	0.9359	0.5316	-21.7649	0.9681

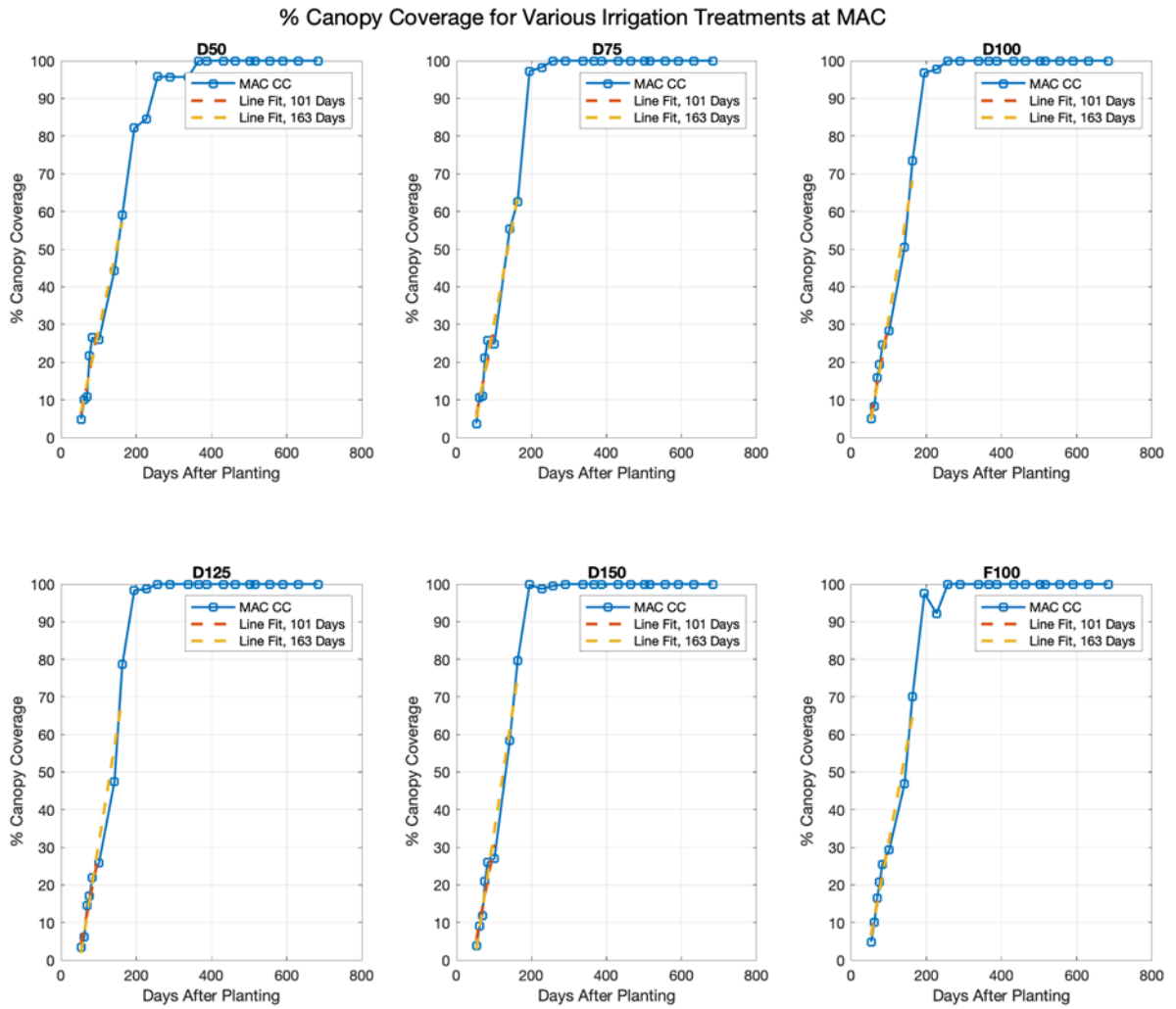


Figure 9. AquaCrop results from initial runs using data acquired from MAC.

Adjustments can be made within AquaCrop to complete different runs with different coefficients (Figure 10).

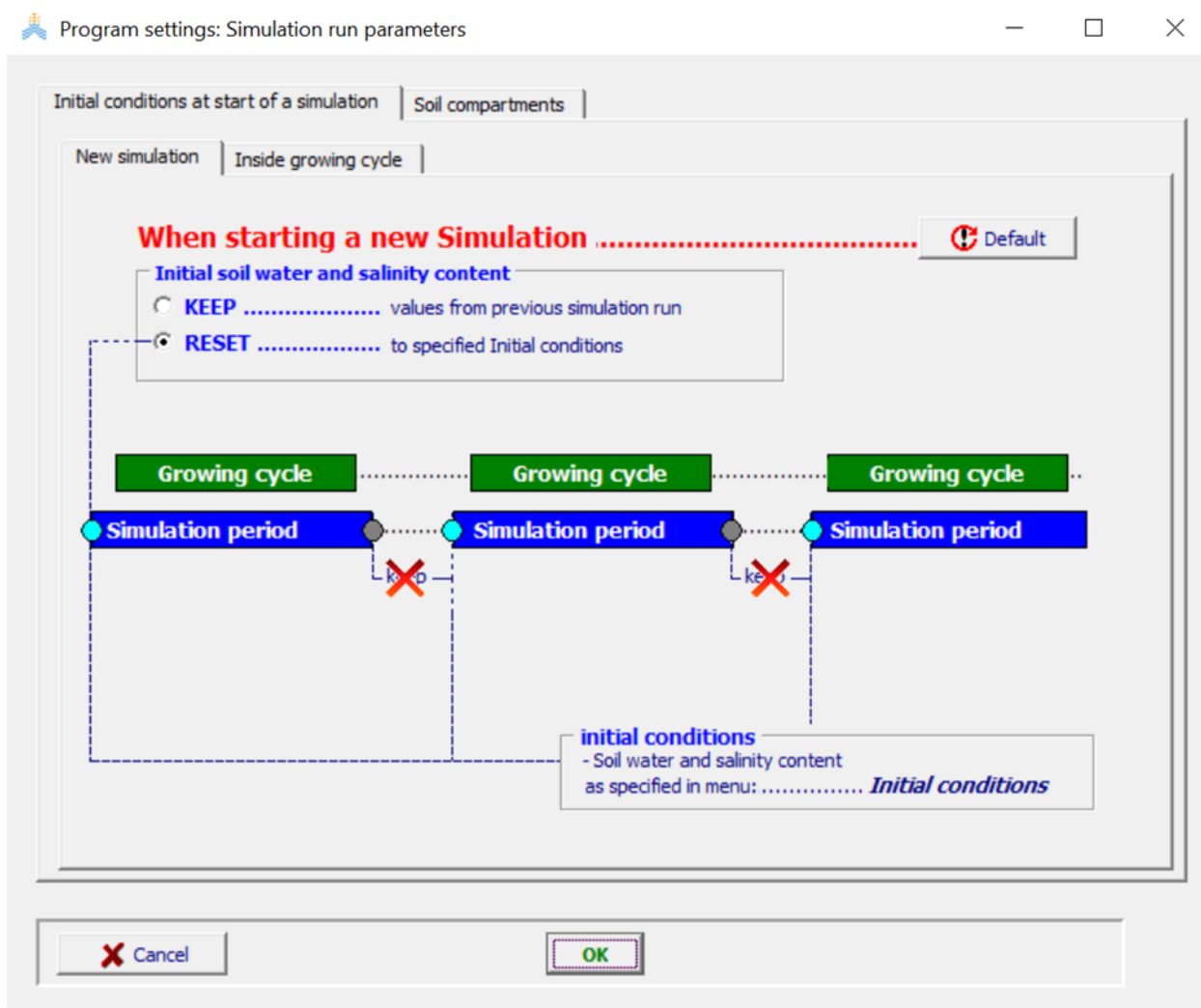


Figure 10. AquaCrop can be used to chain together simulations (dormancy).

The current data sources referenced within our AquaCrop modeling efforts are the same as previously reported.

Development of BioCrop Model:

We performed a preliminary study on the BioCrop model and consulted with the model creator last year. The model is computational based and can predict useful information about crop behavior and yield. However, BioCrop requires a relatively large amount of input parameters that are not readily available for guayule. Therefore, BioCrop has been put on hold for the time being. In the future, we may consult with the expert again and perform an additional study to determine the feasibility of adapting the BioCrop model for guayule.

Guayule Density Trials (Direct-Seeded and Transplant-Established):

Plants were scheduled to be harvested in March but that has been postponed due to physical distancing.

Range of N and P Application:

AZ-2 seedlings are being grown in trays. Delivery pumps installed. Experiment on hold due to physical/social distancing.

Installation of TDR, Infrared Cameras, and Flowmeter System:

Katterman purchased parts for five infrared camera and TDR sensors. He is constructing the sensor systems at home due to coronavirus. We have added temperature and humidity sensors to some stations for camera calibration and evapotranspiration estimation. Danielle is continuing camera calibration and interfacing with the cloud and server. We selected electronic flowmeters for the new experiment, but Bridgestone already has a sensor system that fulfills the need for the next experiment. We are going to use the money to pay for neutron tubes and other neutron installation expenses.

Python MySQL WINDS Model Integration with Existing Tools:

We have been focusing on the scientific validation and calibration of the WINDS model within the Excel/VBA program. With three different soils, two different crops, and three types of irrigation systems, this project has provided the opportunity to calibrate the WINDS model for a range of expected conditions. It has been challenging; however, we are making progress.

Katterman is calibrating the model for the guayule experiments and Hadiqa Maqsood is calibrating the model for the guar experiments. The major challenges are calibrating the model to match the measured soil moisture changes during the growing season to the model, calibrating the crop coefficients to observed data for each crop, integrating remote sensing data into the model, and developing an automated model calibration system so that it can be quickly deployed to farmers. Once these are completed, we will transfer the algorithms to the python WINDS model.

We are also parameterizing the AquaCrop model for guayule and guar. Hadiqa Maqsood is carrying out this work for guar and we are assisting Patrick Lohr on this work for guayule.

Irrigation Experiments – Guayule and Guar:

Field experiments were harvested at Maricopa and Eloy for the first two-year cycle. We harvested three replicates in each plot. Each replicate was three meters long. Each replicate was bagged and delivered to Bridgestone. This was a great accomplishment. It is wonderful to conduct a two-year experiment at two sites and successfully manage, monitor, and harvest the experiments at both sites. Congratulations are in order for Diaa El Shikha and Bridgestone personnel.

Diaa El Shikha continues to develop relationships between irrigation requirements, remote sensing data and plant maturity in the guayule fields. He is developing excellent graphs that show a strong relationship between NDVI and crop coefficient. While this relationship is expected, it provides a useful tool for future irrigation management with remote sensing. The team has also developed relationships between overall irrigation amount and yield. The new guayule stress irrigation experiment is being seeded at Eloy. We look forward to this new collaborative effort. Sangu Angadi and his team at Clovis have been extremely helpful to Hadiqa Maqsood in the analysis of guar irrigation. They provided yield and all field and weather

information for the 2019 experiment. It is great for Hadiqa to have two years of field data as she calibrates the irrigation and crop stress-irrigation models.

Deficit irrigation study (water stress):

Research plans are finalized; this experiment has been initiated.

Objective 5. Develop soil quality and health knowledge critical to environmental sustainability.

Task #	Description of Task	Deliverable	Target Completion Date
1 Maier/ Neilson	Chemical and physical analysis of 108 soil samples	pH, EC, OrgM, NO ₃ -N, P, K, cations, and SAR analysis complete	31 Dec 19
		Soil texture characterization complete	31 Dec 19
		Identify commercial lab for sample processing	1 Feb 20
2 Maier/ Neilson	DNA extraction of soil samples for microbiome analysis	DNA extraction from samples	1 Apr 20
		Amplicon sequencing	1 Apr 20
		Bioinformatics analysis of data generated from amplicon sequencing	1 Jun 20
		Assess spatial/temporal distributions of fungal pathogens on microbial community dataset	1 Jun 20
3 Maier/ Neilson	Soil sample collection for guayule-microbe irrigation study	Collect/archive soil samples for DNA and RNA analysis from 108 samples immediately after harvest	1 Apr 20
4 Maier/ Neilson	Winter dormancy rubber production studies	Chemical analysis of root zone soils collected; analyzed for pH, EC NH ₄ -N, bioavailable P and Organic C	31 Dec 20
		DNA extraction of guayule root zone samples	31 Oct 20
		Quantification of bacteria and fungi	31 Dec 20
		Amplicon sequencing of bacteria, archaea, and fungi	1 Feb 20
			30 Jun 20

		Statistical analysis of microbial community dynamics and associations	
5 Maier/ Neilson	Temporal microbiome analysis of community interactions	Sample F50 and F100 treatments of Eloy irrigation trial	1 May 20
		Collect temperature data	1 May 20
		DNA extraction for 215 samples	30 Jun 20
		Amplicon sequencing: bacteria, archaea, fungi	1 Aug 20
		Generate microbial community profiles and network analysis	1 Oct 20

Chemical and Physical Analysis:

Chemical analysis by Brookside labs is complete for all Year 2 (2019) soils. Kyle presented a statistical spatial analysis of field chemical properties at the UA SBAR meeting. He has all data available for any research group that requests. 2018 chemical analysis will not be completed due to issues with the NMSU analytical lab. Insufficient soils remain for analysis by Brookside although single soil properties could be analyzed as needed.

Soil texture analysis is in process. Can't be completed until UA reopens after the COVID10 closure. QC soils have been analyzed by Brookside.

Chemical assessment of 108 field samples from the MAC and Irrigation field trials was complete. Data is available to all research groups.

Table 14. Range in values for select soil chemical parameters in MAC and Eloy irrigation field trials. Data is based on 108 soil samples collected in 2019 after 1 year of quayule growth. (A) Data from MAC field trial; (B) Data from Eloy field trial. Nutrient concentrations are generally

A.	Analysis	Range	Mean	Std Dev	%CV
	NO ₃ ⁻ (ppm)	0.9 - 2.9	1.8	0.4	23
	OM (%)	0.5 - 1.0	0.85	0.09	11
	Olsen P (mg/kg)	0.5 - 9.0	4.2	2.2	52
	K (mg/kg)	117 - 310	210	39.5	19
	CEC (meq/100 g)	13.6 - 20.9	17.3	1.6	9
	Fe (mg/kg)	2.0 - 18.0	3.8	2.3	60
	Zn (mg/kg)	0.5 - 2.0	0.82	0.3	34
	Cu (mg/kg)	0.9 - 1.3	1.1	0.1	9

B.	Analysis	Range	Mean	Std Dev	%CV
	NO ₃ ⁻ (ppm)	1.2 - 5.8	2.9	0.9	30
	OM (%)	1.6 - 2.3	1.9	0.2	9
	Olsen P (mg/kg)	0.5 - 9.0	3.5	2.2	61
	K (mg/kg)	403 - 672	494	58.8	12
	CEC (meq/100 g)	29.5 - 36.4	33.2	1.6	5
	Fe (mg/kg)	2.0 - 9.0	5	1.4	29
	Zn (mg/kg)	0.4 - 1.4	0.78	0.2	26
	Cu (mg/kg)	1.7 - 3.0	2.4	0.2	9

Variation in soil nutrient level across the fields was slight; however, slight but significant treatment effects were observed for potassium, iron, copper and cation exchange capacity (CEC) at MAC and for potassium, iron and copper at Eloy. Iron and copper were highest in the D50 treatment at MAC and potassium and the CEC were highest in the F100 treatment. At Eloy, potassium and copper were highest in the D125 treatment and iron was highest for F100.

Kyle Brown worked with plant pathologist Dr. Alex Hu at UA to identify fungi infecting diseased guayule plants harvested from MAC. *Fusarium* was isolated from the roots of plants suffering root rot; however, *Fusarium* is a saprophytic fungus that can colonize and decompose plant tissue that has been compromised for other reasons. It is not necessarily a pathogen. Kyle consulted with Dr. Hu to generate a list of putative pathogens that may be of significance to guayule growth. The relative abundance of these pathogens will be monitored with plant establishment and growth across all irrigation treatments at both fields. The relative abundance of the following fungal phylotypes will be monitored for this study:

Phytophthora drechsleri
Rhizotonia solani
***Pythium* spp**
***Sclerotinia* spp**
***Maacrophomina* spp**

DNA Extraction for Microbiome Analysis:

Extractions are complete for the 108 samples collected in 2018 and in progress for the 2019 samples. Approximately 25% of the 2019 soil extractions remain to be completed. Work has stopped due to the COVID 19 closure.

Amplicon sequencing complete for Year 1 Eloy samples. Bioinformatics analysis in progress to determine microbial community metrics for bacteria, archaea, and fungi. Task has not been completed.

Soil sampling for guayule-microbe irrigation study:

Soil samples collected in March 2020 in conjunction with final plant harvest from MAC and Eloy fields. Soils will be sent to Brookside for chemical analysis when UA research labs reopen

Winter Dormancy Rubber Production Study:

This study is complete and a manuscript is in preparation with the McMahan research group. Rubber production in guayule shows strong seasonal variation. Soil samples were collected in conjunction with plant samples in November, February and April to evaluate the dynamics of soil biochemical properties that might vary in parallel with increased rubber production during guayule winter dormancy (February). Six plants harvested at each of the three time points revealed temporal and spatial variation in plant rubber content as shown in Table 15.

Table 15. Average and range of rubber concentration for six plants harvested at each of the sampling times. November, February and April represent onset of dormancy, winter dormancy and active spring growth, respectively. Rubber content is cumulative; thus, the temporal increase is indicated by the difference between consecutive values. It is significant to note that a greater than 2x spatial variability in plant rubber content was observed amongst the 6 plants sampled from different field locations in February. All plants were sampled from the D100 irrigation treatment. These results will be compared to data obtained by D. El-Shikha and D.Dierig for the irrigation field trial.

	Rubber Content (%)		
	November	February	April
Min (%)	0.65	1.05	2.39
Max (%)	0.95	2.72	2.94
Average (%)	0.79	2.16	2.72
Percent difference	39%	81%	21%

Data reported in the 2019 Q4 report showed significant temporal shifts in the soil biomass and microbial community composition that correlated with changes in plant growth stage. Biomass values were higher during winter dormancy than in November. The analysis from this quarter evaluates correlations between plant, soil chemistry and microbial community composition metrics.

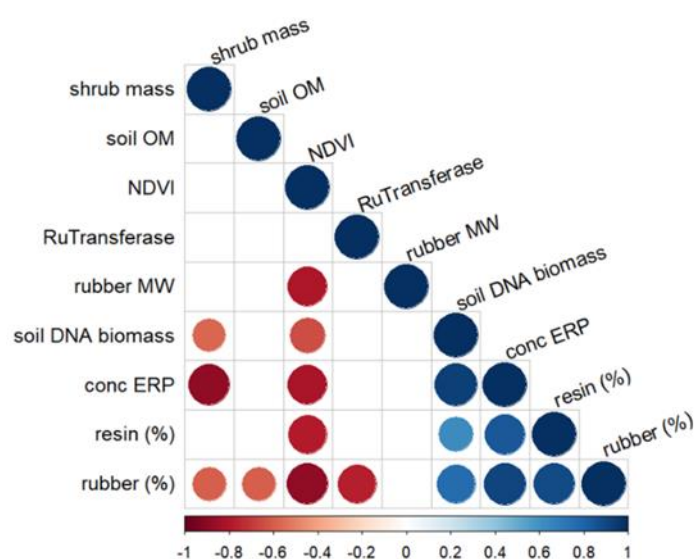


Figure 11. Correlations between soil and plant metrics were evaluated to identify potential interactions between soil health and plant productivity. Red circles represent negative correlations and blue circles represent positive correlations. The size of the circle indicates the significance of the correlation (p-value) and the color intensity represents the strength of the correlation as indicated by the gradient bar.

The results in Figure 11 indicate that plant rubber content (%) correlates positively with % resin, the concentration of extractable rubber particles (ERP) and the soil DNA biomass. In contrast, negative correlations were documented between rubber content and shrub mass, soil organic matter, and NDVI (plant vegetation index that is associated with chlorophyll content). Thus,

plant growth metrics such as plant mass and NDVI correlate with soil nutrient metrics such as organic matter; however, plant rubber content correlates negatively with plant growth, but positively with soil biomass. Since a significant increase in soil biomass accompanied by a change in microbial community composition was observed during the period of greatest rubber production, further analysis was conducted to evaluate the significance of the observed microbial community changes. A linear discriminant effect size microbial community analysis (LEfSe) was conducted to identify biomarker organisms that defined the distinct microbial communities associated with the different guayule plant growth stages.

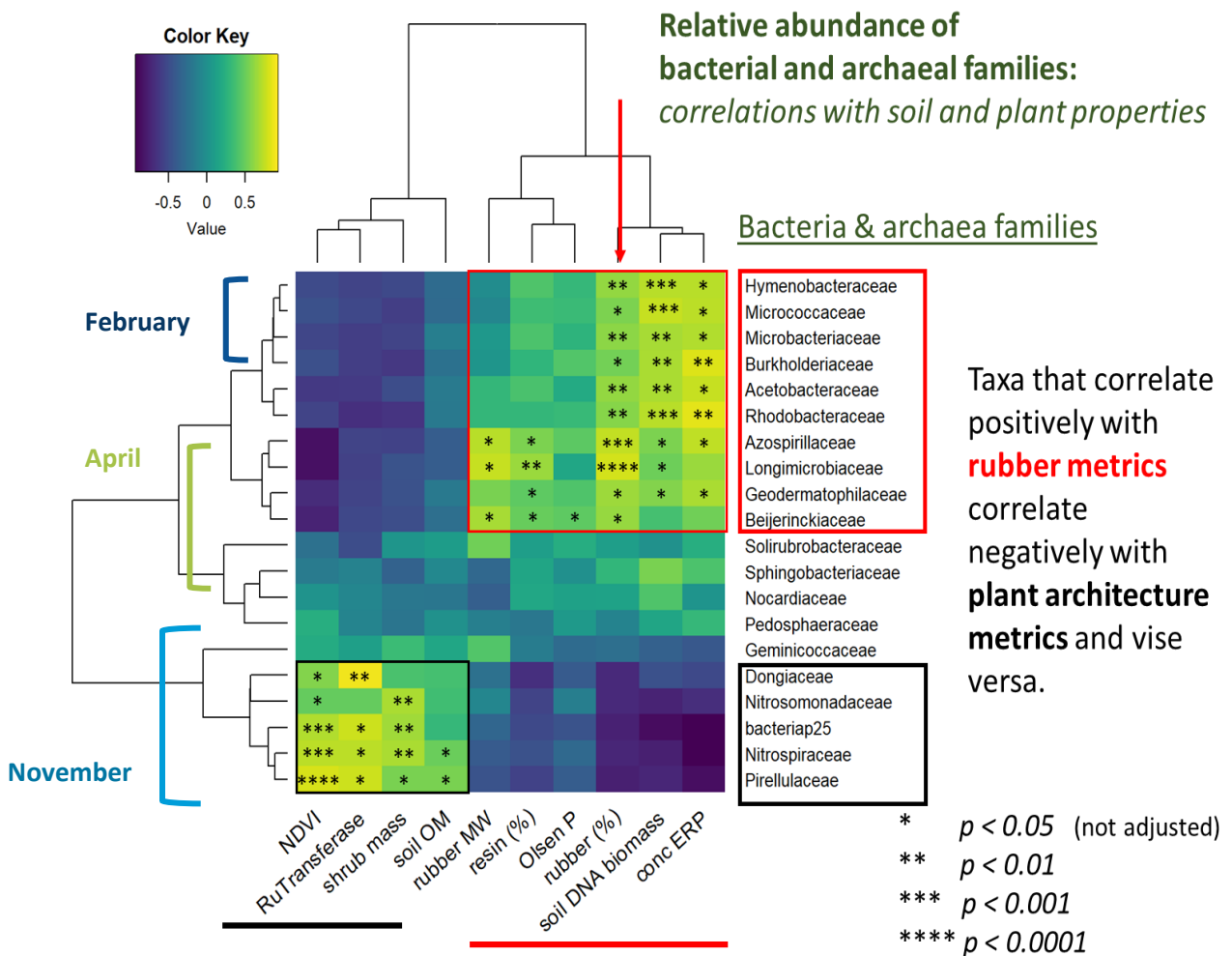


Figure 12. The specific microbial taxa that best defined the difference between the microbial communities present at the three sampling time points were identified by LefSe and are labeled on this figure. The relative abundance of four of the February biomarkers and four of the April biomarkers correlated strongly with plant rubber content and soil DNA biomass. In contrast, the relative abundance of these organisms showed no significant correlation with plant metrics or soil organic matter. Conversely, the relative abundance of five of the taxa associated with the November community correlated with growth metrics, but not with plant rubber content. Distinct putative nitrogen nutrient cycling capacities are associated with the organisms from the different plant growth stages.

One group of organisms of potential significance to rubber production are the phosphate solubilizers. Phosphate is a component of the rubber monomer and associations between bioavailable P levels and rubber production are poorly understood. The soil analysis indicates that bioavailable P levels increase with time from November to April; however, the increase is not significant. Undergraduate Jessica Ledesma, did a literature survey of putative P-solubilizing bacteria for her undergraduate thesis. She searched the amplicon sequence data base generated for this study and found significant relative abundances of a diverse group of these putative P-solubilizers. She cultured two soil samples from the MAC farm sample sites on phosphate solubilizing media (PSM) and enumerated 6×10^6 cfu/g soil P-solubilizing bacteria. Fungi capable of solubilizing phosphate were also cultured as shown in Figure 13. She isolated the putative P-solubilizers and intended to identify them by sequencing the 16S rRNA gene, however, the COVID closure has prevented this part of her research.

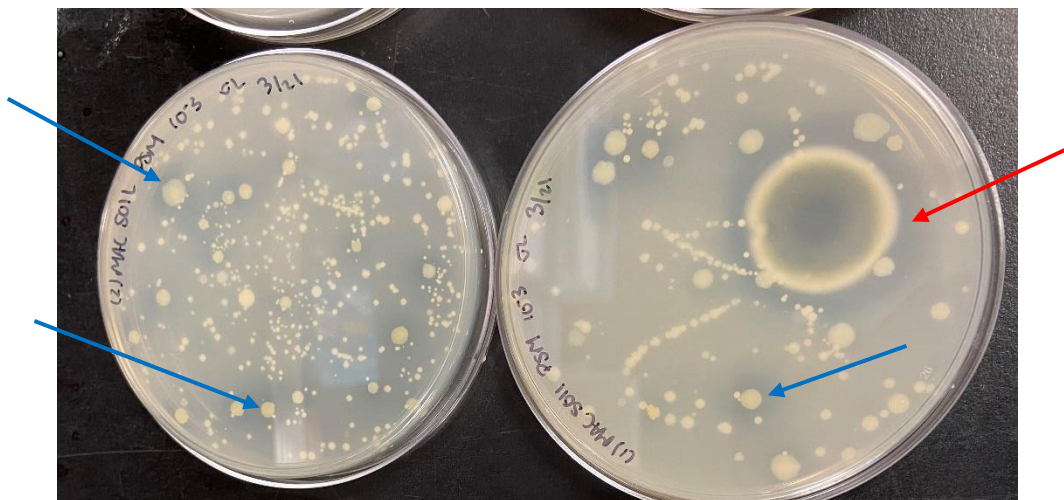


Figure 13. Bacterial (blue arrows) and fungal (red arrow) colonies surrounded by a clearing zone indicate organisms capable of solubilizing phosphate. The abundance and diversity of these organisms in the MAC farm soils suggests that further research should be pursued to evaluate correlations between microbial P-solubilizing capacity and activity and guayule rubber production.

Temporal microbiome analysis of community interactions:

The significant patterns observed in the Winter Dormancy study, led postdoc Yongjian Chen to design a more extensive study evaluating soil microbiome community dynamics associated with guayule growth stage. Samples were collected monthly from August 2019 to May 2020 from the flood 100 and flood 50 irrigation treatments at the Eloy farm. The sampling period included transitions from active plant growth in August/September through the onset of rubber transferase production in November and winter dormancy (Dec – February). The final samples will be collected when the plants begin flowering in April/May 2020 to indicate a return to active growth.

CHARACTERIZATIONS & CO-PRODUCTS

Project Coordination: Following group discussions, it was decided in February to rename this component to “Characterizations & Co-Products” because the tasks associated with post-harvest logistics were moved (a better fit) to the System Performance & Sustainability Component. All of the remaining objectives and tasks are related to biochemical characterization of molecules and identifying possible uses of those molecules or components.

The Characterizations working group meetings are hosted by NMSU once monthly, and led by Dr. Catherine Brewer. During these meetings, progress reports for all component tasks are provided by team members, issues and challenges are discussed for resolution, and specific tasks are integrated where possible. Data exchange is accommodated via a shared access folder online, and meeting minutes are maintained as a reference.

Issues/Risks:

Brewer: With respect to the lab-scale supercritical CO₂ extraction instrument, we were informed in January that Waters was discontinuing their line of supercritical fluid extractors. Rather than purchase a piece of equipment for which support would soon be unavailable, we sought other options that allow us to meet overall goals while maximizing resource synergies for the near and long-term. In that search, we learned of two pieces of equipment for supercritical fluid extraction (SFE), in uncertain levels of functionality, that a recently-retired faculty member in the Department of Plant & Environmental Sciences had put into storage. We also learned that no other company makes an SFE extraction system at this small of a scale for analytical sample preparation; nearly all SFE units are bigger and designed for production, or the companies only sell specific parts (e.g. high-pressure pumps) that can be used to construct an SFE system.

With feedback from the SBAR leadership team, we decided to use the \$50k from SBAR towards labor and parts for re-construction of a functional SFE instrument from the parts that we have. Dehghanizadeh was able to locate the software needed for one of the instruments that had been missing and is working with the company on completing the control system reconnection.

On March 13, the NMSU administration ordered that all laboratories be locked down with the exception of those that requested and received specific permission to continue essential activities (care for plants/animals, maintenance of sensitive equipment, etc.). Since that time, all laboratory work on the project has stopped. This closure will delay analyses, re-building and testing SFE equipment, preparing and characterizing guayule resin fractions, and conducting insect repellency trials (the urban entomology lab staff are allowed to maintain insect populations but not to start any new experiments). Rosalez and Knagg are expected to be able to complete MS and senior thesis requirements for graduation this spring/summer based on the data already obtained. We anticipate a return to laboratory operation in time to get the last co-HTL characterization data to prepare the manuscript by the target deadline. If the laboratories are still closed by Q3, we anticipate further delays.

Gunatilaka: As a result of UA mandated COVID-19 response, all laboratory operations had to be halted on March 16, 2020, hindering progress of this project. However, the postdoc and research technician involved in this project will be working from home analyzing their data and preparing reports and manuscripts.

Holguin: COVID-19 guidelines allowing only essential activities to continue has delayed our research activities. We are hopeful to catch up once restrictions are lowered by the end of Q3 (<6-month delay). We previously reported that a gas chromatography (our primary instrument for metabolomics work) was nonfunctional. The instrument has been evaluated and parts have been ordered and are on the way (<6-month delay). The Holguin lab's laboratory manager overseeing chemical analysis has resigned. We have received approval for a replacement and anticipate hiring soon. Interviews are currently being completed; hiring is anticipated to be complete by the end of Q2 (<6-month delay).

Ogden: COVID19 Issues – focusing on writing however all analytical work to evaluate adhesive structures and to analyze distillation fractions is on hold as are distillation experiments. Bridgestone in Ohio is also closed and they are doing some of the analytical work for us. The University of Arizona including the laboratories is closed for students, and employee's safety. It is hard to predict how long the university will be closed. The experiments are postponed. We will try to catch up once the university is open.

Objective 1. Evaluate how seasonality, processing, and storage affect product quality, conversion efficiency, and economics.

Task #	Description of Task	Deliverable	Target Completion Date
1 Holg	Biochemical composition analysis of guayule and respective products	Metabolomics and lipidomic assessment during abiotic stress and adaptation	31 Aug 20
		Generate 2 nd manuscript on metabolomics cold adaptation/ pathway regulation	31 Aug 20
		Generate manuscript on high resolution mass spectrometry analysis of guayule resin	31 Aug 20
2 Holg	Biochemical composition analysis of guar and respective products	Develop standard operational methods to characterize polysaccharide composition of purified guar gum	31 Aug 20
3 Holg	Analytical evaluation of thermochemical conversion products	Complete composition information and sample extracts	31 Aug 20
		Contribute to manuscripts	31 Aug 20

Guayule Biochemical Composition Analysis:

We continue to perform biomass characterization methods with Dr. Brewer's group on bagasse and resin material. Dr. Jarvis has acquired positive- & negative-ion ESI and positive-ion APPI FT-ICR mass spectra of the whole resin, the nonpolar fraction, and polar fraction of the resin as well as HTL biocrudes generated from guayule bagasse and algae. Dr. Jarvis is still working on

processing the data and generating images and reports of results to be worked into future publications. Revisions for the first paper detailed FT-ICR MS analysis of guayule resin were submitted to *Industrial Crops & Products* and the final version is now published.

We are to perform High Temperature GC-TOF MS and LC-TOF MS/MS followed by NIST library spectra matching, which has been delayed to do instrumental issues that we had hoped to resolve early in Q1. The GC portion has been delayed due to COVID-19 complications in shipping.

Mr. Sergei Shalygin has been assigned to work on the resins along with Dr. Jarvis and Mr. Dehghanizadeh. Resins for the LC-TOF MS/MS were resuspended in the toluene/methanol solution in proportion 60/40. A Waters Ultima mass spectrometer was tuned for accuracy in order to more efficiently identify resin's compounds. Draft direct infusion experiments are being used to optimize voltages to achieve the best fragmentation patterns. In addition, software MSDIAL has been connected to the NIST library with approximately 600,000 known compounds (MS/MS spectra). MSDIAL was installed to the supercomputer and is ready to be used for the search against a large reference library. We were still in the optimization stage when our COVID-19 guidelines were implemented.

Guar Biochemical Composition Analysis:

We have isolated *Rhizobium* from nodules of guar plants grown at NMSU: Leyendecker Plant Science Center and Fabian Garcia Science Center and performed the sequencing.

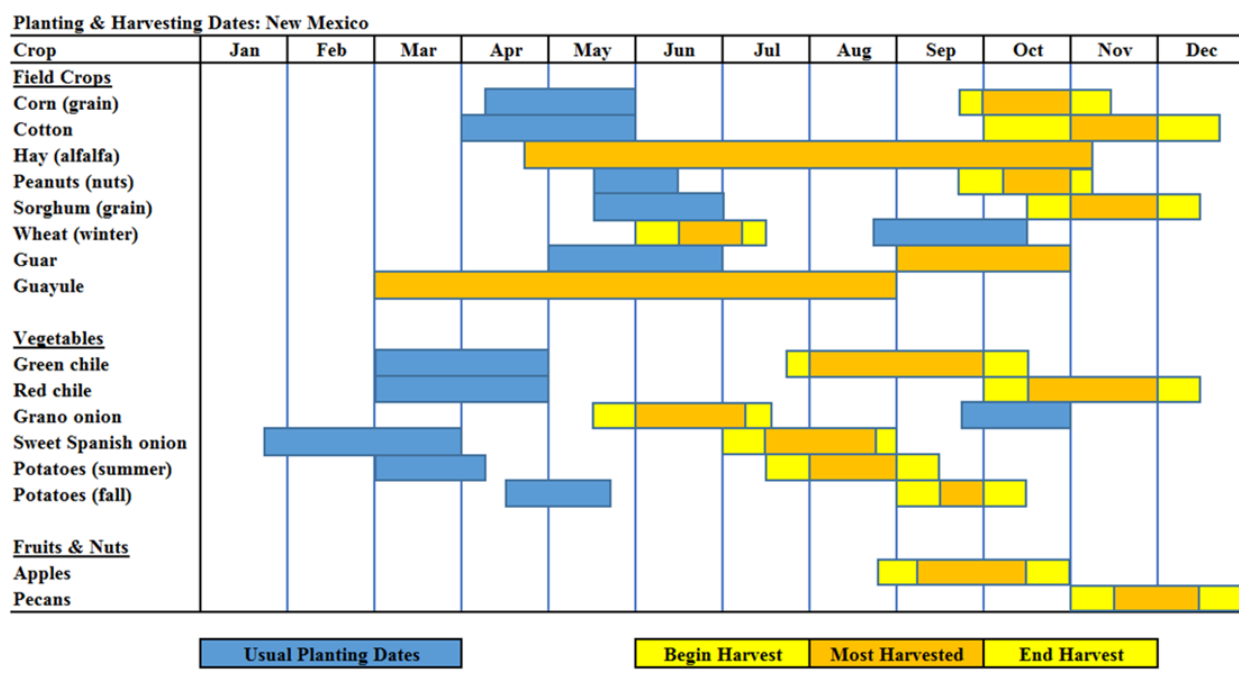
- Genomic DNA was isolated from *Rhizobium* from both types of nodules.
- The 16S ribosomal gene was amplified from *Rhizobium* genomic DNA and sequenced.
- *Rhizobium* was identified for the determinate nodules and is being identified for the *Rhizobium* found in indeterminate nodules
- Five *Rhizobia* species were identified within the guar plants grown in Fabian Garcia : *Rhizobium azibense* 23C2, *Rhizobium* sp. AC93c, *Rhizobium* sp. T1Gsb2, *Rhizobium* sp. Cap_B1, and *Rhizobium pakistanense* BN-19.
- Three species of nodule associated bacteria identified: *Pseudomonas*, *Bordetella*, and *Agrobacterium*.
- **This research has been completed!**
- **The results of this project were submitted to SBAR for the project highlights on the SBAR webpage in March. (Posted 3 April 2020)**

Analytical Evaluation of Thermochemical Conversion Products:

Metabolomics and Biochemical Analysis – We have also continued our work with Dr. Von Mark V. Cruz and Dr. David Dierig on characterization of cold adaptation of guayule leaf material. Ms. Ujala Sehar has joined the previous quarter. She has begun processing the metabolomic samples. This work has been delayed due to COVID-19 guidelines to carry out only essential work. However, the identification of the metabolic biomarkers in two guayule germplasms responsive to cold-acclimation and freezing has been completed. Pathways analyses of these metabolic biomarkers are currently in preparation.

Publications – Ms. Kelly Laje is currently addressing co-author edits and comments for the final draft publication “Natural Products in the Desert Southwest: Guayule (*Parthenium argentatum*)

and Guar (*Cyamopsis tetragonolobus*).” Final revisions for figures, along with formatting according to American Phytopathological Society guidelines for authors, is nearly complete. This publication will be ready for submission to the “Plant Management Network” by the end of April, 2020. Below is figure from the manuscript indicating a crop rotation strategy for New Mexico crops including guar and guayule.



Planting and harvesting dates of common New Mexico crops; revised and adapted from New Mexico MEP Agriculture Review, 2018. Guayule and guar have been added to the figure to demonstrate its value as a rotation crop against other commonly grown crops in New Mexico.

Figure 14. Example figure from publication that is currently in process.

Objective 2. Demonstrate feasibility of farm to fuel conversion of bagasse.

Task #	Description of Task	Deliverable	Target Completion Date
1	Prepare 2 manuscripts on guayule/guar bagasse composition, biomass-to-conversion method matching (HTL product yields)	Manuscripts prepared	31 Aug 20
Brewer		Manuscripts submitted for peer-review process	31 Aug 20

Manuscript Preparation:

The review article manuscript on pyrolysis conversion of low-cost, higher-nitrogen biomass residues was published in *Journal of Analytical & Applied Pyrolysis*. The original research manuscript on guayule bagasse and resin characterization, including some of the high-resolution FT-MS data for resin composition, was published in *Journal of Industrial Crops & Products*; the accompanying article for *Data-in-Brief* is currently under review.

Objective 3. Identify economic co-products in guayule and guar, e.g., biologically active components.

Task #	Description of Task	Deliverable	Target Completion Date
1 Brewer	Prepare manuscripts on low-cost biomass conversion methods review, and co-HTL of guayule bagasse and algae.	Prepare manuscript; Submit manuscript to peer review journal	31 Mar 20
2 Brewer	Perform separations and fraction characterization of guayule resin	Purchase supercritical solvent extraction system	31 Aug 20
		Perform liquid-liquid, accelerated, and filtration separations	31 Aug 20
		Prepare manuscript of guayule resin separation	31 Aug 20
3 Gunat	Chemical and microbial transformations	Develop chemical and/or microbial methods for the conversion of guayule by-products into value-added products	31 Dec 19
4 Gunat	Evaluate major metabolites of guayule	Evaluate transformation products of argentatins A, B, C for potential anticancer/antimicrobial activities	30 Apr 20
5 Gunat	Isolate and characterize major metabolites of guayule terpene solution	Identify metabolites within solution that can be converted to value-added products	31 Jul 20
6 Ogden	Evaluation of major fractions of guayule resin	Recommendation of potential products that can be separated from resin fractions	31 Aug 20
7 Ogden	Cost analysis of potential resin products	Initial incorporation of resin products into TEA	31 Aug 20

Prepare Manuscript on Low-Cost Biomass Conversion Methods:

Dehghanizadeh continued work with the Quinn group at CSU on the guayule resin composition and application review manuscript with economic information to help down-select target value-added applications. That manuscript is now expected to be submitted in Q2 in 2020. Two applications identified for evaluation are polymer tackifiers/modifiers and pesticides. Quinn's group supplied presentation slides for the upcoming Post-Harvest Logistics and Co-Products advisory board meeting, scheduled for April 29.

Dehghanizadeh and Knagg, in collaboration with Romero Alvero's group at NMSU, designed and conducted a preliminary avoidance experiment with cockroaches using arenas with applications of diluted whole guayule resin. Results indicated no effect at the applied concentration. Assuming that higher concentrations of certain compounds is needed to observe avoidance behavior, they created three fractions of guayule resin for testing: fatty acid-rich,

defatted, and low-molecular-weight rubber-rich. Knagg prepared a draft of her senior honors thesis incorporating the background information and results of the cockroach studies to date.

Separations and Fraction Characterization of Guayule Resin:

Rosalez continued his work on algae + guayule co-HTL conversion product characterization and on preparation for his thesis defense in Q2 of 2020.

Chemical and Microbial Transformations:

Our previous work suggested that 2-amino pyrimidine analogues (**1** and **2**) to exhibit moderate cytotoxicity against NCI-H460 (non-small cell lung cancer) and MCF-7 (breast adenocarcinoma) cell lines (see Quarterly Report Q3 of 2019). Therefore, it was of interest to prepare additional analogues of **1** and **2** for possible improvement of their potential anticancer activity. For this purpose, moderate scale reactions were carried out resulting in analogues **1** and **2** in reasonable overall yields (Figure 15). These analogues will be used for further derivatization and/or analogue preparation.

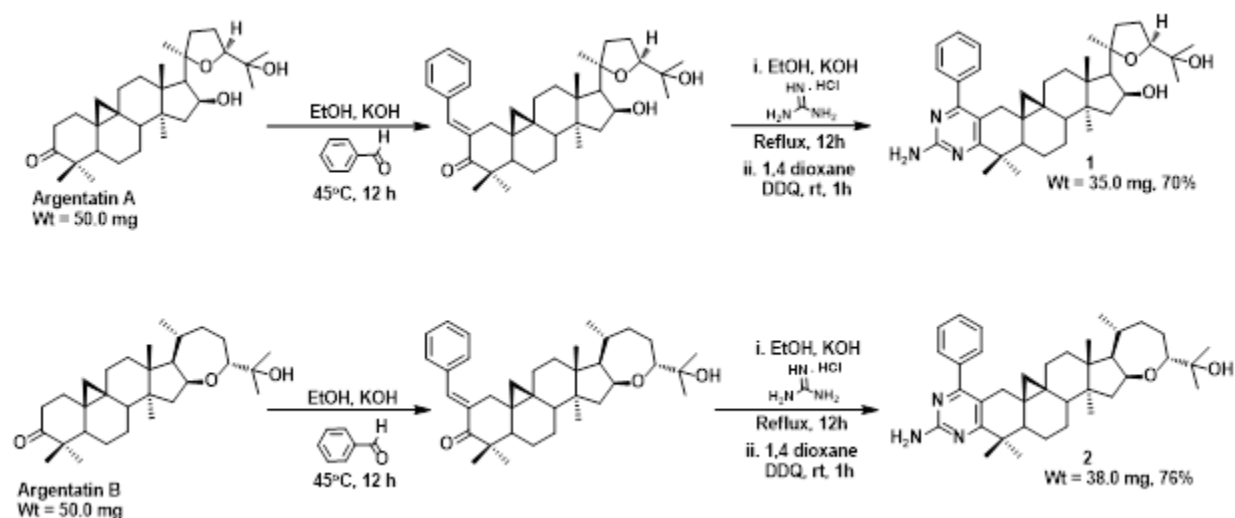


Figure 15. Semi-synthesis of 2-amino-pyrimidine analogues (**1** and **2**) of argentatins A and B.

Evaluate Major Metabolites of Guayule:

The work on isolation and structure elucidation of new constituents of guayule resin has been completed and a manuscript describing this work will soon be submitted to *Journal of Agriculture and Food Chemistry*. Another manuscript describing semi-synthesis and biological evaluation of some heterocyclic analogues of argentatins A and B is currently in preparation.

Isolate and Characterize Major Metabolites of Guayule Terpene Solution:

Chemical work on guayule terpene solution (20.0 g) led to the isolation of partially pure γ -eudesmol (5.3 g), argentatin B (1.5 g), argentatin A (1.2 g), and pure carissone (10.0 mg, Figure 16) together with a complex mixture of other inseparable compounds (10.6 g). This result suggested that guayule terpene solution is rich in γ -eudesmol, a sweet tasting compound found to occur a number of food items such as rosemary, ginkgo nuts, mango, and common thyme.

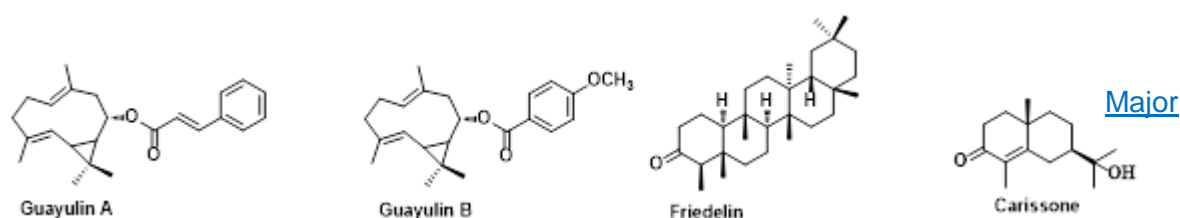


Figure 16. Structures of chemical constituents other than argentatins isolated from guayule resin samples.

Work on isolation and characterization of major metabolites of guayule resin was carried out with a large quantity (32.0 g) of the polar resin sample recently received from Bridgestone. This led to the isolation of the major constituents, guayulin A (865.0 mg, 2.7%) and guayulin B (660.0 mg, 2.1%) together with a minor metabolite identified as friedelin (27.0 mg) (Figure 16). We are currently in the process of attempting chemical and microbial transformations of guayulins A and B to obtain potentially value-added coproducts.

Fractions of Guayule Resin:

Sarocho is working on writing manuscripts related to adhesives and particle board from guayule resin and bagasse. A draft of the first paper was sent to Bridgestone for review and discussion. There is some analytical work that is required prior to publication that will be complete when laboratories open again. We will be working on filing a disclosure with Tech Launch as well.

Cost Analysis of Potential Resin Products:

Andrew has developed a set up for fractionating the resin using vacuum distillation. It was tested with oil and Bridgestone came for a visit to the laboratory to discuss how best to operate the system. One distillation run has been completed, but further experiments are on hiatus. (Figure 17) Eleven different fractions were obtained from the resin with volumes ranging from 0.3 to 9 mL. The largest fraction being primarily solvent. Bridgestone will analyze the collected fractions for content and purity when their lab reopens. In the meantime, Andrew is focusing on thesis writing, literature research, and modeling Collaborating with Jason and Catie on the incorporation into TEA and this is going well.

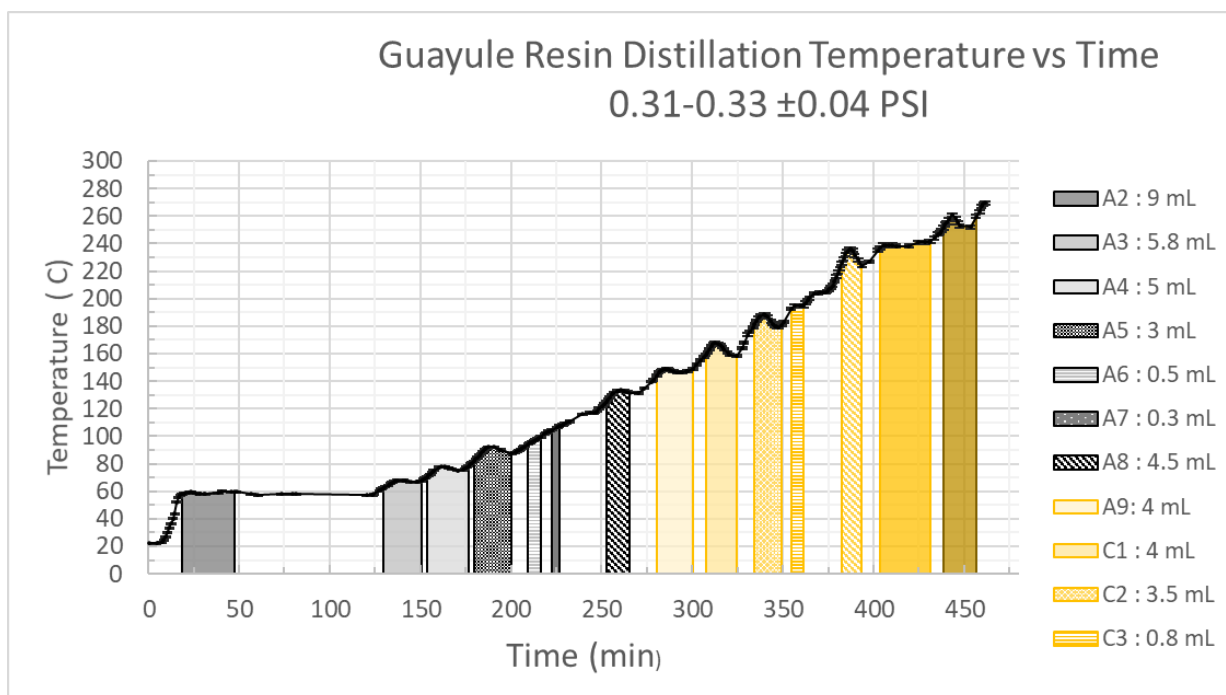


Figure 17. Results of the distillation of guayule resin under pressure (0.32psi).

SYSTEM PERFORMANCE & SUSTAINABILITY

Project Coordination: Colorado State University (Dr. Jason Quinn) leads the bi-monthly working group webinar/phone calls. The meetings are leveraged to ensure all team members are on schedule and work can seamlessly integrate across institutions. The structure for the team meetings has been alternating between team updates and deep-dive presentations by individuals across the team. The focus this quarter has been:

- Developing and presenting results to the Advisory Board
- Submission of manuscript on guayule
- Refinement of the integrated model
- Model integration across the sustainability team focused on validation and improved fidelity
- Development of a publication on guar
- Development and moderation of sustainability team meetings on a bi-monthly basis in support of model integration and data integration
- Preliminary investigation of resin economic potential
- Developed web content for spotlight section on SBAR website (published 13 March)

All notes and presentation materials are maintained in a community workspace available to all partners for future reference.

Issues/Risks:

Fan: The optimization model's input is a key component. Therefore, even though the information was taken from the literature review or publicly available information from some official websites, the opinion of experts is always recommended. Feedback and comments from the System Performance and Sustainability Team and the UA Research Group are highly valuable to achieve the deliverable of Tasks. The model and results will be updated and included in the paper. Additionally, there's no optimization research for modeling the farmers' perspective. Therefore, an extensive literature review in the engineering databases (e.g. AccessEngineering, ScienceDirect, Springer) will be performed. As for the analysis of the future guar area, further meeting will be scheduled with Dr. Angadi and SBAR researchers from New Mexico to identify the input required for the optimization model.

Landis: Scheduling one-on-one meetings with the leaders of the field trials in order to get a better idea of trial scheduling and to encourage data sharing was beneficial. Though there has been a bit of delay in some of the planned data transfer dates due to the global COVID-19 pandemic. I will be emailing to get updates on data transfer plans.

Seavert: Depending on the timeline of the COVID-19 pandemic, meeting with producers may need to be postponed in this reporting year.

Objective 1. Develop a scalable engineering process model for crop production and processing that is coupled with Techno-Economic Analysis (TEA) and Life Cycle Analysis (LCA) to understand the economic impact to rural communities through input-output methods.

Task #	Description of Task	Deliverable	Target Completion Date
1 Gutierr	Functional integration of economic analysis into system model	Gather information for farm level scenarios using different avg. farm sizes, irrigation, and acreages	31 Aug 20
		Conduct input/output analysis of system model results	31 Aug 20
		Validate preliminary analysis for farm production and profitability	31 Aug 20
		Generate publication on the economic analysis for guar and guayule	31 Aug 20
2 Gutierr	Initiate development/testing of online producer systems model	Create online tool for evaluating guar/guayule alternative crops	31 Mar 20
3 Landis	Field data transfer	Develop SOP/protocol for transferring field data to LCA team in useful formats	31 Dec 19
4 Landis	LCA first order model	Journal publication submitted for 1 st order LCA	31 Mar 20
5 Landis	Integrate current field data into LCA/TEA model	Update LCA/TEA model inputs with field data; identify new scenarios	31 Aug 20
		Manuscript generated and submitted to peer review journal	31 Dec 20
6 Landis	Sensitivity and scenario analysis	LCA Scenario Analysis complete	31 Aug 20
7 Quinn	Techno-economic and Life Cycle Assessment results	Update/finalize economic and environmental impact results	1 Aug 19
8 Quinn	Data integration	Integrate experimental data into foundational processing model	31 Aug 20
9 Seav	Validated integrated model	Update and incorporate new information under various scenarios	31 Aug 20
10 Seav	Diversify integrated model for broader audience	Incorporate returns/costs of additional crops into integrated model	31 Aug 20
11 Teeg	Facilitate working agreement between Tribal Farms and Bridgestone to establish experimental plots	Signed agreement established between Gila River Farms and Bridgestone	31 Aug 20

		Experimental plots established on Tribal lands	31 Aug 20
12 Teeg	Validated integrated model	Update and incorporate new information under various scenarios	31 Aug 20

Functional Integration of Economic Analysis into System Model:

The goal of identifying farm level inputs to be used in the integrated systems model was accomplished. The first draft of the farm-level economics has been integrated into the systems model. NMSU has been in collaboration with OSU and UA in developing the farm level model. The whole farm-level economic analysis has been successfully developed for integration into the system model. Identify crop mix and potential acreage of crops in southern NM counties.

- Analyze potential acreage for the adoption of guar and guayule at 10%, 15%, and 20% adoption rates.
- Validate preliminary analysis; finalize the farm-level analysis

Online Producer Systems Model:

The enterprise budgets dealing with costs and returns and narrative detailing the agronomic and cultural practices in the production of guar and guayule have been developed in draft form and are under the peer review among SBAR teams. Also, sensitivity analysis associated with net returns of guar and guayule production has been designed with varying costs, yields, and price per pound of dry matters from our key assumption.

Field Data Transfer:

Mealing has met with all the PI's leading field trials and has collected data sets from them and/or set an expected timeline for when they will be able to share data. Converting the data sets various formats to useful excel format for the integration continues as the data is received. Continued thanks to the support of the sustainability team and all field trial collaborators.

First Order LCA Model:

Manuscript for First order LCA model of guar agriculture from literature is submitted (*Industrial Crops and Products*) and under review.

Integrate Field Data into LCA/TEA Model:

Mealing gave a presentation to the sustainability team on updated progress of field data collection and integration. Continuing to work on organizing data, in order to utilize in integrated model. As data continues to be collected, integration methods are being explored.

Sensitivity and Scenario Analysis for Integrated Model

Nothing new to report.

Techno-economic and Life Cycle Assessment Results:

A variety of efforts were perused as a part of this task with a summary presented below:

Model Integration: CSU continues to lead the integration effort with the development of a modeling framework to support the integration of the research across all research groups. This effort includes directly working with Clark Seavert on updating the agricultural economics. As previously reported, an integrated model has been developed and the CSU team continues to

work with collaborators in improving the fidelity of individual components of that model. CSU continues to lead the LCA and TEA components of the modeling work.

Guayule: The integrated model served as the foundation for the generation of results for the manuscript that is currently in peer review. CSU lead the effort of pulling together this publication. As a part of the publication development, various errors in the model were identified and fixed. This included updating the agricultural economics, transportation, and processing. A significant effort was made to understand the impact of co-product economics with more information present below.

Resin Work: Co-products have been identified as a critical aspect to the economic viability of the guayule biorefinery concept. The bagasse represents a very known quantity with minimal opportunity for improving the value of this co-product. The resin represents a significant unknown in terms of value. This quarter the CSU team focused on understanding the potential and the corresponding impact of improving the resin value. The results from this work show guayule resin realistically has an estimated value ranging from 0.1 to 6.8 \$/kg depending on the co-product targeted. Of the various potential end uses the following were identified as targeted: domestic pesticides, paints and coatings, wood preservative coatings, amine-epoxy strippable coatings, and adhesives. These five were identified out of the many based on a combination of high economic value and moderate market size. This data has been provided to various team members.

Guar: Work this quarter has focused on obtaining data for the guar model and building appropriate functionality in preparation for the submission of a manuscript. Efforts are focused on input data accuracy and validation of results. In preparing this work, various errors were identified and fixed, improving model quality. Furthermore, communication between the SBAR sustainability team and Guar Resources was established and we are working to validate portions of the integrated model.

Data Integration:

Experimental data integration represents a critical need for the sustainability team. In collaboration with CSM the agricultural partners have been contacted and we are continuing to work on a format to facilitate the seamless integration of experimental data for model validation. The current hurdle is data collection. As mentioned in the section intro, a standing agenda item is data. This standing agenda item is intended to keep CSM on task and identify issues with partners that can be overcome.

Validated Integrated Model:

Updating the integrated models for guayule and guar by validating machine operations and continuity of output between guar and guayule models.

Diversify Integrated Model for Broader Audience:

Updating the integrated models with incorporating the costs and returns of fallow and three hemp crops – oil, seed, and fiber.

Facilitate and Foster Relationship between Tribal Farms and Bridgestone:

Continue to assist in securing experimental plots on at least two tribal farms. 1) Connect Bridgestone and CRIT farms for experimental acreage agreement, establish introduction meeting and started contract negotiations 2) Connecting Bridgestone and Fort McDowell Farm or Ak Chin Farms for experimental acreage agreement. Started the conversation, but still trying to establish an agreement that will work for both parties. This is a long process and will take some time to complete.

Validated Integrated Model:

Continue enhancement to the farm level scenarios using different average farm sizes, irrigation technologies, and add in different crops into the mix for both New Mexico and Arizona.

Objective 2. Integrate regionally appropriate metrics and combine results from SBAR-developed data into sustainability models to provide a path to commercialization of biofuels and bioproducts.

Task #	Description of Task	Deliverable	Target Completion Date
1 Quinn	Downstream process modeling	Integrate downstream process modeling	1 Nov 20
2 Quinn	Scenario analysis	Generate results of scenario analysis Present results of scenario analysis at conferences for feedback	1 Feb 20 28 Feb 20
3 Quinn	Stochastic modeling	Evaluate system at a system level through Monte Carlo sensitivity modeling	30 Jun 20

Downstream Process Modeling

Research continues as planned; nothing new to report.

Scenario Analysis:

Research continues as planned; nothing new to report.

Stochastic Modeling

Research continues as planned; nothing new to report.

Objective 3. Interface with regional growers to de-risk US production of guayule and guar while evaluating social impacts.

Task #	Description of Task	Deliverable	Target Completion Date
1 Landis	Clarify social sustainability metrics	Develop overview of sustainability tools and list of potential metrics	30 Nov 19
		Generate publication/presentation for conference proceedings	30 Apr 20
2 Landis	Social sustainability	Collect data from annual SBAR meeting	31 Dec 19
		Data analyzed and report drafted	31 Aug 20

Clarify Social Sustainability Metrics:

Review to identify appropriate indicators of SBAR areas of interest from current literature continues. A manuscript will not be submitted, but a draft will be complete by the target completion date.

Social Sustainability:

Nothing new to report.

Objective 4. Develop and optimize system-level logistics models for demand-driven harvesting.

Task #	Description of Task	Deliverable	Target Completion Date
1 Fan	Comprehensive sustainability and economics analysis	Conference presentation	31 Mar 20
		Manuscript submitted to peer review journal	31 Mar 20
2 Fan	Apply integer optimization approaches to design smart farm production plan/ scheduling	Manuscript submitted to conference/ journal summarizing research	31 Aug 20
3 Fan	System-level model/algorithm generation for decision support for guar and guayule	Preliminary results shared during project component team meetings	31 Aug 20
		Data/model/algorithm shared for Yr4 research (integration of 3 decision modules)	31 Aug 20

Comprehensive Sustainability and Regional Economics Analysis:

In Quarter 1 of 2020, based on the most likely crops to switch to Guayule – cotton, grains, and oilseeds, (CGO), the optimal processing facility location was identified for Guayule in the counties of Maricopa and Pinal, AZ, as shown in Figure 18. Additionally, the county of Dona Ana was also analyzed to identify the optimal processing facility location for Guar (Figure 19). Furthermore, the expected guayule and guar productivity for each of the CGO group farms was identified as well. The transportation routes from farms to optimal facility were also identified through our models and algorithms.

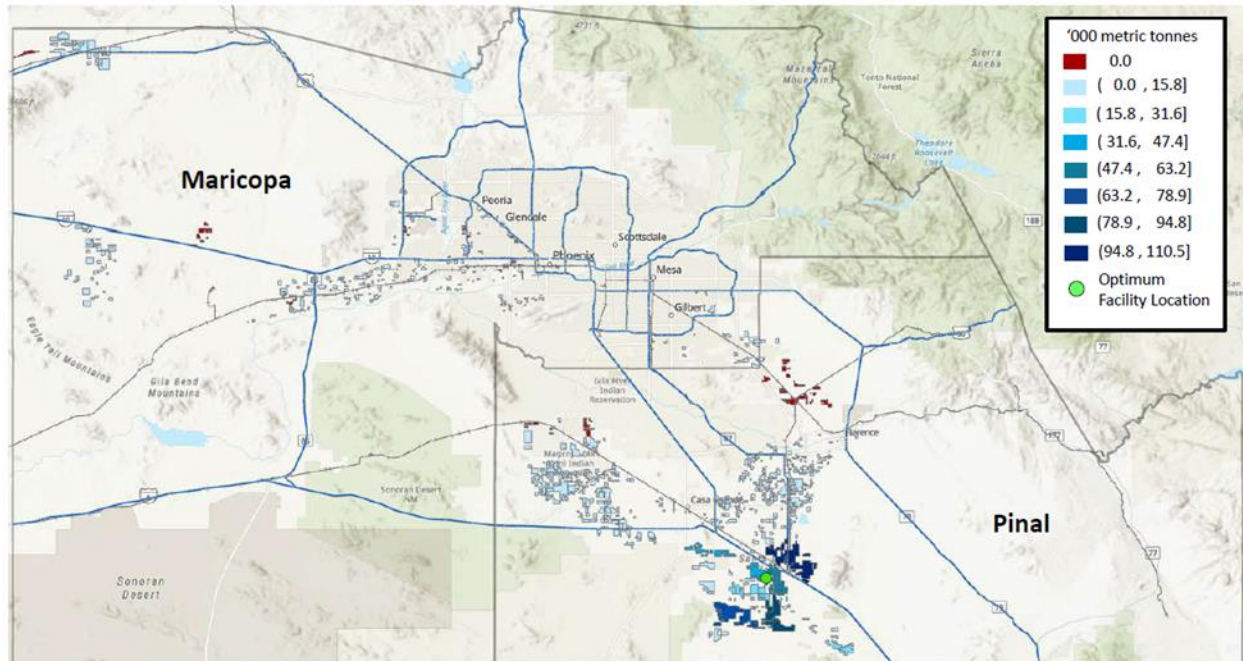


Figure 18. Expected guayule productivity from Maricopa and Pinal Counties' CGO farms.

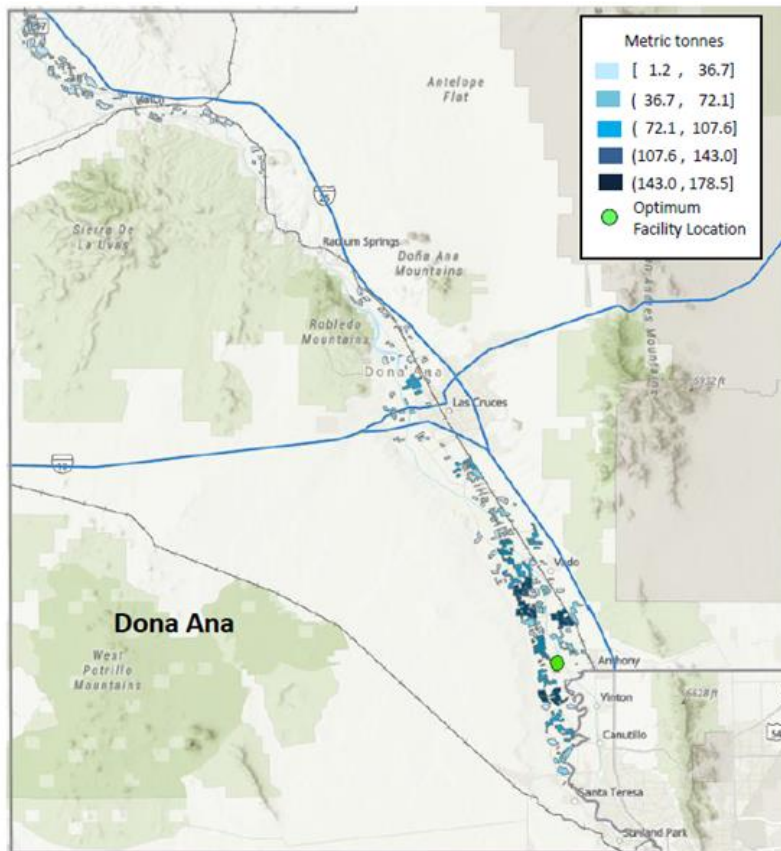
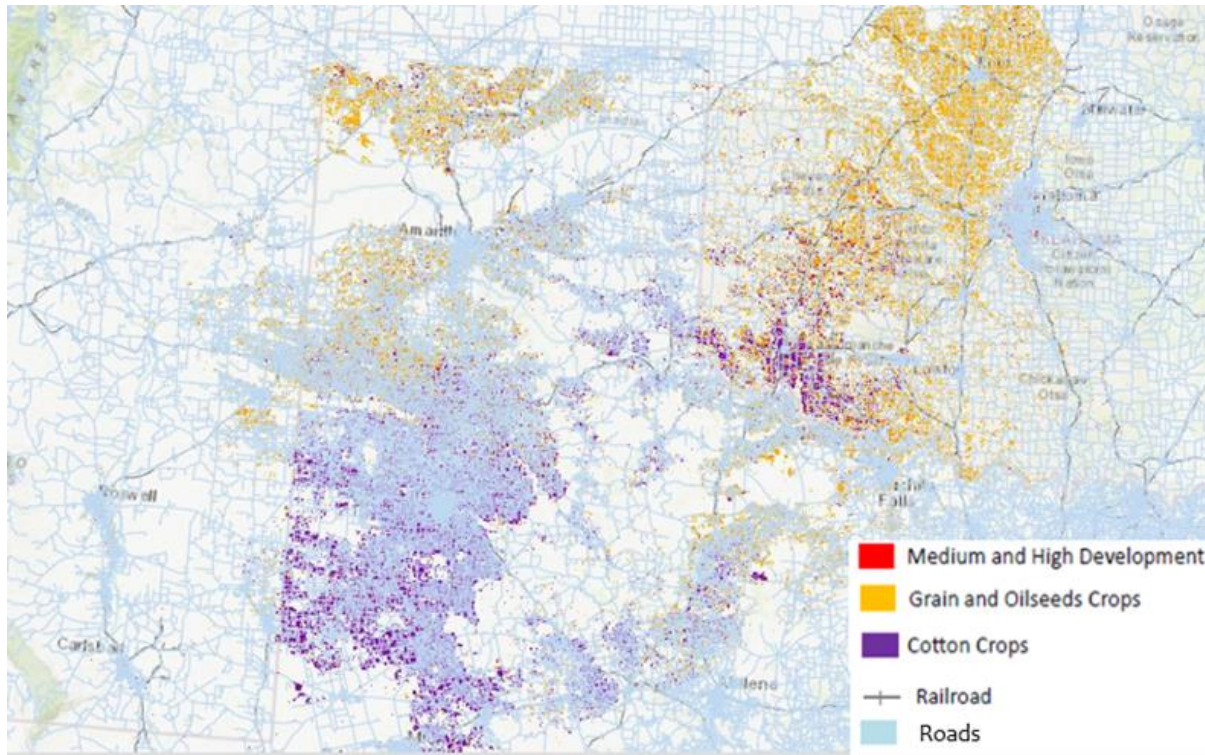


Figure 19. Expected guar productivity from Dona Ana County's CGO farms.

Based on a meeting with the System Performance & Sustainability team and Guar Resources, work has also been done on an initial analysis of the “Future Guar Area,” as defined in Figure 20. This area includes the eastern part of New Mexico, the northern part of Texas, and the western half of Oklahoma. Additional information input is being gathered to run the optimization model for such area.



Integer Optimization Approaches for Smart Farm Production/Scheduling:

The literature review continued, and several models were analyzed to determine which optimization approach is the best fit for the smart farm production planning and scheduling model. This research will also include the farmers' perspective to identify their optimal crop adoption. Further literature is required to include the former aspect into the optimization model.

System-level Model/Algorithm for Decision Support:

Feedbacks from the presentations to the Sustainability Meeting Group and the UA Research Meeting Group have been implemented and proper changes have been made to the optimization models. A review of the model's input was performed, and the data was updated accordingly. All optimization models are coded using the programming language C++, the solver CPLEX, and the high-performance computing (HPC) Ocelote or SIE Dragoon server from the University of Arizona.

EXTENSION & OUTREACH

Project Coordination: Dr. O. John Idowu (New Mexico State University) and Blase Evancho (University of Arizona) continue to serve as the co-leads for the Extension & Outreach working team. When the larger Education and Extension & Outreach components jointly meet, Dr. Idowu and Evancho work with Dr. Chavarria to draft meeting agendas. Cara Duncan (UA) has been tasked with coordinating meeting details and ensuring that notes are captured and maintained in the Box folder for future access/reference.

The Extension & Outreach team has two main foci – youth development (through 4-H activities and STEM mini-camps), and grower education/outreach. These two sub-groups meet at least once per month to discuss tasks and to improve component integration. The combined Education and Extension & Outreach teams meet once monthly to provide updates and address larger concerns regarding over-arching tasks that facilitates seamless project implementation in Arizona and New Mexico.

Issues/Risks:

Angadi: Guar outreach was affected by two things during the quarter. First, unusual growing season of 2019 did not allow us to come up with recommendations from any of our trials. Now, we have to repeat most of those trials and summarize after 2020 field season. Second, pandemic of COVID-19 is restricting our work in the lab and our plan to develop time lapse videos for educational activities will be delayed. The delays will be more than six months. Even some of the outreach activities that we plan in spring like spring field day, ACES Open House were cancelled.

Evancho: While progress is being made in several areas, the impacts we have are greatly reduced because of the COVID-19 protection protocols. This will be on-going on task completion until restrictions are released.

Fields: There have been a number of changes that have slowed progress during this quarter. Classroom observations that had been planned were not able to take place (as described above) because of school closures. I will need to rethink the appropriate way to evaluate how teacher/fellow lesson plans may have been delivered in a remote learning environment. Also, because of the changes in 4-H approaches, coupled with the COVID causing cancellations and/or postponements of summer activities, I need to revise my evaluation plan for this component as well. I will be able to return to green status before the end of the project year. Some tasks are on track as planned (i.e. the online summer professional development) while others are requiring the development of new evaluation tools and timelines.

Grover: Due to the current COVID pandemic, the university was locked down in March interrupting most of the extension activities. The activities will resume as soon as the situation allows. The meetings among the SBAR collaborators will continue and plan outlined for moving forward.

Idowu: No issues this quarter. However, for the next quarter, we are anticipating delays in field demonstration trials due to COVID-19 pandemic. We may also not be able to establish trials at

all the planned sites due to the state and NMSU COVID-19 pandemic regulations. We will keep watching the situation and adjust our plans for field trials accordingly.

Morris: The suspension of in-person engagement until Aug 1 at the earliest is a challenge, but we have positioned 4-H to benefit in SBAR by partnering with the education team to pilot some STEM ambassador activities. Additionally, by reimagining STEM camps as virtual experiences and delaying the face to face programs, we are using the multiple platforms for implementing ambassador activities and volunteer training and volunteer activities. Though this has not necessarily delayed program outcomes, it changes the methods of completion.

Rock: On March 30th the Governor issued a stay at home order due to health concerns related to COVID-19. Accordingly, the University of Arizona has also issued specific guidance eliminating personal contact by all University students, staff, and faculty and halting all field and laboratory operations in which personal protection cannot be ensured. Currently, we do not have guidance on an approximate "all clear" date where we can return to normal operations.

Because our grant objectives specifically target in-person training and education for student interns, our project team is essentially at a standstill. Additionally, the University guidance is that we are to cancel all summer-based programs through July. Because this would essentially cut our interns short of the required time, and because of our uncertain future, we can't in good faith offer opportunities to students for Summer 2020.

We would like to propose to shift the intern experiences to the Fall 2020 Semester. This would allow our research and extension team to re-schedule interns for the upcoming semester and allow the project team to full-fill remaining project objectives. This of course may change based on University guidance in coming months as well as student availability during the Fall Semester.

Teegerstrom: Depending on the COVID-19 pandemic, meeting with producers may need to be postponed in this reporting year.

Objective 1. Produce Extension bulletins and web materials to inform growers of agronomic and irrigation requirements.

Task #	Description of Task	Deliverable	Target Completion Date
1 Angadi	Guar photographs and videos	Obtain photographs of guar growth stages	31 Aug 20
		Create videos of guar germination and growth	31 Aug 20
		Provide photos and videos for publication	31 Aug 20
2 Angadi	Guar agronomy research	Gather/analyze data; develop peer-reviewed article on N and P fertilization study	31 Aug 20

		Train graduate students in guar agronomic management	31 Aug 20
3 Angadi	Guar critical stage irrigation study	Produce report on guar crop growth based on irrigation management	31 Aug 20
4 Evan	Produce guayule newsletter articles	At least 2 guayule articles drafted and published – targeting AZ growers	31 Aug 20
5 Evan	Develop outreach documents for guayule	Produce a USDA Plant Guide for guayule in Arizona	31 Aug 20
6 Fields	Design/schedule evaluation tools, protocols, and metrics for all Extension & Outreach activities	Fall tools developed/refined; evaluation data gathered	31 Dec 19
		Spring tools developed/refined; evaluation data gathered	31 May 20
		Summer tools developed/refined; evaluation data gathered	31 Jul 20
		Data synthesized; evaluation report generated	31 Aug 20
7 Grover	Establish guar trial and showcase guar as potential crop in NM	Host field day	31 Aug 20
		Collect data; results synthesized	31 Aug 20
		Generate peer-reviewed Extension publication	31 Aug 20
8 Grover	Guar demonstration	Identify farm willing to host a demonstration field trial	31 Aug 20
		Collect data; results synthesized	31 Aug 20
9 Gutierr	Develop extension programs and reports for guar/guayule demonstrations	Summarize and validate guayule and guar demonstration farms' data	31 Aug 20
		Develop producer summary and presentations for agronomic, climatic, input/output, field emissions, and plant growth data	31 Aug 20
		Generate 3 extension bulletins	1 Feb 20
10 Idowu	Travel to conferences	Present SBAR info/materials at 4-5 grower commodity conferences	31 Aug 20
11 Idowu	Establish guayule and guar trials in Las Cruces, Los Lunas, Clovis, and Tucumcari, NM	Showcase trial experiments at field days	31 Aug 20
		Gather data/synthesize results (toward generating an Extension bulletin)	31 Aug 20

		Generate first year trial summary (published on SBAR website)	31 Aug 20
12 Idowu	Establish on-farm demonstration trials	Identify locations for 3 on-farm guar trials	31 Aug 20
		Plant guar on-farm trials	31 Aug 20
		Identify locations for 2 on-farm guayule trials	31 Aug 20
		Plant guayule on-farm trials	31 Aug 20
		Collect and summarize planting data for on-farm trials	31 Aug 20
		Schedule/Host on-farm walking tour for guar and guayule on-farm demonstration sites	31 Aug 20
13 Idowu	Host guar-focused conference for producers and ag professionals	Present research results and information on guar	31 Mar 20
		Showcase on-farm and on-station trials	31 Mar 20
14 Idowu	Newsletters to inform stakeholders	Produce 3 newsletters to highlight SBAR project	31 Aug 20
		Distribute fall newsletter	31 Dec 19
		Distribute spring newsletter	30 Apr 20
		Distribute summer newsletter	31 Aug 20
15 Idowu	Design/schedule/implement E&O evaluation	Fall evaluation data gathered	31 Dec 19
		Spring evaluation data gathered	31 May 20
		Summer eval data gathered	31 Jul 20
		Eval info synthesized; report generated	31 Aug 20
16 Teeg	Generate an interactive farm-level economic and financial model (guar and guayule)	Validate and revise BENCO Model for use in Extension/Outreach meetings	31 Aug 20
17 Teeg	Co-develop informational tools for driving profitability/feasibility of crop adoption in AZ & NM	Extension bulletins submitted for review	31 Aug 20
		Enterprise budget and BENCO Model available online	31 Aug 20
18 Teeg	Participate in Extension meetings; disseminate economic info for guar and guayule	Provide 2 presentations to growers in NM	31 Aug 20
		Provide 2 presentations to growers in AZ	31 Aug 20

Guar Photographs and Videos:

We have developed a few preliminary time-lapse videos, which have shown lots of promise. We wanted to remake those videos with temperature specific germination process. We also trying to develop root growth time lapse with a paper scanner. Initial run seems very impressive. However, COVID-19 is limiting our work in labs and process will be delayed.

Guar Agronomy Research:

Field samples from guar Nitrogen and Phosphorous response study from Clovis and Tucumcari were threshed and data were sent to Dr. Idowu. Since the data was not great, we have decided to repeat the trial.

Guar Critical Stage Irrigation Study:

Deficit irrigation management data from two years was analyzed and report is was written. A poster titled 'Sustaining Irrigation Water of the Southern High Plains Using Guar' was presented to clientele attending Alternative Crops Conference. We also discussed with a few farmers about guar crop. The 2019 growing season was unusual and did not favor most summer crops. Frequent rainfall in the region affected planting different crops and growing season was wet with frequent rains. However, there was spell of very hot and dry period that affected growth and yield of crops. The trial will be repeated one more year before an extension article is written.

Produce Guayule Newsletter Articles:

The SBAR Newsletter was sent to 319 subscribers to Central AZ Extension Newsletter in December. A second SBAR Newsletter to update stakeholders will be released this summer.

Develop Outreach Documents for Guayule:

USDA Plant Guide draft has been completed and circulated for review. After questions, comments and concerns have been addressed, the document will be published by USDA.

Design and Implement Evaluation Tools:

Grower-Focused Extension – Evaluation for the grower-focused extension group initially was to create an evaluation tool for use during specifically the scheduled Bridgestone tour, but that tour has now been postponed. Additional conversations have happened around how we move from collecting demographic information at outreach/extension events to beginning to collect data that indicates changes in knowledge/attitudes/behaviors. Extension staff feel that having the economic model in place will be a key tool for shifting grower interest towards guar and guayule. There has been an uptick in interest among growers in guar in NM, as reported by Dr. Idowu.

Youth Development Extension – 4-H/Outreach for the project experienced shifts for both NM and AZ. In NM, Rodriguez-Uribe has been working with multiple groups, both middle school and high school, to try out some of the experiments/lesson plans she has been developing related to SBAR content. Because the events were largely single-contact events, it is impossible to draw conclusions about the impact of the event on shifts in attitudes (i.e. college interest) or behaviors. Some data can be collected about content learning, but those are more scaled to the lesson specifically (i.e. how to separate a mixture) than to the SBAR project goals more broadly. As lessons are being developed, I have now begun to review them for pedagogy and will

collaborate directly with Rodriguez-Uribe as drafts are ready for review. She is currently preparing lessons in conjunction with/for use by Future Farmers of America, but the hope remains to work through extension/4-H throughout NM as well. In AZ, a new leader for the 4-H effort was brought in but the plans had not been solidified when I met with the Director earlier during the quarter. Recently, additional funding was identified to continue AZ 4-H efforts. During Q2, I will work directly with Morris to understand the schedule/scope of activities and to develop new evaluation tools. There were plans to continue the UA-based summer camp experience, but given the COVID pandemic those plans are on hold until further information is available.

Showcase Guar as Potential Crop in New Mexico:

Nothing new to report.

Guar Demonstration:

Nothing new to report.

Develop Extension Programs and Reports for Guar/Guayule Demonstrations:

Nothing new to report.

Travel to Conferences:

SBAR tabling events took place at NM Cotton Growers Conference, NM Chile Growers Conference, NM Organic Farming Conference and NM Alternative Crops Conference. Total number of people reached during this quarter = at least 510

Establish Guayule and Guar Trials in New Mexico:

We continued to process the 2019 harvest of guar from four on-station trials. Processing was completed and the results are currently being entered into a spreadsheet.

Establish On-Farm Demonstration Trials:

Nothing new to report.

Host Guar-Focused Conference for Producers and Ag Professionals:

The NM Mexico Alternative Crops Conference was held on March 10th, 2020 in Portales, NM. Fifty participants attended the conference. Information on guar was presented and guar processors from Guar Resources shared information on guar contracting processes with farmers. SBAR fellows presented their posters during the event. Based on the

evaluation conducted at the end of the meeting, over 90 percent of the attendees indicated that they increased their knowledge on the variety of topics presented on guar.



Photo 1. New Mexico Alternative Crops Conference was hosted in Portales, New Mexico.

Newsletter to Inform Stakeholders:

Nothing new to report.

Design and Implement Extension & Outreach Evaluation:

Nothing new to report.

Interactive Farm-Level Economic and Financial Model (Guar and Guayule):

Continue to add and update relevant extension model scenarios and data.

Informational Tools for Driving Profitability/Feasibility of Crop Adoption in AZ & NM:

Continue to work with AZ and NM Extension team, with the inclusion of new crop options with the current baseline for whole farm analysis to be used in the presentations during the extension/outreach activities. Future of this task depends on COVID-19 restrictions and preferred delivery methods.

Dissemination of Guayule and Guar Economic Information through Extension Meetings:

Working with the extension team to start setting dates for inclusion in extension workshop using the whole farm and budgeting tools. Was not able to schedule participation in any of the extension activities this past quarter but will be able to provide some base information this spring. Future of this task depends on COVID-19 restrictions and available programming efforts.

Objective 2. Hold workshops throughout the region on sustainable practices to expand crop production to new rural regions and Native Nation lands.

Task #	Description of Task	Deliverable	Target Completion Date
1 Angadi	Arrange guar field day/field walk at Agricultural Science Centers, NM	Present guar crop information to ~100 producers in the region	31 Aug 20
2 Angadi	Educate local growers	Establish guar demonstration on a local farmer's field	15 Jul 20
1 Evan	Hold workshops and present information to growers in Arizona	Host two presentations on guayule agronomic production and irrigation at regional extension events	31 Aug 20
		Present guayule production to Native American farming communities	31 Aug 20
		Collect needs assessment information directly from Native American farming communities	31 Aug 20
2 Grover	Hold workshops and present information to growers	Host 2 presentations on guar agronomic production as an interim step to bulletin	31 Aug 20
		Present SBAR project information and materials	31 Aug 20

Educate Local Producers about Guar:

Along with Dr. John Idowu and a few other extension agents from NMSU, organized the Alternative Crops Conference at Portales, NM on March 10th. The news of spreading coronavirus dampened attendance in the conference a bit. But, people attending the conference were extremely interested in alternative crops. Speakers from New Mexico, Colorado, Kansas and Texas spoke on very diverse crops and topics. Speakers were from universities, land institute and private industries. There was good interest in guar and a few famers showed interest in trying the crop this year. We will follow up with a field day in 2020.

Establish Farm Demonstration Site in New Mexico:

We are actively recruiting one or two famers to conduct a field scale demonstration during 2020 season. I am also involved in a pilot study to introduce crop insurance for guar in Texas by RMA. We expect the successful introduction of insurance will encourage farmers to try new crops like guar.

Grower Workshops in Arizona:

Dr. Abdel-Haleem presented his crop improvement work on guayule to 45 individuals at the NexGen Cotton Symposium held at the USDA Arid Land Research Center.

Dr. El-Shikha discussed and showcased his drone work to evaluate crop production and soil moisture levels being conducted at the Maricopa Agriculture Center. (Photo 1)

Teegerstrom has been in constant contact with multiple tribes, but has made little progress to develop further interest in guayule production.

Total individuals contacted this quarter: 210

(Youth: 71:210) By traveling to agricultural meetings and grower's farms throughout Arizona, we have been able to reach 114 individuals and communicate the progress of the SBAR grant.

- 1/14 – 24 adults, 2020 Winter Field Crops Meeting, Pima County
- 1/15 – 20 adults, 2020 Winter Field Crops Meeting, Pinal County
- 1/30 – 45 adults, NexGen Cotton Symposium, Pinal County
- 2/5 – 20 adults, Deltapine Seed Meeting, Pinal County
- 2/6 – 4 adults, Farm visit, Pima County
- 2/17 – 1 adult, Farm visit, Pinal County

Grower Workshops in New Mexico:

Efforts were invested in creating awareness and disseminating information about the SBAR project with focus on guar as a potential alternative crop in the region through invited talks at local and international forums.



Photo 2. SBAR guayule fields at Maricopa Agriculture Center are subject to drone technology to evaluate crop production and soil moisture levels.

Objective 3. Involve youth in internships, 4-H projects, and STEM summer camps.

Task #	Description of Task	Deliverable	Target Completion Date
1 Gutierr	Develop/improve SBAR 4-H Camp curriculum	Adapt camp curriculum for use in NM (train-the-trainer and FFA STEM curriculum)	31 May 20
2 Gutierr	School enrichment and 4H Camp/FFA activities	Plan/Host 6 SBAR Day camps targeting Hispanic and Native youth	31 Aug 20
		Plan/Host 15 SBAR school enrichment events	31 Aug 20
		Host a train-the-trainer camp for 4H Agents and teachers	31 Aug 20
		FFA Science Fair: Promote SBAR curriculum use	30 Jun 20
3 Morris	Adapt existing curriculum for 4H program	Two existing 4H curricula adapted for SBAR topics (bioeconomy)	1 Jun 20
4 Morris	Develop county level STEM Ambassador Program (SBAR-related)	Host focus group meeting with STEM Camp Counselors in June	31 Aug 20
		Ambassador guidebook for county implementation	31 Aug 20
5 Morris	Design STEM volunteer training program; recruit volunteers	Recruit 5 STEM certified volunteers	30 Apr 20
		Host 3 STEM volunteer trainings	30 Apr 20
6 Morris	Develop STEM internship program plan, recruitment plan, evaluation plan	Completed internship program plan, recruitment plan, and evaluation plan	30 Sep 20
7 Rock	Develop SBAR internal factsheets on <i>Project Puente</i>	Generate <i>Project Puente</i> resource document(s) for SBAR faculty	28 Feb 20
8 Rock	Recruit students for summer <i>Project Puente</i> internships	Update application materials to highlight on-going SBAR research opportunities	1 May 20
		Recruit 6 students for Yr3 cohort of <i>Project Puente</i> interns	1 May 20
9 Rock	Recruit faculty mentors for summer <i>Project Puente</i> internships	Recruit 5 faculty mentors for Yr3 cohort of <i>Project Puente</i> interns	1 May 20
10 Rock	<i>Project Puente</i> student project development and deployment	Work with SBAR faculty to identify appropriate internship projects (research and extension)	26 Jul 20

		Facilitate SBAR internship projects; final poster presentations highlighting student work	31 Aug 20
11 Rock	<i>Project Puente</i> case study video	Design and develop short video highlighting student/mentor experiences for future training needs	31 Aug 20

Adapt SBAR Curriculum for 4-H and FFA Camps:

Train-the-trainer and 4-H curriculum was developed and used in the SBAR 4-H Day camps and mini-camps hosted in NM. SBAR FFA curriculum is currently under development for use by high school FFA instructors. The first SBAR/FFA lesson plan was completed, revised, and double-branded. It is currently under final revision by Jennifer Fields.

Recruited Dr. Jose Luis Ortega Carranza, an NMSU Research Scientist, to collaborate in the development of curriculum related to alternative crops.

SBAR 4-H Day Camps or Mini-Camps:

Led SBAR hands-on activities for the 4-H Senior Leadership Retreat (“*Opening the Door to Your Future*”), hosted at the Santa Ana Pueblo, New Mexico on January 24-26. Thirty-two senior students and three adult 4-H leaders participated in this event. (Photo 2)

Organized and carried out the 4-H Project Day with NMSU SBAR on February 18th. Eight students and one adult parent attended this event.

Presented the first SBAR/FFA Lesson Plan and activity to sixteen college students from the AXED 445/545 Developing Excellent Programs in Career and Technical Education class on March 12th.

Developed the syllabus for the NMSU EEO 2020 Summer Camp planned for July 2020.

Adapt Existing Curriculum for 4H Program:

SBAR Education team has submitted current lessons completed and in development March 2020. Review of curriculum to begin April 2020

-Goal is to identify 5 curricula for adaptation to 4-H



Photo 3. Students participating in hands-on SBAR activities at the 4-H Senior Leadership Retreat – “*Opening the Door to Your Future*” – held at the Santa Ana Pueblo, New Mexico.



Photo 4. A 4-H Project Day was hosted at New Mexico State University, 18 February 2020.

-Will work with University of Arizona 4-H Agents to review in May
Curriculum review has begun, but only by PI. SBAR 4-H Agent partners will begin to work together in May.

Develop County-Level STEM Ambassador Program (SBAR-related):

Outline of ambassador roles and responsibilities completed March 2020

1hr SBAR introduction meeting with 5 -H Agents

1.5 hr working meeting to outline county STEM ambassador program

Curriculum review service to SBAR Fellows organized April 10, scheduled to begin late April 2020

Piloting ambassador work by connecting HS aged 4-H members with SBAR education fellows to provide feedback and assessment of developed programs and activities.

Design STEM Volunteer Training Program; Recruit Volunteers:

Training program planned for July to coincide with Science in Agriculture Programming.

Tentatively, volunteers would receive two days of introduction to content during the week prior to Science in Agriculture week, they would observe and/or participate in the Plant Science and Environment/Sustainability program.

These volunteers and potentially others will receive training on the Greenhouse project to be implemented as day camps in the fall.

Develop STEM Internship Program, Recruitment, and Evaluation Plans:

No progress made thus far.

Internal Factsheets on *Project Puente* Internships:

During this reporting period the extension team has continued to work to recruit additional SBAR faculty to participate in *Project Puente* for Summer of 2020. As part of our 2020 goals was to develop new resource documents for SBAR faculty on expectations of mentors, expectations of students, timelines, reporting structure, among other topics. We will also created a short PowerPoint presentation directed at recruitment of faculty to participate in the program as well as to be used as an advertisement of the program to the broader campus community. Our initial goal was to increase participation to a total 6 student interns and associated SBAR faculty to participate in the project in year three. Additionally, at the culmination of year three, the extension team planned to create a short case study video to highlight the success of the program for broad dissemination.

Project Puente Internship Recruitment:

Activities have been halted due to COVID-19.

Project Puente Student Project Development and Deployment:

Activities have been halted due to COVID-19.

EDUCATION

Project Coordination: Dr. Sara Chavarria (University of Arizona) serves as the lead for the Education Team, which meets once monthly to cover broader topics related to specific Education objectives and tasks. Smaller working groups meet weekly for specific action items (such as planning and coordinating the weekly SBAR Fellow Seminar). The Education Team also meets monthly with the Extension & Outreach Team to ensure that selected curriculum and activities is integrated for associated workshops and camps.

Issues/Risks:

Brewer: On March 16, the Las Cruces Public Schools were closed for a three-week spring break in response to the spread of COVID-19, with the original intention of re-opening on April 6. At the beginning of April, it was announced that schools would shift to remote learning for the rest of the year, with technology/methods practice to occur the week of April 6-10, and official learning to start April 13. In that time, the district developed unified learning targets for each grade with defined curricula that could be done with technology (providing tablets and assistance with getting internet connection) or without technology (paper material packets to be picked up and returned at meal pick up locations). Individual teachers had to shift to online communication platforms (Zoom, Class Dojo, etc.) and help their students work through the district-defined materials. All in-person activities were cancelled for the remainder of the school year.

The school closures and shift to defined remote curriculum instruction has greatly limited the amount that fellows can do in terms of incorporating/testing SBAR activities. Their current focus is on design/production of videos towards the summer online professional development program, and refining their lesson plans with whatever feedback they were able to get in the classroom/at the afterschool program before the closure. As their teachers are able to identify ways that the fellows can help with remote learning activities, they are. Substantial time and effort have been required for the teachers and fellows to adjust to online platforms and limited long-term direction from the district, so little progress on lesson development is expected for April and May.

Recruitment for the summer professional development program has been on hold in light of all of the changes and uncertainty, and needs to be restarted. Even with recruitment, teachers are expected to be hesitant to commit to any plans for the summer or the 2020-2021 school year, which will likely reduce participation.

Chavarria: Before school closure, Knox and Anderson observed two pairs of SBAR Teachers/Fellows. While classroom visits are not possible with schools closed, these will be managed by the bi-weekly seminar, bi-weekly office hours and meeting with Fellows individually. In our frequent contact with Fellows, we are able to hear about their work with their teachers. The Education team also held a Zoom meeting with teachers to learn about their school situation and to discuss how the Fellows can best support them. This was an opportunity for Chavarria, Knox, Anderson and Duncan to express their support and set up a plan for the Fellows to meet with their teachers on a bi-weekly basis. The classroom visits are a great way to see what takes place in the classroom, but with classrooms closed, we are seeing their digital work with students. If anything, we now have more contact with the Fellows who are updating us

on their work with their educator regularly. Fellow video interviews is also another way to observe how they are presenting information and to give feedback. The frequent contact/support from the Education team decreases the impact of not visiting their schools.

Before COVID-19, meetings were held with Nick Morris to use the 4H network to recruit 4H leaders and teachers for the Summer PD. In addition, S. Chavarria had connected with her contact at the Bureau of Indian Education and he is helping to recruit teachers (mostly in New Mexico). With teachers' schedules changing, we are adjusting from recruiting 10 teachers to exploring the best option for involving any number of interested teachers in the Summer PD.

The format of the Summer PD will adjust per the following considerations: (1) preference for amount of digital time on Zoom, (2) preference for bite-size presentations per digital lessons and activities (in preparation for another potential online semester scenario) with the needs of teachers as we don't want to keep everyone on a Zoom meeting for a week, or (3) preference for online presentations and activities spread out throughout the academic year instead of a one week workshop. We also need to determine what teacher capacity is per what their districts demand. Contingencies are being made to facilitate all of these possible scenarios. The Education team has discussed the need to be sensitive with their emotional well-being and to explore the best approach for the Summer PD. Our hope is that teachers will be open to more online activities and part of the sell is that they are going to have access to graduate students. Providing a digital PD is timely with schools being closed and, as noted above, we are evaluating the best approach to meet teacher needs and provide a PD that could be used again in future years.

Objective 1. Train teams of students and teachers with focus on rural and under-represented groups.

Task #	Description of Task	Deliverable	Target Completion Date
1 Brewer	Supervise/Assist NM SBAR Fellows and Teacher Mentors through 2018-2019 school year	Design/deliver after school program for middle school	31 May 20
		Design/vet STEM activities	31 May 20
2 Brewer	Recruit and train SBAR Fellows and Teachers for 2019-2020 school year	Identify 4 new NM SBAR Fellows and any replacements, as necessary	31 Jul 20
		Identify 4 new NM SBAR Middle school teachers	31 Jul 20
3 Chav	Plan/Design/Coordinate Fall 2019 and Spring 2020 SBAR Fellow seminar	Plan Fall 2019 seminar content	31 Aug 19
		Plan Spring 2020 seminar content	31 Dec 19
		Generate education products on SBAR Fellow activities (digital publications)	31 Jul 20

4 Chav	Visit classrooms for observations (delivery of SBAR content)	Implement Fall teacher observation	30 Nov 19
		Implement Fall SBAR Fellow observation	30 Nov 19
		Implement Spring teacher observation	30 Apr 20
		Implement Spring SBAR Fellow observation	30 Apr 20
5 Chav	Recruit for summer Teacher Professional Development	Plan/develop itinerary for summer PD session	31 Jan 20
		Recruit 10+ teachers	30 Apr 20
6 Fields	Design/Schedule classroom evaluation tools, protocols and metrics for all Education activities	Fall tools developed/refined; evaluation data gathered	31 Dec 19
		Spring tools developed/refined; evaluation data gathered	31 May 20
		Summer tools developed/refined; evaluation data gathered	31 Jul 20
		Data synthesized; evaluation report generated	31 Aug 20

Assist NM SBAR Fellows and Teacher Mentors (2019-2020):

The fellows met with Brewer three times this quarter as a group to review progress, work on plans for video recordings, coordinate efforts for the afterschool program, and assist Rodriguez-Uribe at NMSU with the design of the New Mexico summer camp for middle school students planned for July 6-10. As their schedules allowed, fellows participated in the UA fellows' seminar. Fellows continued to work in the classrooms with their teachers (Mikesell, Bradley, and Strand) and with the *Guardians of the Biosphere* (GOB) afterschool programs. Video recording equipment (GoPro) and associated editing software was purchased; the fellows are currently learning to use it.

Recruit and Train SBAR Fellows and Teachers (2019-2020):

Nothing new to report.

SBAR Fellow Seminar (Fall 2019 / Spring 2020):

At the beginning of the semester, Fellows were tasked with conducting a SBAR career/discipline interview, an explainer video with their partner teacher and a lesson revision. The Education team scheduled studio time at the College of Education for the SBAR Teacher/Fellow pairs to record explainer videos that could be shared online. We set up four class meetings to check in on projects and attend a video training from Michael Griffith in the College of Education. With COVID-19, we adjusted the program to meet the needs of the participants. We now hold a bi-weekly Zoom Seminar to check in with both the AZ and NM Fellows to explore how to best support teachers/schools with school closures. On the weeks that the Seminar is not occurring,

Knox and Anderson are hosting digital office hours to be available to AZ and NM Fellows to work on the products and strategies for supporting educators remotely. Knox and Anderson are also meeting with AZ Fellows individually to support them as they develop products and give feedback. Before the University of Arizona closure, one pair of teachers were able to film an explainer video in the College of Education studio. Fellows are still working on their interview videos but have had to adjust to conducting the videos through Zoom since in-person interviews are not possible. The seminar continues to move forward with Fellows working on lesson plans and remotely supporting their teachers. Though we are not able to meet in person, our weekly check-ins with Fellows is intended to support them during the challenges of COVID-19. New opportunities continue to develop as we adjust to COVID-19, such as encouraging Fellows to develop more ready products like short videos that could be shared with teachers looking for material, having a SBAR Fellow curate SBAR products/interviews on a YouTube channel and working closely with 4H Summit to share the work of SBAR Education and connect with 4H participants.

Classroom Observations (Delivery of SBAR Content):

Due to the COVID-19 pandemic, this activity is delayed.

Teacher Recruitment for Summer Professional Development:

Knox is developing the plan/itinerary for the summer PD. She is sharing her developments with the Education team and adjusting for the changes due to COVID-19. Four standalone modules are being developed and a community D2L site has been created that will be used as a platform for PD onboarding, training and sharing of materials. Some targeted recruitment has taken place through existing channels. Further information is provided below on the change of approach to recruiting 10 + teachers. It is likely that for this summer the PD will consist of intermittent and small group training.

Design and Implement Classroom Evaluation Tools:

During the Q1 of 2020, the primary tasks related to the evaluation of the EEO components of the SBAR project were to 1) work directly with Education team members to develop evaluation plans/tools for spring/summer activities, 2) continue to review documents/project artifacts such as teacher and fellow lesson plans to monitor progress towards curriculum deliverables; and 3) understand the changes in approach for the 4-H/outreach teams in both NM and AZ in order to rethink the evaluation that is possible given the shift in direction and some personnel for both NM and AZ.

Evaluation activities for the education group largely centered around informing plans for the new digital delivery format for the summer 2020 Professional Development activities. Additionally, focus group interviews and meetings were held in late spring with select participating teachers and fellows. The questions focused largely around how the Corona Virus pandemic and subsequent closing of schools will affect their ability to deliver/prototype/refine SBAR activities and how the graduate fellows will support teachers given the school closures and social distancing. Planned evaluation for the spring included classroom observations, so those did not happen given the school closures. I will need to shift my focus for evaluation to an analysis of what was able to occur online given the remote learning mode that teachers have entered. In some ways, this will be a bonus though as it will provide information about how others might be able to use the curriculum in an online format rather than in person. Other evaluation activities

included reviewing lesson plans and related documents/photos/videos that have been submitted by teachers, fellows, and project staff as they relate to curriculum development.

Objective 2. Develop and disseminate agricultural bioenergy and bioproduct K-12 modules.

Task #	Description of Task	Deliverable	Target Completion Date
1 Brewer	Develop/Offer train-the-trainer biofuels education program for 4-H agents/volunteers and teachers/fellows	Develop/Host 3-day summer train-the-trainer program at NMSU	31 Jul 20
		Recruit 4-H youth and GK-12 participants	31 Jul 20
2 Chav	Edit Cohort 1 lessons and materials for online publication	Edit lessons	31 Oct 19
		Submit final lessons/activities for SBAR website and online publication	31 Dec 19
3 Chav	Support lesson plan design by teacher-Fellow partnerships	Fall lesson plans from each Fellow developed	30 Nov 19
		Spring lesson plans from each Fellow developed	30 Apr 20
		Advice and support NM teach as requested/needed	31 May 20
		Draft lesson plans from Cohort 2 teachers	31 Jul 20
		Cohort 2 summer support on lesson redesign for publication	31 Jul 20

Design and Implement Train-the-Trainer Education Program for 4-H Youth Development:

An announcement about the summer online teacher professional development program (June 22-26) was created for distribution to recruit teachers around NM, specifically within those counties with high potential for growing guar/participating in SBAR extension efforts. This announcement was shared with extension agents and to attendees at the Alternative Crops Conference in Portales, NM on March 10.

Cohort #1 Lessons and Materials:

Nothing new to report.

Support Lesson Plan Design by Teacher-Fellow Partnerships:

Nothing new to report.

Objective 3. Develop a biofuel certificate program at the university level.

Task #	Description of Task	Deliverable	Target Completion Date
1 Molnar	Develop MS and/or PhD education opportunities within the University of Arizona around the theme of “Sustainable Bioeconomy”	At least 2 tracks (study concentration areas) within UA GIDPs	31 Dec 19

Development of Education Opportunities:

This task is complete; nothing new to report.

AWARDS

2020

Ossanna, L. *National Science Foundation Graduate Research Fellowship*. Awarded 3 years of funding to complete a PhD.

2019

Bayat, H.; Hoare, D.; Moreno, L.; Singh, J.; Steichen, S.; Summers, H.; Wright, A. *SBAR Interdisciplinary Face-Off – Silver Lightning Award for Best Overall Design*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona.

Bayat, H.; Hoare, D.; Moreno, L.; Singh, J.; Steichen, S.; Summers, H.; Wright, A. *SBAR Interdisciplinary Face-Off – Smooth Moves Award for Most Creative Concept*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona.

Brown, K.; Dehghanizadeh, M.; Lohr, P.; Singh, P.; Soto, A.; Zuniga-Vasquez, D. *SBAR Interdisciplinary Face-Off – Ninja Visionary Award for Best Overall Concept*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona.

Katterman, M.; Ossanna, L.; Pruitt, D.; Soliz, N.; Sproul, E. *SBAR Interdisciplinary Face-Off – Energy Zone Award for Overall Audience Favorite*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona.

PRODUCTS GENERATED.

September 2017 – December 2019

PUBLICATIONS, CONFERENCE PAPERS AND PRESENTATIONS

Items appearing in blue font are new in this quarter.

Publications

1. **Abdell-Haleem H.; Luo Z.; Ray, D. 2019.** Chapter 6. Genetic Improvement of Guayule (*Parthenium argentatum* A. Gray): An Alternative Rubber Crop. In: J. Al-Khayri (ed.). *Advances in Plant Breeding Strategies: Industrial and Food Crops*. Springer Nature Switzerland AG (Invited Book Chapter). p.151-178.
2. **Chen, F.; Bayat, H.; Jena, U.; Brewer, C.E. 2020.** Impact of feedstock composition on pyrolysis of low-cost, protein and lignin-rich biomass: a review. *Journal of Analytical & Applied Pyrolysis*, 147, 104780, DOI: 10.1016/j.jaap.2020.104780.
3. **Chen, F.; Dehghanizadeh, M.; Audu, M.A.; Jarvis, J.M.; Holguin, F.O.; Brewer, C.E. 2020.** Characterization and evaluation of guayule processing residues as potential feedstock for biofuel and chemical production. *Industrial Crops and Products*, 150, 112311. DOI: 10.1016/j.indcrop.2020.112311.
4. **Cheng, F.; Jarvis, J.M.; Yu, J.; Jena, U.; Nirmalakhandan, N.; Schaub, T.M.; Brewer, C.E. 2019.** Bio-crude oil from hydrothermal liquefaction of wastewater microalgae in a pilot-scale continuous flow reactor, *Bioresource Technology*, 294, 122184, DOI: 10.1016/j.biortech.2019.122184.
5. **Cheng, F.; Le-Doux, T.; Treftz, B.; Miller, J.; Woolf, S.; Yu, J.; Jena, U.; Brewer, C.E. 2019.** Modification of a pilot-scale continuous flow reactor for hydrothermal liquefaction of wet biomass. *MethodsX*, 6, 2793-2806, DOI: 10.1016/j.mex.2019.11.019.
6. **Cheng, F.; Bayat, H.; Jena, U.; Brewer, C.E. ND.** Impact of feedstock composition on pyrolysis of low-cost, protein-rich lignocellulosic biomass: a review. *Journal of Analytical & Applied Pyrolysis*, revised, under review.
7. **Cheng, F.; Dehghanizadeh, M.; Audu, M.; Jarvis, J.M.; Holguin, F.O.; Brewer, C.E. ND.** Characterization and evaluation of guayule bagasse and processing residues as potential feedstock for biofuel and chemical production. *Industrial Crop & Products*, in revision.
8. **Dehghanizadeh, M.; Cheng, F.; Jarvis, J.M.; Holguin, F.O. Brewer, C.E. ND.** Characterization of resin extracted from guayule (*Parthenium argentatum*): a dataset including GC-MS and FT-ICR MS. *Data in Brief*, under review.
9. **Luo, Z.; Thorp, K.R.; Abdel-Haleem, H. 2019.** A high-throughput quantification of resin and rubber contents in *Parthenium argentatum* using near-infrared (NIR) spectroscopy. *Plant Methods* 15, 154 (2019) DOI:10.1186/s13007-019-0544-3.
10. **Nelson, A.D. L.; Ponciano, G.; McMahan, C.; Ilut, D.C.; Pugh N.A.; Elshikha, D.E.; Hunsaker, D.J.; Pauli. D. 2019.** Transcriptomic and evolutionary analysis of the mechanisms by which *P. argentatum*, a rubber producing perennial, responds to drought. *BMC Plant Biology*. 19:494.
<https://bmcpplantbiol.biomedcentral.com/articles/10.1186/s12870-019-2106-2>
11. **Sun, O.; Fan, N. 2020.** A Review on Optimization Methods for Biomass Supply Chain: Models and Algorithms, Sustainable Issues, Challenges and Opportunities. *Process*

Conference Papers

1. **Audu, M.; Dehghanizadeh, M.; Cheng, F.; Bayat*, H.; Holguin, O.; Jena, U.; Brewer, C.E. 2019.** *Co-Products and Biofuels from Guar and Guayule Processing Residues*. 2019 ASABE Annual International Meeting. Boston, Massachusetts. 8 July. Paper #1900361.
2. **Cruz, V.M.V.; Lynch, A.; Wang, G.S.; Dittmar, S.; Sullivan, T.; Prock, R.; Niaura, W.; Dierig, D.A. 2019.** *Guayule germplasm characterization for variation in ploidy and biomass production*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 36.
3. **Dehghanizadeh, M.*; Cheng, F.; Jarvis, J.M.; Holguin, F.O.; Brewer, C.E. 2019.** *High Resolution Mass Spectrometry for Characterization of Resin from Guayule (*Parthenium argentatum*)*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 39.
4. **Dierig, D.A.; Wang, G.S.; El-Shikha, D.E.M.; Sullivan, T.; Dittmar, S.; Cruz, V.M.V. 2019.** *Guayule growth and yield over time at two locations at high and low irrigation treatments*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 31.
5. **Dong, C.; Ponciano, G.; Wang, Y.; Huo, N.; Hunsaker, D.; El-Shikha, D.E.M.; Gu, Y.Q.; McMahan, C. 2019.** *Gene expression of guayule field plants under drought stress: A comparative RNA-Seq study*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 35.
6. **El-Shikha, D.E.M.*; Waller, P.M.; Hunsaker, D.J.; Dierig, D.A.; Wang, G.S.; Cruz, V.M.V.; Thorp, K.R.; Bronson, K.F.; Katterman, M.E. 2019.** *Growth and yield of direct-seeded guayule under SDI and furrow irrigation*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 30.
7. **Khanal, S.; Robbs, J.; Acharya, R.; Gutierrez, P. 2019.** *Import demand and potential for domestic production of guar*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 43.
8. **Maqsood, H.; Waller, P.; El-Shikha, D.E.M.; Hunsaker, D.; Katterman, M.E.; Dierig, D.A.; Wang, G.S.; Ogden, K. 2019.** *Assessment of irrigation requirement for guayule using WINDS model*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 32.
9. **Maqsood, H.; Angadi, S.; El-Shikha, D.E.M.; Waller, P.; Singh, J.; Hunsaker, D.; Barau, B. 2019.** *Evaluating crop water status for guar using WINDS model*. In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 42.

10. **McCloskey, W.; Wang, G.S. 2019.** *Guayule (Parthenium argentatum A. Gray) seedling tolerance to topically applied carfentrazine-ethyl herbicide.* In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 34.
11. **Placido, D.F.; Dong, N.; Pham, T.; Huynh, T.; Amer, B.; Baidoo, E.; McMahan, C. 2019.** *Down-regulation of squalene synthase in guayule (Parthenium argentatum).* In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 37.
12. **Seavert, C.; Teegerstrom, T.*; Gutierrez, P.; Khanal, S. 2019.** *Whole farm analysis tool for evaluating the adoption of guayule and guar into southwest producers' current operation.* In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 40. Best Oral Presentation Award for the Rubber and Resin Division.
13. **Wang, G.S.; Dierig, D.A.; Ray, D.T. 2019.** *Guayule response to plant population.* In: 31st Annual Meeting Program and Abstracts of the Association for the Advancement of Industrial Crops. Cruz, V.M.V. and Berti, M. (eds.). Tucson, Arizona. 8-11 September. p. 38.

Scholarly Presentations

1. **Angadi, S.V. 2018.** *Sustainable Bio-economy for Arid Regions: Growing Guar.* Extension Field Day. Clovis, New Mexico. 9 August.
2. **Angadi, S.V.*; Begna, S.H.; Singh, S.; Katuwal, K.; Singh, J.; Gowda, P.; Ghimire R. 2018.** *Multiple Approaches to Sustain Ogallala Aquifer in the Southern Great Plains of the United States of America.* Agrosym 2018. Jahorina, Bosnia. 4-7 December.
3. **Angadi, S.V.*; Begna, S.H.; Singh, S.; Katuwal, K.; Singh, P.; Singh, J.; Umesh, M.R. 2019.** *Crop Diversification and Critical Stage-Based Irrigation to Sustain Ogallala Aquifer.* UCOWR/NIWR Annual Water Resources Conference, Snowbird, Utah. 11-13 June.
4. **Angadi, S.V.*; Begna, S.H.; Umesh, M.R. 2018.** *Crop diversification for sustainable soil and water resources use in semi-arid regions of USA.* XXI Biennial National Symposium of Indian Society of Agronomy, Udaipur, India. 24-26 October.
5. **Angadi, S.V.*; Singh, J.; Begna, S.H. 2019.** *Crop growth stage based deficit irrigation management in guar crop.* Annual Report, Agricultural Science Center at Clovis, New Mexico. 20 February.
6. **Angadi, S.V.; Singh, J.*; Begna, S.H. 2020.** *Crop growth stage-based deficit irrigation management in guar crop.* Annual Report, Agricultural Science Center at Clovis, New Mexico. 29 February.
7. **Audu, M.*; Dehghanizadeh, M.; Cheng F.; Bayat H.; Holguin, O.; Jena U.; Brewer, C.E. 2019.** *Co-Products and Biofuels from Guar and Guayule Processing Residues.* ASABE Annual International Meeting, Boston, Massachusetts, 7-10 July.
8. **Bayat, H.*; Cheng, F.; Jena, U.; Brewer, C.E. 2019.** *Introduction to low-cost protein-rich lignocellulosic biomass for advanced biofuels.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
9. **Brewer, C.E. 2018.** *Pairing biomass residues with conversion technologies.* Advanced Bioeconomy Leadership Conference, Washington, D.C. 28 February.

10. **Brewer, C.E. 2018.** *Polymerization and guar gum bubbles.* Outreach event activity. New Mexico 4-H State Conference. 11 July.
11. **Brewer, C.E. 2018.** *Identifying Co-Products from Guar and Guayule Processing Residues.* 2018 American Institute of Chemical Engineers Annual Meeting. Pittsburgh, Pennsylvania. 30 October.
12. **Brown, K.S. 2020.** *Soil chemistry ... and other topics.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 25 March.
13. **Brown, K.S.*; Neilson, J.W.; Waller, P.M.; Ray D.T.; Dierig, D.; Maier, R.M. 2018.** *Microbial contributions to soil health: Optimizing guayule (Parthenium argentatum) production in an arid environment.* SWESx Earthday Symposium. Tucson, Arizona. 15 April. [poster]
14. **Brown, K.S.*; Neilson, J.W. 2018.** *Microbial contributions.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. April.
15. **Brown, K.S.*; Neilson, J.W.; Waller, P.M.; Ray D.T.; Dierig, D.; El-Shikha, D.; Maier, R.M. 2019.** *Microbial contributions to soil health: Optimizing guayule (Parthenium argentatum) production in an arid environment.* SWESx Earthday Symposium. Tucson, Arizona. 27 March. [poster]
16. **Brown, K.S.*; Neilson, J.W.; Waller, P.M.; Ray, D.T.; Wang, S.; Dierig, D.; El-Shikha, D.E.M.; Maier, R.M. 2019.** *Soil health and guayule microbial community metrics.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
17. **Cheng, F.*; Audu, M.; Dehghanizadeh, M.; Treftz, B.; Le-Doux, T.; Jena, U.; Brewer, C.E. 2018.** *Characterization and Conversion of Guar and Guayule Bagasse as Potential Resources for Biofuels Production.* Symposium on Thermal and Catalytic Sciences for Biofuels and Bio-based Products. Auburn, Alabama. 9 October.
18. **Cheng, F.; Le-Doux, T.; Jena, U.; Brewer, C.E.* 2018.** *Characterization and Conversion of Guar Bagasse.* Symposium on Thermal and Catalytic Sciences for Biofuels and Bio-based Products. Auburn, Alabama. 9 October.
19. **Cheng, F. 2018.** *Hydrothermal Liquefaction of Microalgae in Batch and Continuous Flow Reactors.* PhD Dissertation Defense. New Mexico State University, Las Cruces, New Mexico. 24 October.
20. **Cheng, F.*; Rosalez, R.; Dehghanizadeh, M.; Brewer, C.E. 2019.** *Co-Hydrothermal Liquefaction of Guayule Bagasse and Wastewater Treatment Microalgae.* American Institute of Chemical Engineers (AIChE) Annual Meeting, Orlando, Florida. 10-15 November.
21. **Cheng, F.*; Le-Doux, T.; Treftz, B.; Woolf, S.; Guillen, S.; Usrey, J.; Martinez Bejarano, C.; Bayat, H.; Jena, U.; Brewer, C.E. 2018.** *Characterization of Flow and Heat Transfer Parameters in a Continuous Flow Hydrothermal Liquefaction Reactor.* 2018 American Institute of Chemical Engineers Annual Meeting, Pittsburgh, Pennsylvania. 1 November.
22. **Cheng, F.*; Rosalez, R.; Dehghanizadeh, M.; Brewer, C.E. 2019.** *Co-Hydrothermal Liquefaction of Guayule Bagasse and Wastewater Treatment Microalgae.* 2019 American Institute of Chemical Engineers Annual Meeting, Orlando, Florida. 10-15 November.
23. **Dehghanizadeh, M.*; Cheng, F.; Jarvis, J.M.; Holguin, F.O.; Brewer, C.E. 2019.** *High Resolution Mass Spectroscopy for Characterization of Resin from Guayule.*

- SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
24. **Deirig, D. 2017.** *Bridgestone's perspective on a domestic source of natural rubber in the desert.* Invited Speaker at the New Mexico Sustainable Agriculture Conference. Los Lunas, New Mexico. 13 December.
 25. **Dong, C.; Ponciano, G.; Wang, Y.; Huo, N.; Hunsaker, D.; Elshikha, D.; Gu, Y.Q.; McMahan, C. 2019.** *Transcriptome analysis of guayule reveals rubber biosynthesis pathways' response to drought stress.* SBAR Annual Retreat, University of Arizona, Tucson Arizona. 11-13 September. [poster]
 26. **El-Shikha, D.E.M. 2018.** *Update – Guayule irrigation experiments at Maricopa Agricultural Center.* SBAR UA Research Team Seminar Series, Tucson, Arizona. 12 September.
 27. **El-Shikha, D.E.M.*; Waller, P.M.; Hunsaker, D.J.; Dierig, D.; Wang, S.; Cruz, V.M.V.; Bronson, K.F.; Katterman, M.E. 2019.** *Direct seeded guayule grown in Arizona under furrow and subsurface drip irrigation.* American Society of Agricultural and Biological Engineers (ASABE) Annual International Meeting, Boston, Massachusetts. 8 July. [poster]
 28. **El-Shikha, D.E.M*.; Waller, P.M.; Hunsaker, D.J.; Dierig, D.; Wang, G.S.; Cruz, V.M.V.; Thorp, K.R.; Katterman, M.E.; Bronson, K.F.; Wall, G. 2019.** *Growing direct-seeded guayule with furrow and subsurface drip irrigation in Arizona.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
 29. **Evancho, B.*; Teetor, V.H.; Willmon, J.; Bennett, M.C.; Montes, M.; Schmaltzel, C.; Ray, D.T. 2018.** *Root structure differentiation between common guayule planting methods.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 2 August. [poster]
 30. **Evancho, B. 2018.** *Guayule Fuels the Future.* IES – Energy Talks Seminar, Sky Bar, Tucson, Arizona. 9 October.
 31. **Evancho, B. 2019.** *Guayule: How Close Are We?* Marana Winter Field Crops Clinic. Marana, Arizona. 10 January.
 32. **Evancho, B. 2019.** *Guayule: How Close Are We?* Casa Grande Winter Field Crops Clinic. Casa Grande, Arizona. 15 January.
 33. **Evancho, B. 2019.** *Comparing direct-seeded and transplanted guayule roots.* SBAR UA Research Team Seminar, University of Arizona, Tucson, Arizona. 13 November.
 34. **Evancho, B. 2020.** *Growth response of guayule to a gradient of nitrogen fertilizer.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 29 April.
 35. **Evancho, B.*; Moreno, L.; Peck, A.; Teetor, V.H., Schmalzel, C.; Ray, D.T. 2019.** *Root structure differentiation between guayule planting methods.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
 36. **Fan, N. 2018.** *Review on Optimization Methods for Biomass Supply Chain.* SBAR UA Research Team Seminar. University of Arizona, Tucson, Arizona. 28 November.
 37. **Fan, N.; Sun, O. 2019.** *GIS-based, two-stage stochastic facility location problem considering planting plan uncertainty.* American Institute of Chemical Engineers (AIChE) Annual Meeting, Orlando, Florida. 11 November.
 38. **Garcia, A.*; Grover, K.; Stringam, B.; Schutte, B.; VanLeeuwen, D. 2018.** *Growth and performance of guar (*Cyamoposis tetragonoloba* L.) under various irrigation regimes in semi-arid region of New Mexico.* 73rd SWCS International Annual Conference, Albuquerque, New Mexico. 29 July – 1 August.

39. **Garcia, A.*; Grover, K.; Stringam, B.; Schutte, B.; VanLeeuwen, D. 2018.** *Growth and performance of guar under various irrigation regimes in semi-arid region of New Mexico.* Annual SBAR Retreat, University of Arizona, Tucson, Arizona. 1-3 August. [poster]
40. **Garcia, A.*; Grover, K.; Stringam, B.; Schutte, B.; VanLeeuwen, D. 2018.** *Performance of guar under various irrigation regimes in southern New Mexico.* Extension Field Day, New Mexico State University Agricultural Science Center, Artesia, New Mexico. 23 August.
41. **Garcia, A.*; Grover, K.; Stringam, B.; Schutte, B.; VanLeeuwen, D. 2018.** *Performance of guar under various irrigation regimes in southern New Mexico.* New Mexico Sustainable Agriculture Science Conference, Los Lunas, New Mexico. 12 December.
42. **Garcia, A.*; Grover, K.; Schutte, B.; Stringam, B.; VanLeeuwen, D. 2018.** *Growth and performance of guar under various irrigation regimes.* Proceedings of the 2018 Annual Meeting of the American Society of Agronomy, Crop Science Society of America and the Soil Science Society of America. Baltimore, Maryland. 4-7 November.
43. **Garcia, A.*; Grover, K.; Schutte, B.; Stringam, B.; VanLeeuwen, D. 2019.** *Growth and performance of guar under different irrigation regimes.* NMSU College of Agriculture, Consumer and Environmental Sciences (ACES) Open House. 6 April. [poster]
44. **Gloria, T.*; Grover, K.; Garcia, A. 2018.** *Guar: a potential alternative crop in New Mexico.* Annual SBAR Retreat, University of Arizona, Tucson, Arizona. 1-3 August. [poster]
45. **Gloria, T.*; Grover, K.; Garcia, A. 2018.** *Guar: a potential alternative crop in New Mexico.* Extension Field Day, New Mexico State University Agricultural Science Center, Artesia, New Mexico. 23 August.
46. **Gloria, T.*; Grover, K.; Garcia, A. 2018.** *Guar: a potential alternative crop in New Mexico.* New Mexico Sustainable Agriculture Science Conference, Los Lunas, New Mexico. 12 December.
47. **Gloria, T.*; Flores, M.; Allen, R.; Valenzuela, V.; Ben, G.; Moore, K.; Castillo, P.; Garcia, A.; Grover, K. 2019.** *Evaluating guar as a potential alternative crop in New Mexico.* NMSU College of Agriculture, Consumer and Environmental Sciences (ACES) Open House, Las Cruces, New Mexico. 6 April. [poster]
48. **Godfrey, D.J; Bennett, M.C.*; Willmon, J.; Waltz, Q.; Coronado, G.; Teetor, V.H.; Schmalzel, C.; Ray, D.T. 2018.** *Vegetative propagation of Parthenium argentatum (Guayule).* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 2 August. [poster] Won first place for undergraduate posters.
49. **Godfrey, D.*; Willmon, J.; Teetor, V.H.; Schmalzel, C.; Ray, D.T. 2018.** *Vegetative propagation of guayule.* 2018 Annual Conference, American Society for Horticultural Science, Washington D.C. 30 July – 3 August 2018.
50. **Gonzalez, C.; Dierig, D.A.; Cruz, V.M.V.* 2019.** *Pollen studies in guayule: Comparison of staining and sampling procedures and survey of pollen size variation.* 31st Annual Meeting for the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]
51. **Gonzalez, C.*; Cruz, V.M.V.; Dierig, D.A. 2019.** *Pollen viability and size variation in guayule germplasm.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]

52. **Grover, K. 2017.** *Guar as a potential alternative crop in New Mexico.* Invited Speaker at the New Mexico Sustainable Agriculture Conference. Los Lunas, New Mexico. 13 December.
53. **Grover, K. 2018.** *Sustainable agriculture and guar production in New Mexico.* New Mexico State 4-H Conference, Las Cruces, New Mexico. 10 July.
54. **Grover, K. 2018.** *An overview of guar and other research in the Plant and Environmental Sciences Department.* A presentation to student ambassadors of College of Agriculture, Consumer and Environmental Sciences, New Mexico State University, Las Cruces, New Mexico. 8 August.
55. **Grover, K. 2018.** *Guar as an alternative crop in New Mexico.* Extension Field Day, New Mexico State University Agriculture Science Center, Clovis, New Mexico. 9 August.
56. **Grover, K. 2018.** *Guar as an alternative crop in New Mexico.* Extension Field Day, New Mexico State University Agriculture Science Center, Artesia, New Mexico. 23 August.
57. **Grover, K. 2018.** *Guar and Sustainable Crop Production.* An invited presentation to students of AGRO/HORT 100 Introductory Plant Sciences. New Mexico State University, Las Cruces, New Mexico. 31 August.
58. **Grover, K. 2018.** *Guar and Sustainable Crop Production.* An invited presentation to students of AXED 466V: "John Muir: Lessons in Sustainability." New Mexico State University, Las Cruces, New Mexico. 25 September.
59. **Grover, K. 2019.** *Guar as an alternative rotation crop in the chili production system of New Mexico.* New Mexico Chili Industry and Researcher Meeting, Las Cruces, New Mexico. 5 February.
60. **Grover, K. 2019.** *Guar: A potential alternative crop in New Mexico.* Climate Change Strategies for a Changing World Workshop, New Mexico State University, Las Cruces, NM. 5 February. [invited speaker]
61. **Grover, K. 2019.** *Do you know what plants are these and what's in them?* Future Farmers of America (FFA), New Mexico Chapter Presentation. Las Cruces, New Mexico. 5 April.
62. **Grover, K. 2019.** *Guar: A potential alternative crop in New Mexico.* New Mexico Master Gardener's Meeting. Las Cruces, New Mexico. 8 May.
63. **Grover, K. 2019.** *Guar as an alternative crop in New Mexico.* New Mexico Sustainable Agriculture Field Day. Las Cruces, New Mexico. 26 June.
64. **Grover, K. 2019.** *Guar as an alternative crop in New Mexico.* SBAR Train-the-Trainer Workshop. Las Cruces, New Mexico. 2 July.
65. **Grover, K. 2019.** *Guar as an alternative crop in New Mexico.* SBAR Train-the-Trainer Workshop, Las Cruces, New Mexico. 2 July.
66. **Grover, K. 2019.** *Guar research and extension program in New Mexico.* Departmental External Review, Las Cruces, New Mexico. 10 October.
67. **Grover, K. 2020.** *Guar as an alternative crop in southwest USA.* 18th International Congress of Soil Science, Sindh Agriculture University, Tandojam, Pakistan. 11-13 February. [invited speaker]
68. **Grover, K. 2020.** *Guar in changing climate.* Climate Change Strategies for a Changing World, New Mexico State University, Las Cruces, New Mexico. 3 March. [invited speaker]

69. **Grover, K.*; Garcia, A. 2018.** *Evaluating guar as a potential alternative crop in New Mexico.* University Research Council Meeting, New Mexico State University. Las Cruces, New Mexico. 15 February.
70. **Grover, K.*; Garcia, A.; Schutte, B.J.; Stringam, B.; Darapuneni, M.K.; VanLeeuwen, D. 2019.** *Response of guar to various irrigation regimes.* ASA-CSSA-SSSA International Annual Meetings, San Antonio, Texas. 12 November.
71. **Gutierrez, P.; Khanal, S.; Seavert, C.; Teegerstrom, T. 2020.** *Economic impacts of producing alternative crop: guar, guayule and industrial hemp in New Mexico.* Alternative Crops Conference. Portales, New Mexico. 10 March.
72. **Hoare, D.M. 2018.** *Irrigation Sensors and the WINDS Model.* SBAR UA Research Team Seminar Series, Tucson, Arizona. 26 September.
73. **Hoare, D.M.*; Katterman, M.; Waller, P. 2019.** *Development of a remote crop condition sensing system utilizing Internet of Things.* 31st Annual Meeting of the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]
74. **Huynh, T.*; Resendiz, M.; McMahan, C.; Dong, N. 2019.** *The Content and State of the In-Vitro Guayule Inventory in Tissue Culture and Opportunities to Improve our Methods.* Seminar Presentation and Discussion, USDA-ARS WRRRC, Albany, California. 18 November.
75. **Idowu, O.J. 2018.** *Introduction to the SBAR Project.* Las Cruces, New Mexico. 6 Feb.
76. **Idowu, O.J. 2018.** *Sustainable Bio-economy for Arid Regions: Update.* Extension Field Day, Clovis, New Mexico. 9 August.
77. **Idowu, O.J. 2018.** *Sustainable Bio-economy for Arid Regions: Guar and Guayule.* Extension Field Day, New Mexico State University Agricultural Science Center, Artesia, New Mexico. 23 August.
78. **Idowu, O.J.*; Pruitt, D. 2019.** *Sustainable Bio-economy for Arid Regions.* Extension Field Day. Fabian Garcia Research Center, Las Cruces, New Mexico. 26 June.
79. **Katterman, M. 2020.** *Guayule sensor and irrigation modeling + SBAR Education update.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 18 March.
80. **Khanal, S.*; Gutierrez, P. 2019.** *Farm-level impact analysis of growing guar (at 5% total acres adoption rate) in Dona Ana, New Mexico.* SBAR System Performance and Sustainability Team Seminar, Colorado State University, Ft. Collins, Arizona. 11 November.
81. **Khanal, S.*; Gutierrez, P.; Robbs, J.; Acharya, R. 2019.** *The Economic Potential of Producing Guayule in the Southwest.* Department of Agricultural Economics and Agricultural Business, New Mexico State University, Las Cruces, New Mexico. [poster]
82. **Khanal, S.; Gutierrez, P.; Seavert, C.; Teegerstrom, T. 2020.** *The economic impacts of producing guar using the input-output model.* New Mexico Alternative Crops Conference, Portales, New Mexico. 10 March. [poster]
83. **Khanal, S.; Gutierrez, P.; Seavert, C.; Teegerstrom, T. 2020.** *Guar research manuscript update.* SBAR System Performance and Sustainability Seminar. Colorado State University, Fort Collins, Colorado. 15 April.
84. **Khanal, S.; Seavert, C.; Gutierrez, P.; Teegerstrom, T.* 2019.** *The economic potential of producing guayule in the Southwest.* 31st Annual Meeting of the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]

85. **Ledesma, J.*; Ossanna, L; Pacido, D.; El-Shikha, D.E.; Dong, C.; Ponciano, G.; McMahan, C.; Neilson, J.W.; Maier, R.M. 2020.** *Associations between soil bioavailable phosphorus and guayule plant growth and rubber production.* 31st Annual Undergraduate Biology Research Program Conference, University of Arizona, Tucson, Arizona. 25 January.
86. **Leo, A. 2019.** *Microbial adaptations for arid regions and middle schoolers.* Institute for Energy Solutions (IES) Energy Talks public lecture series, Sky Bar, Tucson, Arizona. 14 March.
87. **Levy, T.*; Rock, C.; Idowu, O.J.; Dery, J.; Brassil, N.; Zozaya, S. 2019.** *Growers' perceptions and comprehension of biofuel, bioproducts, and guar in the Southwest Arid Region.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
88. **Lewis, M. 2019.** *Salt stress tolerance in guayule.* SBAR UA Research Team Seminar, University of Arizona, Tucson, Arizona. 23 October.
89. **Lewis, M.*; Judkins, A.; Teetor, V.H.; Ray, D.T. 2019.** *Evaluating guayule germplasm for salt tolerance.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
90. **Lohr, P. 2020.** *AquaCrop modeling of guayule.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 5 February.
91. **Lopez, E. 2018.** *Sustainable Bioeconomy for Arid Regions: Activities for education, extension and outreach.* American Institute of Chemical Engineers Rocky Mountain Regional Student Conference. Provo, Utah. 23 March.
92. **Lopez, E.*; Fox, S.; Brewer, C.E. 2018.** *GK-12 Lesson Documentation Spreadsheet.* American Institute of Chemical Engineers Annual Meeting, Pittsburg, Pennsylvania. 29 October.
93. **Maqsood, H. 2018.** *Guar Crop Coefficient Development for New Mexico Environments.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 7 November.
94. **Maqsood, H. 2020.** *Model parameterization for guar irrigation schedule and biomass estimation using remote sensing.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 1 April.
95. **Maqsood, H.*; Angadi, S.; El-Shikha, D.E.M.; Waller, P.; Singh, J.; Hunsaker, D.; Barua, B. 2019.** *Evaluating crop water status for guar using WINDS model.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
96. **Marinez, C.*; Lopez, G.U.; Cabrera D.d.J. 2019.** *The University of Arizona Cooperative Extension 4H Program Collaborating Statewide in Preparing the Next Generation of STEM Innovators.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
97. **McCloskey, W. 2018.** *Weed Trial Results for Guayule.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 14 November.
98. **McCloskey, W. 2019.** *Guayule Weed Control Research.* The 9th Annual Central Arizona Farmer Field Day. Maricopa Agricultural Center (MAC), Maricopa, Arizona. 8 October.
99. **McCloskey, W. 2020.** *2019 Herbicide Progress Report: Aim herbicide experiments and preemergence herbicide experiment failures.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 29 January.

100. **McMahan, C. 2018.** *Flowering Reduction in Guayule*. SBAR UA Research Team Seminar Series, Tucson, Arizona. 19 September.
101. **McMahan, C. 2019.** *USDA-ARS Rubber Lab Update*. SBAR UA Research Team Seminar Series, Tucson, Arizona. 27 March.
102. **McMahan, C.*; Placido, D.; El-Shikha, D.E.M.; Dong, C.; Ponciano, G.; Neilson, J.W. 2019.** *Dormancy and the guayule (Parthenium argentatum A. Gray) soil microbiome*. 31st Annual Meeting of the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]
103. **McMahan, C.*; Placido, D.; Resendiz, M.; Ponciano, G. 2020.** *Flowering downregulation in guayule*. Update to SBAR Advisory Board. Online presentation. 12 February.
104. **Mealing, V. 2018.** *An overview of sustainability analysis methods of a new biofuel feedstock: bagasse from guar*. 6th Colorado School of Mines Graduate and Discovery Symposium. Golden, Colorado. 5 April.
105. **Mealing, V. 2019.** *Criteria, Methods, Opportunities, and Needs for Social Sustainability of Emerging Technology*. 7th Colorado School of Mines Graduate Research and Discovery Symposium. Golden, Colorado. April.
106. **Mealing, V. 2019.** *Sustainability assessment of guayule agriculture: Potential processing improvements for guayule co-products*. USDA-ARS, Western Regional Research Center, Albany, California. 3 July. [invited speaker]
107. **Mealing, V. 2019.** *Field Data Collection and Integration*. SBAR System Performance and Sustainability Seminar, Colorado State University, Fort Collins, Colorado. 13 November.
108. **Mealing, V. 2020.** *Field data collection update*. SBAR System Performance and Sustainability Seminar, Colorado State University, Fort Collins, Colorado. 19 February.
109. **Mealing, V.*; Harris, T.; Landis, A.E. 2019.** *Criteria, Methods, Opportunities, and Needs for Social Sustainability of Emerging Technology*. 15th International Conference on Environmental, Cultural, Economic and Social Sustainability. Vancouver, Canada. February.
110. **Mealing, V.*; Summers, H.M.; Sproul, E.; Eranki, P.L.; Landis, A.E.; Quinn, J.C. 2018.** *Life Cycle Assessment of Cultivating Guar in the American Southwest*. LCA XVIII Conference. Fort Collins, Colorado. October [poster] Won second place in graduate student posters.
111. **Mealing, V.*; Summers, H.M.; Sproul, E.; Eranki, P.L.; Quinn, J.C.; Landis, A.E.. 2018.** *Life Cycle Assessment of Cultivating Guar in the American Southwest*. National Society of Black Engineers, Fall Regional Conference. Las Vegas, Nevada. November [poster]
112. **Mealing, V.S.*; Landis, A.E. 2019.** *Life cycle assessment of guar agriculture in the Southwest, USA*. 31st Annual Meeting of the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]
113. **Mealing, V.S.*; Landis, A.E. 2019.** *SBAR Sustainability*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
114. **Mi, W.*; Teetor, V.H.; Ray, D.T. 2018.** *Rubber and Resin Extraction of Differentially Treated Biomass in Guayule (Parthenium argentatum)*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 2 August. [poster]
115. **Morris, N. 2020.** *SBAR 4-H opportunities and future directions*. SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 19 February.

116. Neilson, J.W. 2019. *Soil Microbiome Resilience to Stress: How much is too much?* USDA-ARS, Western Regional Research Center, Albany, California. June. [invited speaker]
117. Neilson, J.W.; Ossanna, L. 2020. *Associations between the guayule rhizosphere microbiome and plant growth architecture, and rubber/resin production*. SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 4 March.
118. Niu, D., 2018. *Partial cloning of APETALA1 (AP1) gene from guayule*. cDNA Lab Seminar, USDA-ARS Western Regional Research Laboratory. 28 March.
119. Ogden, K. 2017. *Introducing new USDA NIFA CAP grant awardees – Developing regional AJF supply chains: Sustainable Bioeconomy for Arid Regions*. CAAFI-SOAP Jet Webinar. Hosted online. 13 October. [invited speaker]
120. Ogden, K. 2017. *Sustainable Bioeconomy for Arid Regions*. Biomass Research and Development Technical Advisory Board Meeting. 15 November. [invited speaker]
121. Ogden, K. 2018. *Sustainable Bio-economy for Arid Regions*. Southwest Indian Agricultural Association Annual Meeting. Laughlin, Nevada. 16-18 January.
122. Ogden, K. 2018. *Potential of the Bioproducts and Biofuels Economy*. AIChE Annual Meeting, Pittsburg, Pennsylvania. October [invited speaker]
123. Ogden, K. 2020. *Sustainable Bioeconomy for Arid Regions*. Grain Processing Lecture Series, Michigan Technological University, Houghton, Michigan. 17 January [invited speaker]
124. Ogden, K. 2020. *SBAR Project Update*. Southwest Indian Agriculture Association (SWIAA) 32nd Annual Conference, Laughlin, Nevada. 20-23 January [invited speaker]
125. Ogden, K. 2020. *Sustainable Bioeconomy for Arid Regions*. University of Utah, Salt Lake, Utah. 2 March. [invited distinguished lecturer]
126. Ogden, K.*, White, R., Brewer, C.E. 2018. *Public Private Partnerships*. ABLC Conference. Washington, D.C. 27-28 February.
127. Ossanna, L.*; Placido, D.; El-Shikha, D.E.M.; Dong, C.; Ponciano, G.; McMahan, C.; Maier, R.M., Neilson, J.W. 2019. *Root-zone microbiome dynamics and guayule rubber production*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
128. Ponciano, G.*; Dong, N.; Placido, D.; Borg, K.; Fonseca, L.; Howard, C.; Shintani, D.; McMahan, C. 2019. *Bioengineering of guayule (*Parthenium argentatum*) to enhance tocopherols content*. 31st Annual Meeting of the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]
129. Pruitt, D.*; Idowu, O.J.; Sanogo, S.; Angadi, S.; Steiner, R.L. 2019. *The effects of mycorrhizae inoculation and soil amendments on growth of guar and pinto beans*. ASA-CSSA-SSSA International Annual Meetings, San Antonio, Texas, 13 November.
130. Rock, C.*, Brassill, N. 2018. *Importance of Cooperative Extension in University Research*. University of Arizona, Tucson, Arizona. 14 March.
131. Rogstad, A. 2018. *Real World Supply Chain Development: USDA Coordinated Agriculture Projects*. SBAR Overview. CAAFI Biennial General Meeting and Integrated ASCENT Symposium. Washington, D.C. 4-6 December. [invited speaker]
132. Rogstad, A. 2019. *SBAR Overview*. Association for the Advancement of Industrial Crops 31st Annual Meeting. Tucson, Arizona. 8 September. [invited speaker]
133. Rodriguez-Uribe, L.*; Gutierrez, P. 2019. *Implementing the Science of SBAR with Youth*. SBAR UA Research Team Seminar, University of Arizona, Tucson. 25 September.

134. **Rosalez, R.*; Brewer, C.E.; Jena, U. 2019.** *Co-Hydrothermal liquefaction (HTL) of guayule bagasse and wastewater treatment microalgae*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
135. **Sapkota, P.*; Imel, R.K.; Liu, W.; Angadi, S.; Trostle, C.; Williams, R.B.; Peffley, E.B.; Auld, D.L.; Burrow, M.D. 2019.** *Evaluation of breeding populations of guar for cultivation in Southwestern United States*. ASA-CSSA-SSSA International Annual Meetings, San Antonio, Texas, 12 November.
136. **Singh, J. 2020.** *Guar growth and development under pre-season and in-season irrigation management in the southern High Plains*. Master of Science Thesis. New Mexico State University, Las Cruces, New Mexico. 3 April.
137. **Singh, J.*; Angadi, S.V.; Begna, S.H. 2018.** *Crop Growth Stage Based Deficit Irrigation Management in Guar Crop*. The Western Sustainable Agriculture Conference (WSARE), University of New Mexico – Valencia Campus, Los Lunas, New Mexico. 12 December [poster]
138. **Singh, J.*; Angadi, S.V.; Begna, S.H. 2019.** *Identify guar germplasm suitable for cooler northern latitudes*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster] Won 2nd Place in graduate student poster presentation competition.
139. **Singh, J.*; Angadi, S.V.; Begna, S.H. 2020.** *Identify guar germplasm suitable for cooler northern latitudes of the Southern High Plains*. *In: Agricultural Science Center 2020 Annual Report*. New Mexico State University, Clovis, New Mexico.
140. **Singh, J.*; Angadi, S.V.; Begna, S.H.; Guzman, I.; Idowu, O.J. 2019.** *Sustaining water resources using guar crop under different irrigation practices*. ACES-Open House, New Mexico State University, Las Cruces, New Mexico. 6 April. [poster]
141. **Singh, J.*; Angadi, S.V.; Begna, S.H.; Idowu, O.J. 2019.** *Guar as an alternative crop*. Annual Agricultural Field Day. Agricultural Science Center, Clovis, New Mexico. 8 August.
142. **Singh, J.*; Angadi, S.V.; Begna, S.H.; Idowu, O.J.; Guzman, I.; VanLeeuwen, D. 2019.** *Water extraction patterns of guar under different irrigation strategies in the Southern High Plains*. Western Society of Crop Science Annual Meeting. Pasco, Washington. 25-26 June. [poster] Won 1st Place in student poster competition.
143. **Singh, J.*; Angadi, S.V.; Begna, S.H.; Idowu, O.J.; Guzman, I.; VanLeeuwen, D. 2019.** *Evaluating the effect of different irrigation practices on guar in the Southern High Plains*. Western Society of Crop Science Annual Meeting. Pasco, Washington. 25-26 June. Won 2nd Place in student oral presentation competition.
144. **Singh, J.*; Angadi, S.V.; Begna, S.H.; VanLeeuwen, D.; Idowu, O.J. 2019.** *Drought response and yield formation of guar under different water regimes in the Southern High Plains*. ASA-CSSA-SSSA International Annual Meetings, San Antonio, Texas. 10 November.
145. **Singh, J.*; Angadi, S.V.; Begna, S.H.; VanLeeuwen, D.; Idowu, O.J.; Guzman, I. 2020.** *Sustaining Irrigation Water of the Southern High Plains Using Guar*. New Mexico Alternative Crops Conference, Portales, New Mexico. 10 March. [poster]
146. **Skuse, K.*; Dery, J.; Zozaya, S.; Brassill, N.; Rock, C. 2018.** *Public interest in guayule being used as a biofuel*. University of Arizona, Maricopa Agricultural Center, Maricopa, Arizona. 26 July. [poster]

147. **Skuse, K.*; Dery, J.; Zozaya, S.; Brassill, N.; Rock, C. 2018.** *Public interest in guayule being used as a biofuel.* Oral presentation of student internship work. University of Arizona, Maricopa Agricultural Center, Maricopa, Arizona. 26 July.
148. **Smith, A. 2020.** *Valorization of guayule resin.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 22 April.
149. **Soliz, N.*; Brewer, C.E.; Jena, U.; 2019.** *Bomb calorimetry of guayule bagasse and hydrothermal liquefaction products.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
150. **Soto, A.L.*; Placido, D.; Dong, C.; Ponciano, G.; McMahan, C.; Maier, R.M.; Neilson, J.W. 2019.** *Soil parameters that influence natural rubber production in guayule (*Parthenium argentatum*) during winter dormancy.* SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster] Won 2nd Place in intern student poster presentation competition.
151. **Sproul, E. 2020.** *Integrated Economic & Environmental Analysis of Guayule and Guar Production.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 22 January.
152. **Sproul, E.*; Summers, H.M.*; Quinn, J.C. 2019.** *Techno-Economic and Environmental Impact Analysis of Guayule and Guar.* International Symposium on Sustainable Systems and Technology, Portland, Oregon. June. [poster] Won 1st Place in student poster competition.
153. **Sproul, E.*; Summers, H.M.; Mealing, V.; Landis, A.E.; Seavert, C.; Teegerstrom, T.; Gutierrez, P.; Robbs, J.; Fan, N.; Sun, O.; Quinn, J.C. 2019.** *Integrated environmental and economic assessment of guar and guayule.* American Center for Life Cycle Assessment (ACLCA) LCA XIX, Tucson, Arizona. 24-26 September. [poster]
154. **Sun, O. 2018.** *GIS-Based Two-stage Stochastic Facility Location Considering Planting Plan Uncertainty.* INFORMS Annual Meeting, Phoenix, Arizona. 5 November.
155. **Sun, O. 2018.** *GIS-Based Two-stage Stochastic Facility Location Considering Planting Plan Uncertainty.* SBAR UA Research Team Seminar. University of Arizona, Tucson, Arizona. 28 November.
156. **Sun, O. 2019.** *Optimization of a Biomass Supply chain from Economic, Environmental, and Social Perspectives.* Dr. Fan's Group Meeting, University of Arizona, Tucson, Arizona. 13 March.
157. **Sun, O. 2019.** *Biomass Supply Chain Configuration and Management.* SBAR UA Research Team Seminar. University of Arizona, Tucson, Arizona. 10 April.
158. **Sun, O. 2019.** *Integrating Environmental and Social Impacts into Biomass Supply Chain.* SBAR System Performance and Sustainability Team Seminar. Virtual meeting space, Tucson, Arizona. 2 May.
159. **Sun, O.*; Fan, N. 2018.** *Harvest scheduling.* SBAR Logistics Team Group Meeting. (webinar) New Mexico State University. Las Cruces, New Mexico. 5 February.
160. **Sun, O.*; Fan, N. 2018.** *Optimization of feedstock logistics.* SBAR UA Research Seminar. University of Arizona. Tucson, Arizona. 14 February.
161. **Sun, O.*; Fan, N. 2018.** *Optimally locating biorefineries.* SBAR Sustainability Working Group Seminar. (webinar) Colorado State University. Lakewood, Colorado. 8 March.
162. **Summers, H.M.*; Sproul, E.; Johnson, J.; Quinn, J.C. 2017.** *Sustainability assessment of bioproducts from southwest arid crops.* 21st Century Energy Transition Symposium, Colorado State University, Fort Collins, Colorado. October.

163. **Summers, H.M.*; Sproul, E.; Johnson, J.; Quinn, J.C. 2017.** *Sustainability assessment of bioproducts from southwest arid crops*. Colorado State University Graduate Student Showcase, Colorado State University, Fort Collins, Colorado. November.
164. **Summers, H.M.*; Sproul, E.; Johnson, J.; Quinn, J.C. 2018.** *Economic Viability and Environmental Impact of processing arid crops in the American Southwest*. International Congress on Environmental Modelling and Software. Colorado State University, Fort Collins, Colorado. June.
165. **Summers, H.M.*; Sproul, E.; Johnson, J.; Quinn, J.C. 2019.** *Economic and Environmental Impact Assessments of Drought Tolerant Crops in the American Southwest*. 21st Century Energy Transition Symposium, Denver, Colorado. April.
166. **Summers, H.M.*; Sproul, E.; Mealing, V.; Eranki, P.L.; Landis, A.E.; Quinn, J.C. 2018.** *Process Modeling and Life Cycle Assessment of Rubber from Guayule*. LCA XVIII Conference, Fort Collins, Colorado. October.
167. **Teegerstrom, T; Seavert, C. 2020.** *Whole farm analysis for evaluating the adoption of guayule and guar into Southwest producers' current operations*. SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 12 February.
168. **Usrey, J.*; Dehghanizadeh, M.; Audu, M.; Rosalez, R. 2019.** *SBAR Education/Outreach at Lynn Middle School and Mesilla Valley Leadership Academy*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
169. **Waller, P. 2018.** *WINDS Model: A status report and connection to SBAR research*. SBAR UA Research Team Seminar Series, Tucson, Arizona. 10 October.
170. **Wang, G.S.*; Lynch, A.; Cruz, V.M.V.; Dierig, D.A. 2019.** *Temperature requirements for guayule seed germination*. 31st Annual Meeting of the Association for the Advancement of Industrial Crops. Tucson, Arizona. 8-11 September. [poster]
171. **Willmon, J.*, Hu, J., Teetor, V.H., and Ray, D.T. 2018.** *Screening Parthenium argentatum for resistance to Phymatotrichum omnivorum*. 2018 Annual Conference, American Society for Horticultural Science, Washington, D.C. 30 July – 3 August.
172. **Willmon, J.; Montes, M.*; Coronado, G.; Bennett, M.C.; Teetor, V.H.; Hu, J.; Ray, D.T. 2018.** *Screening Parthenium argentatum for Resistance to Phymatotrichum omnivora*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 2 August. [poster]
173. **Wright, A.*; Brewer, C.E.; Jena, U. 2019.** *CHNS elemental analysis of guayule and products*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
174. **Zuniga-Vasquez, D. 2019.** *Two-stage stochastic multi-objective optimization for biomass supply chain integrating environmental and social impacts*. SBAR Annual Retreat, University of Arizona, Tucson, Arizona. 11-13 September. [poster]
175. **Zuniga-Vasquez, D. 2019.** *Stochastic scenarios for guayule production*. SBAR System Performance and Sustainability Seminar, Colorado State University, Fort Collins, Colorado. 8 October.
176. **Zuniga-Vasquez, D. 2019.** *Stochastic multi-objective optimization for guayule supply chain integrating environmental and social impacts*. SBAR UA Research Seminar, University of Arizona, Tucson, Arizona. 4 December.

177. **Zuniga-Vasquez, D.; Fan, N. 2020.** *Optimization for guayule and guar logistics and transportation.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 19 February.
178. **Zuniga-Vasquez, D. 2020.** *Optimization for guayule and guar logistics and transportation.* SBAR UA Research Team Seminar. University of Arizona. Tucson, Arizona. 8 April.
179. **Zuniga-Vasquez, D.; Sun, O.; Fan, N. 2020.** *Optimization for guayule and guar logistics and transportation integrating environmental and social impacts on the supply chain.* New Mexico Alternative Crop Conference, Portales, New Mexico. 10 March. [poster]

Total Audience Demographics for Project-Related Presentations (when captured)

Audience Demographic Parameter	Previous Total (Cumulative)	This Quarter Total	Cumulative Project Total
Gender			
Males	1,244	403	1,647
Females	561	192	753
Race/Ethnicity			
Hispanic	253	106	359
Asian	156	48	204
Native American	242	67	309
African American	57	6	63
Anglo/White	1,097	368	1,465

Audience Cumulative Total (when captured): 2,400 ppl

WEBSITE(S) OR INTERNET SITE(S)

SBAR Project Website

1. [.https://sbar.arizona.edu](https://sbar.arizona.edu)

NEW TECHNOLOGIES OR TECHNIQUES GENERATED

None this reporting period.

INVENTIONS, PATENT APPLICATIONS, AND/OR LICENSES

1. **Dec 2017.** 24c SLN Label for Gramoxone SL 2.0 Herbicide (Paraquat dichloride), for control of weeds in guayule. SLN Registration Number: AZ120005. Expiration: 31 Dec 2022. Arizona Department of Agriculture, Environmental Services Division.
2. **Dec 2017.** 24c SLN Label for Fusilade DX Herbicide (*Propanoic acid, 2-(4-((5-(trifluoromethyl)-2-pyridinyl)oxy)phenoxy)-, butyl ester, (R)-*), for control of emerged

weeds in guayule. SLN Registration Number: AZ070006. Expiration: 31 Dec 2022.
Arizona Department of Agriculture, Environmental Services Division.

OTHER PRODUCTS GENERATED

Brochures, Factsheets, and Flyers

1. **Duncan, C.M. 2018.** SBAR USDA-NIFA graduate student fellowship: UA Students. One page promotional flyer. February and March.
2. **Duncan, C.M. 2018.** SBAR USDA-NIFA graduate student fellowship: NMSU Students. One page promotional flyer. February and March.
3. **Duncan, C.M. 2018.** SBAR call for middle and high school science teachers. One page promotional flyer. February and March.
4. **Duncan, C.M. 2018.** SBAR 4-H summer camp: Biofuels powering your world. One page promotional flyer. March.
5. **Duncan, C.M. 2019.** SBAR Call for Middle & High School Science Teachers. One page promotional flyer. March.
6. **Duncan, C.M. 2019.** SBAR USDA-NIFA graduate student fellowship: UA Students. One page promotional flyer. March.
7. **Duncan, C.M. 2019.** SBAR USDA-NIFA graduate student fellowship: NMSU Students. One page promotional flyer. March.
8. **Duncan, C.M. 2019.** SBAR USDA-NIFA graduate science education fellowship. One page general recruiting flyer. April.
9. **Evancho, B. 2019.** Guayule Information & Feedback Session. One page invitation to attend field day and tour. May.
10. **Grover, K. 2018.** Guar – A potential alternative crop in New Mexico. Two page informational handout. January.
11. **Kiela, C. 2018.** Guayule. SBAR Project two-page fact sheet. March.
12. **Kiela, C. 2018.** Guar. SBAR Project two-page fact sheet. April.
13. **Kiela, C. 2018.** History of Guayule. SBAR Project two-page fact sheet. April.
14. **Rogstad, A. 2017.** SBAR – Sustainable Bioeconomy for Arid Regions. One-page informational and promotional card. November.

Press Releases and News Articles

1. 26 Sep 2017. "As NIFA awards \$21.1M to grow the bioeconomy, CABLE debuts to bridge students and industry." BiofuelsDigest.
<http://www.biofuelsdigest.com/bdigest/2017/09/26/as-nifa-awards-21-1m-to-grow-the-bioeconomy-cable-debuts-to-bridge-students-and-industry/>
2. 16 Oct 2017. "UA to Head New Center Focusing on Biofuels and Bioproducts." UA News. <https://uanews.arizona.edu/story/ua-head-new-center-focusing-biofuels-and-bioproducts>
3. 4 Nov 2017. "Biofuels, bioproducts, and an Arizona bioeconomy?" Arizona Daily Wildcat. <http://www.wildcat.arizona.edu/article/2017/11/science-biofuels-and-bioproducts>

4. 29 Nov 2017. "NMSU to host state sustainable agriculture conference in Los Lunas." News Bulletin. http://www.news-bulletin.com/news/nmsu-to-host-state-sustainable-agriculture-conference-in-los-lunas/article_a45281f6-d540-11e7-9530-27dc93258a79.html
5. 16 Jan 2018. "Dr. Quinn's Sustainability Expertise Recruited for Multi-Million Dollar DOE and USDA Grants." Colorado State University, Mechanical Engineering Featured Projects. <http://www.engr.colostate.edu/me/2018/01/16/dr-quinns-sustainability-expertise-recruited-for-multi-million-dollar-doe-and-usda-grants/>
6. 21 Feb 2018. "NMSU collaborating in Sustainable Bio-economy for Arid Regions project." New Mexico State University News Center. <http://newscenter.nmsu.edu/Articles/view/12961/nmsu-collaborating-in-sustainable-bio-economy-for-arid-regions-project>
7. 27 Feb 2018. "Bridgestone receives guayule research grant from USDA." The Smithers Report - A daily and weekly tire industry news source. (4,500 daily subscribers) <https://www.smithersrapra.com/publications/the-smithers-report>
8. 27 Feb 2018. "Bridgestone and research partners earn \$15 Million grant for guayule work." MTD (Modern Tire Dealer). UMW: 62,085. <http://www.moderntiredealer.com/news/728673/bridgestone-and-research-partners-earn-15-million-grant-for-guayule-work>

Tabling Events and Workshops – Marketing and Outreach

1. 14 July 2017. New Mexico Cotton Ginners Conference. New Mexico.
2. 17 Aug 2017. SBAR Project Kick-off Meeting. Tucson, Arizona.
3. 28 Oct 2017. Rocky Mountain Zone Summit (sustainability focus). Denver, Colorado.
4. 05 Dec 2017. Valencia County (New Mexico) Forage Conference. New Mexico.
5. 13 Dec 2017. New Mexico Sustainable Agriculture Conference. Los Lunas, New Mexico.
6. 15-17 Feb 2018. SBAR Display Table. New Mexico Organic Farming Conference. Albuquerque, New Mexico.
7. 24 Feb 2018. Farm Science Day. USDA-ARS, Arid-Land Agricultural Resource Center. Maricopa, Arizona.
8. 24 Feb 2018. 2018 Engineering Fair – Recycled papermaking and guar gum bubbles activity. Las Cruces Museum of Science and Nature. Las Cruces, New Mexico.
9. 15 Mar 2018. Zia Middle School Project – Lead the Way NMSU College of Engineering Day. Recycled papermaking and guar gum bubbles activity. Las Cruces, New Mexico.
10. 22-24 Feb 2018. Southwest Ag Summit. Yuma, Arizona.
11. 19 Mar 2018. Roosevelt Irrigation District Board Meeting. Buckeye, Arizona.
12. 28 Mar 2018. Alfalfa and Forage Workshop. Maricopa, Arizona.
13. 11 Jul 2018. New Mexico 4-H State Conference – Polymerization and guar gum bubbles activity. Albuquerque, New Mexico.
14. 9 Aug 2018. Extension Field Day, New Mexico State University Agricultural Science Center, Clovis, New Mexico.

15. 23 Aug 2018. Extension Field Day, New Mexico State University Agricultural Science Center, Artesia, New Mexico.
16. 12 Dec 2018. New Mexico Sustainable Agriculture Conference, Las Cruces, New Mexico.
17. 10 Jan 2019. Marana Winter Field Crop Clinic. University of Arizona Cooperative Extension, Marana, Arizona.
18. 15 Jan 2019. Casa Grande Winter Field Crop Clinic. University of Arizona Cooperative Extension, Casa Grande, Arizona.
19. 23 Jan 2019. New Mexico Cotton Growers Association Conference, Ruidoso, New Mexico.
20. 13 Feb 2019. Desert Hills S.T.E.A.M. Night. (Science, Technology, Engineering, Art, and Math) Desert Hills Elementary School, Las Cruces, New Mexico.
21. 15-16 Apr 2019. New Mexico Organic Farming Conference, Albuquerque, New Mexico.
22. 11 Apr 2019. Spring Extension Field Day, New Mexico State University Agricultural Science Center, Clovis, New Mexico.
23. 15 May 2019. Annual Agricultural Research Congressional Exhibition and Reception. Rayburn House, Washington, D.C.
24. 30 May 2019. Market Discussion and Field Day. Bridgestone Guayule Research Farm, Eloy, Arizona.
25. 26 Jun 2019. Extension Field Day. Fabian Garcia Research Center, Las Cruces, New Mexico.
26. 2 Jul 2019. SBAR Train the Trainers Workshop. Las Cruces, New Mexico.
27. 8 Aug 2019. Annual Agricultural Field Day. Agricultural Science Center, Clovis, New Mexico.
28. 8 Aug 2019. Agricultural Science and Field Day. Agricultural Science Center, Tucumcari, New Mexico.
29. 15 Aug 2019. Annual Agricultural Field Day. Agricultural Science Center, Los Lunas, New Mexico.
30. 21 Aug 2019. USAID Cochran Fellows Visit from Mali, Clovis, New Mexico.
31. 12 Oct 2019. Cooperative Extension Day. Maricopa Agricultural Center (MAC), Maricopa, Arizona.
32. 14 Jan 2020. Winter Field Crops Meeting, Pima County, Arizona.
33. 15 Jan 2020. Winter Field Crops Meeting, Pinal County, Arizona.
34. 29 Jan 2020. New Mexico Cotton Grower's Conference, New Mexico.
35. 30 Jan 2020. NexGen Cotton Symposium, Pinal County, Arizona.
36. 3-4 Feb 2020. New Mexico Chili Pepper Conference, New Mexico.
37. 5 Feb 2020. Deltapine Seed Meeting, Pinal County, Arizona.
38. 21-22 Feb 2020. New Mexico Organic Farming Conference, New Mexico.
39. 10 Mar 2020. New Mexico Alternative Crops Conference, Portales, New Mexico.

→Total Reach via Tabling Events and Workshops (when captured): **3,562 participants**

YOUTH ACTIVITIES

Biofuel Lessons in Classrooms (SBAR Teacher/Fellow Cohort 2018-2019)

1. Apollo Middle School, Tucson, Arizona.
2. Mesilla Valley Leadership Academy, Las Cruces, New Mexico.
3. Pueblo High School, Tucson, Arizona.
4. Quail Run Elementary School, Marana, Arizona.
5. Sierra Middle School, Las Cruces, New Mexico.
6. Valencia Middle School, Tucson, Arizona.
7. Walter Douglas Elementary School, Tucson, Arizona.

Biofuel Lessons in Classrooms (SBAR Teacher/Fellow Cohort 2019-2020)

1. Apollo Middle School, Tucson, Arizona.
2. Camino Real Middle School, Las Cruces, New Mexico.
3. Mesa Middle School, Las Cruces, New Mexico
4. Mesilla Valley Leadership Academy, Las Cruces, New Mexico.
5. Quail Run Elementary School, Marana, Arizona.
6. Pueblo High School, Tucson, Arizona.
7. Saguaro National Park Environmental Education, Tucson, Arizona.
8. Santa Rosa Ranch School, Sells, Arizona.
9. Sierra Middle School, Las Cruces, New Mexico.
10. Walter Douglas Elementary School, Tucson, Arizona.

Youth participation through classroom activities is tracked at the beginning of the school year in September because the same students are being reached each week by the teacher fellow pairs.

Other SBAR youth activities (4H camps, after school programs, Native Youth Outreach, etc.) are also included in the total when they occur.

Youth Participation Demographics for Project-Related Activities (when captured)

Youth Participation Demographic Parameter	Previous Total (Cumulative)	This Quarter Total	Cumulative Project Total
Age Level			
11-13 years	1,242	0	1,242
14-16 years	433	40	473
Gender			
Males	834	24	858
Females	841	16	857
Race/Ethnicity			
Hispanic	893	3	896
Asian	33	0	33
Native American	159	24	183
African American	47	0	47
Anglo/White	538	5	543
Multiracial	6	8	14

Youth Cumulative Total (when captured): 1,715 ppl

PARTICIPANTS AND COLLABORATING ORGANIZATIONS.

September 2017 – December 2019

PARTNER ORGANIZATIONS

Organization Person*	Project Role	Project Component
Bridgestone Americas,		
Von Mark Cruz	Professional	Feedstock Development & Production
David Dierig	Key Collaborator	Feedstock Development & Production
Stefan Dittmar	Professional	Feedstock Development & Production
<i>Chloe Gonzalez</i>	<i>Intern</i>	<i>Feedstock Development & Production</i>
Amber Lynch	Professional	Feedstock Development & Production
Russell Prock	Professional	Feedstock Development & Production
Theresa Sullivan	Professional	Feedstock Development & Production
Sam Wang	Professional	Feedstock Development & Production
<i>Jocelyn Zhu</i>	<i>Intern</i>	<i>Feedstock Development & Production</i>
Colorado School of Mines		
<i>Pragnya Eranki</i>	<i>Post-doc</i>	<i>System Performance & Sustainability</i>
Amy Landis	Key Collaborator	System Performance & Sustainability
VeeAnder Mealing	Graduate Student	System Performance & Sustainability
Colorado State University		
Austin Banks	Undergrad Student	System Performance & Sustainability
<i>Jack Johnson</i>	<i>Undergrad Student</i>	<i>System Performance & Sustainability</i>
Paula Mendoza Moreno	Undergrad Student	System Performance & Sustainability
Jason Quinn	Key Collaborator	System Performance & Sustainability
Evan Sproul	Graduate Student	System Performance & Sustainability
Hailey Summers	Graduate Student	System Performance & Sustainability
New Mexico State University		
<i>Ram Acharya</i>	<i>Professional</i>	<i>System Performance & Sustainability</i>
<i>Sarah Acquah</i>	<i>Post-doc</i>	<i>Extension & Outreach</i> <i>System Performance & Sustainability</i>
Rowen Allen	Undergrad Student	Extension & Outreach
Sangu Angadi	Key Collaborator	Extension & Outreach Feedstock Development & Production
Matt Armijo	Undergrad Student	Characterizations & Co-Products
<i>Meshack Audu</i>	<i>Graduate Student</i> <i>Fellow</i>	<i>Education</i> <i>Characterizations & Co-Products</i>
<i>Valerie Bailey</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Hengameh Bayat	Graduate Student	Characterizations & Co-Products
Sultan Begna	Professional	Feedstock Development & Production
<i>Geneva Ben</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Pratima Bhandari</i>	<i>Graduate Student</i>	<i>System Performance & Sustainability</i>
Catherine E. Brewer	Key Collaborator	Education Characterizations & Co-Products
<i>Nicolas Carrera-Little</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>

Pedro Castillo	Undergrad Student	Feedstock Development & Production
Ken Cazarez	Undergrad Student	Extension & Outreach
Feng Cheng	Post-doc	Characterizations & Co-Products
Murali Darapuneri	Professional	Extension & Outreach
Mostafa Dehghanizadeh	Graduate Student Fellow	Education Characterizations & Co-Products
Barry Dungan	Professional	Characterizations & Co-Products
Dominic Flores	Undergrad Student	Feedstock Development & Production
<i>Miguel Flores</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>
Leonel Fournier	Undergrad Student	Feedstock Development & Production
<i>Sarah Fox</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
Ryan Fullerton	Undergrad Student	Feedstock Development & Production
<i>Alonso Garcia</i>	<i>Graduate Student</i>	<i>Feedstock Development & Production</i>
Adah Gellis	Undergrad Student	Extension & Outreach
<i>Saba Gill</i>	<i>Graduate Student</i>	<i>Characterizations & Co-Products</i>
<i>Thomas Gloria</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Kulbhushan Grover	Key Collaborator	Extension & Outreach Feedstock Development & Production
Erin Gutierrez	Undergrad Student	Characterizations & Co-Products
Paul H Gutierrez	Key Collaborator	Extension & Outreach System Performance & Sustainability
<i>Befekadu Habteyes</i>	<i>Professional</i>	<i>System Performance & Sustainability</i>
F. Omar Holguin	Key Collaborator	Characterizations & Co-Products
John Idowu	Key Collaborator	Extension & Outreach
Jackie Jarvis	Professional	Characterizations & Co-Products
Umakanta Jena	Professional	System Performance & Sustainability
Sita Khanal	Graduate Student	System Performance & Sustainability
Alix Knagg	Undergrad Student	Characterizations & Co-Products
Kelly Laje	Graduate Student	Characterizations & Co-Products
<i>Travis Le-Doux</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Esai Lopez</i>	<i>Undergrad Student</i>	<i>Education</i>
<i>Alberto Lorenzo</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Sicilee Macklin</i>	<i>Undergrad Student</i>	<i>Education</i> <i>Characterizations & Co-Products</i>
Michael Mares	Undergrad Student	Extension & Outreach
<i>Cesar Martinez-Bejarano</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
Julie Miller	Undergrad Student	Extension & Outreach
<i>Sa'Rae Montoya</i>	<i>Graduate Student</i>	<i>Characterizations & Co-Products</i>
<i>Kyle Moore</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Hasti Mozaffari	Graduate Student	Characterizations & Co-Products
Mohammed Omer	Graduate Student	Extension & Outreach
<i>Jasmine Paquin</i>	<i>Graduate Student</i>	<i>Extension & Outreach</i>
<i>Kaavya Polisetti</i>	<i>Graduate Student</i>	<i>Characterizations & Co-Products</i>
<i>Camila Prieto</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>
Darien Pruitt	Graduate Student Fellow	Education Extension & Outreach
<i>Lucas Ramirez</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Joram Robbs</i>	<i>Graduate Student</i>	<i>Extension & Outreach</i> <i>System Performance & Sustainability</i>
Laura Rodriguez-Uribe	Professional	Extension & Outreach Characterizations & Co-Products
Alvaro Romero	Professional	Characterizations & Co-Products
Rodrigo Rosalez	Graduate Student Fellow	Education Characterizations & Co-Products

<i>Kimberly Salinas</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>
<i>Nathan Schavz</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Tarah Schuman</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Ujala Sehar</i>	<i>Graduate Student</i>	<i>Characterizations & Co-Products</i>
<i>Sergei Shalygin</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Jagdeep Singh</i>	<i>Graduate Student</i>	<i>Education</i> <i>Feedstock Development & Production</i>
<i>Parameer Singh</i>	<i>Graduate Student</i> <i>Fellow</i>	<i>Education</i>
<i>Peter Skelton</i>	<i>Professional</i>	<i>Extension & Outreach</i>
<i>Nicolas Soliz</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Grant Stoner</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>David Struthers</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Stephen Taylor</i>	<i>Undergrad Student</i>	<i>Education</i>
<i>Brian Treftz</i>	<i>Graduate Student</i>	<i>Education</i> <i>Characterizations & Co-Products</i>
<i>Jacob Usrey</i>	<i>Graduate Student</i> <i>Fellow</i>	<i>Education</i> <i>Characterizations & Co-Products</i>
<i>Justin Valdez</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Victoria Valenzuela</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Stephanie Willette</i>	<i>Graduate Student</i>	<i>Characterizations & Co-Products</i>
<i>Scott Woolf</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>April Wright</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
Other		
<i>Jennifer Fields</i>	<i>Professional</i>	<i>Education</i> <i>Extension & Outreach</i>
<i>Clark Seavert</i>	<i>Professional</i>	<i>System Performance & Sustainability</i> <i>Extension & Outreach</i>
University of Arizona		
<i>Torran Anderson</i>	<i>Professional</i>	<i>Education</i> <i>Extension & Outreach</i>
<i>Nick Ashley</i>	<i>Graduate Student</i>	<i>Feedstock Development & Production</i>
<i>Craig Bal</i>	<i>Graduate Student</i>	<i>Education</i> <i>Extension & Outreach</i>
<i>Gloria Villa Barbosa</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>
<i>Armando Barreto</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
<i>Holly Barton</i>	<i>Graduate Student</i> <i>Fellow</i>	<i>Education</i>
<i>Kaitlyn Benally</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>
<i>Megan Bennett</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Natalie Brassill</i>	<i>Professional</i>	<i>Extension & Outreach</i>
<i>Kyle Brown</i>	<i>Graduate Student</i>	<i>Feedstock Development & Production</i>
<i>Kale Burke</i>	<i>Undergrad Student</i>	<i>Characterizations & Co-Products</i>
<i>Daniela Cabrera</i>	<i>Professional</i>	<i>Extension & Outreach</i>
<i>Madasu Chandrashekar</i>	<i>Professional</i>	<i>Characterizations & Co-Products</i>
<i>Connor Chaney</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Sara Chavarria</i>	<i>Key Collaborator</i>	<i>Education</i>
<i>Yongjian Chen</i>	<i>Post-doc</i>	<i>Feedstock Development & Production</i>
<i>German Coronado</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Kamel Didan</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
<i>Cara Duncan Shopa</i>	<i>Professional</i>	<i>Education</i> <i>Extension & Outreach</i>

Diaa El-Shikha	Post-doc	Feedstock Development & Production
Blase Evancho	Key Collaborator	Extension & Outreach
	Graduate Student	Feedstock Development & Production
Neng Fan	Key Collaborator	System Performance & Sustainability
<i>Krista Farmer</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Charles Ferini	Undergrad Student	Feedstock Development & Production
Gunnar Fritz	Undergrad Student	Education
<i>Daryan Godfrey</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Leslie Gunatilaka	Key Collaborator	Characterizations & Co-Products
Wolfgang Grunberg	Professional	ALL AREAS
<i>Matthew Harmon</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Danielle Hoare	Graduate Student	Feedstock Development & Production
<i>Stephanie Honeker</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Arisbeth Ibarra Nieblas	Graduate Student Fellow	Education
Aaron Judkins	Undergrad Student	Feedstock Development & Production
<i>Pujan Kafle</i>	<i>Graduate Student</i>	<i>System Performance & Sustainability</i>
Matthew Katterman	Graduate Student Fellow	Education Feedstock Development & Production
<i>C. Kasia Kiela</i>	<i>Undergrad Student</i>	<i>ALL AREAS</i>
Corey Knox	Professional	Education
Jessica Ledesma	Undergrad Student	Feedstock Development & Production
<i>Ashton Leo</i>	<i>Graduate Student Fellow</i>	<i>Education</i>
<i>Taylor Levy</i>	<i>Intern</i>	<i>Extension & Outreach</i>
Myles Lewis	Professional	Feedstock Development & Production
Manping Liu	Professional	Characterizations & Co-Products
Patrick Lohr	Graduate Student	Feedstock Development & Production
<i>Gerardo Lopez</i>	<i>Key Collaborator</i>	<i>Extension & Outreach</i>
<i>Jasmine Lopez</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>
Raina Maier	Key Collaborator	Feedstock Development & Production
Jonathan Maldonado	Undergrad Student	Feedstock Development & Production
Hadiqa Maqsood	Graduate Student	Feedstock Development & Production
<i>Celestina Martinez</i>	<i>Intern</i>	<i>Extension & Outreach</i>
William McCloskey	Key Collaborator	Feedstock Development & Production
<i>Wenzhe Mi</i>	<i>Intern</i>	<i>Feedstock Development & Production</i>
Istvan Molnar	Key Collaborator	Characterizations & Co-Products Education
<i>Madison Montes</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Leobardo Moreno	Undergrad Student	Feedstock Development & Production
Madison Morris	Undergrad Student	Feedstock Development & Production
Nick Morris	Key Collaborator	Extension & Outreach
Julie Neilson	Professional	Feedstock Development & Production
<i>Andrew Nelson</i>	<i>Post-doc</i>	<i>Feedstock Development & Production</i>
Kim Ogden	Key Collaborator	ALL AREAS
Huitzilin Ortiz	Graduate Student Fellow	Education
Lia Ossanna	Professional	Feedstock Development & Production
<i>Alexandra Peck</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Bryan Pastor	Professional	Feedstock Development & Production
<i>Duke Pauli</i>	<i>Key Collaborator</i>	<i>Feedstock Development & Production</i>
Livvi Pearson	Undergrad Student	Feedstock Development & Production
Alexandra Peck	Undergrad Student	Feedstock Development & Production
<i>Shaira Perez</i>	<i>Undergrad Student</i>	<i>Extension & Outreach</i>

<i>Sam Pernu</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Tenzin Phakdon	Graduate Student Fellow	Education
Sarocho Pradyawong	Post-doc	Feedstock Development & Production
Dennis T. Ray	Key Collaborator	Feedstock Development & Production
<i>Jaspreet Rekhi</i>	<i>Professional</i>	<i>Characterizations & Co-Products</i>
Channah Rock	Key Collaborator	Extension & Outreach
Alix Rogstad	Professional	ALL AREAS
Juan Salas	Undergrad Student	Feedstock Development & Production
Luis Anguiano Sanchez	Professional	Feedstock Development & Production
Carl Schmalzel	Professional	Feedstock Development & Production
Rebecca Sheng	Undergrad Student	Feedstock Development & Production
<i>Stephanie Sikora</i>	<i>Professional</i>	<i>Education</i>
Andrew Smith	Graduate Student	Feedstock Development & Production
<i>Ana Lucia Soto</i>	<i>Undergrad Student Intern</i>	<i>Feedstock Development & Production</i>
Seth Steichen	Graduate Student Fellow	Education
<i>Ou Sun</i>	<i>Graduate Student</i>	<i>System Performance & Sustainability</i>
Trent Teegerstrom	Key Collaborator	Extension & Outreach System Performance & Sustainability
Valerie Teetor	Professional	Feedstock Development & Production
<i>Mira Theilmann</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Christine Toering</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Gianni Velasco</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Peter Waller	Key Collaborator	Feedstock Development & Production
<i>Quinn Waltz</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>John Willmon</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Ya-ming Xu	Post-doc	Characterizations & Co-Products
Ali Yaylali	Graduate Student Fellow	Education
Stevi Zozaya	Undergrad Student	Extension & Outreach
Daniel Zuniga-Vazquez	Graduate Student	Characterizations & Co-Products System Performance & Sustainability
USDA Agriculture Research Service – US Arid Lands Research Center, Maricopa AZ		
Hussein Abdel-Haleem	Key Collaborator	Feedstock Development & Production
<i>Adrianna Chambers</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
<i>Amber Dearstyne</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
Tristan Dunton	Professional	Feedstock Development & Production
Harmony Glover	Undergrad Student	Feedstock Development & Production
<i>Doug Hunsaker</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
<i>Greg Leake</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
Avery Luna	Undergrad Student	Feedstock Development & Production
Aaron Szczepanek	Professional	Feedstock Development & Production
<i>Brandon Vera</i>	<i>Undergrad Student</i>	<i>Feedstock Development & Production</i>
USDA Agriculture Research Service – Western Regional Research Center, Albany CA		
<i>Milagro Adom</i>	<i>Student (SEED)</i>	<i>Feedstock Development & Production</i>
<i>Sheyla Aucar</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
<i>Matthew Canonizado</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
<i>George Chong</i>	<i>Professional</i>	<i>Feedstock Development & Production</i>
Chen Dong	Professional	Feedstock Development & Production
Niu Dong	Professional	Feedstock Development & Production

Trinh Huynh	Professional	Feedstock Development & Production
Colleen McMahan	Key Collaborator	Feedstock Development & Production
Dante Placido	Post-doc	Feedstock Development & Production
Grisel Ponciano	Professional	Feedstock Development & Production
Mariano Resendiz	Graduate Student	Feedstock Development & Production

** Individuals no longer actively working on the SBAR project appear in italic.*

*Total Active Key Collaborators: **23***

*Total Active Professional Staff: **38***

*Total Active Postdoctoral Researchers: **6***

*Total Active Graduate Students: **29***

*Total Active Undergraduate Students: **36***

*Total Active Fellows: **11***

*Total Active /Interns: **0***

*Total Active Participants:**142***

*Total Past Participants (no longer active): **82***

*Total Individuals Involved Since SBAR Inception: **224***

COLLABORATIONS AND OTHER CONTACTS

Collaborations:

<i>Academic Institutions:</i>	<p>CSM (Colorado School of Mines)</p> <ul style="list-style-type: none"> - Dept. of Civil and Environmental Engineering <p>CSU (Colorado State University)</p> <ul style="list-style-type: none"> - Dept. of Mechanical Engineering <p>FSU (Florida State University)</p> <ul style="list-style-type: none"> - National High Magnetic Field Laboratory <p>NMSU (New Mexico State University)</p> <ul style="list-style-type: none"> - Cooperative Extension - Dept. of Agricultural Economics and Agricultural Business - Dept. of Chemical and Materials Engineering - Dept. of Plant and Environmental Sciences <p>UA (University of Arizona)</p> <ul style="list-style-type: none"> - Agricultural and Biosystems Engineering - College of Agriculture and Life Sciences - College of Education - College of Engineering - Cooperative Extension - Dept. of Agriculture and Resource Economics - Dept. of Chemical and Environmental Engineering - Dept. of Language, Reading and Culture - Dept. of Soil, Water and Environmental Sciences - Dept. of Systems and Industrial Engineering - Dept. of Teaching and Teacher Education - Institute of Energy Solutions - Natural Products Center - School of Natural Resources and the Environment - School of Plant Sciences <p>UNM (University of New Mexico) – Gallup</p> <ul style="list-style-type: none"> - Dept. of Mathematics, Physical and Natural Science
<i>Nonprofits:</i>	
<i>Industrial or Commercial Firms:</i>	<p>BASF</p> <p>Bridgestone Americas, Inc.</p> <p>Central Arizona Project (CAP)</p> <p>FMC</p> <p>Guar Resources</p> <p>Syngenta</p>

<i>Federal Government</i>	<p>Saguaro National Park (West), Tucson AZ</p> <ul style="list-style-type: none"> - Environmental Education Department <p>USDA – Agricultural Research Service, Western Regional Research Center, Albany CA</p> <ul style="list-style-type: none"> - Chemistry (Bioproducts) - Plant Genetics <p>USDA – Agricultural Research Service, Grassland Soil and Water Research Laboratory, Temple TX</p> <ul style="list-style-type: none"> - Crop Modeling
<i>State or Local Governments:</i>	Arizona Department of Agriculture, Environmental Services Division
<i>Tribal Governments:</i>	
<i>Schools or School Systems:</i>	<p>BASIS Charter Schools, BASIS Tucson North (high school), Tucson, Arizona</p> <p>Flowing Wells Unified District, Walter Douglas Elementary School, Tucson, Arizona</p> <p>Las Cruces Public Schools, Camino Real Middle School, Mesa Middle School, Mesilla Valley Leadership Academy, and Sierra Middle School, Las Cruces, New Mexico</p> <p>Marana Unified School District, Quail Run Elementary School, Marana, Arizona</p> <p>Tucson Unified School District, Pueblo High School, and Valencia Middle School, Tucson, Arizona</p> <p>Santa Rosa Ranch School District, Santa Rosa Ranch School, Sells, Arizona</p> <p>Sunnyside Unified School District, Apollo Middle School, Tucson, Arizona</p>
<i>Other Organizations (foreign or domestic):</i>	

Other Contacts:

<i>Contacts with others within recipient's organization (interdepartmental or interdisciplinary collaborations):</i>	<p>UA (University of Arizona)</p> <ul style="list-style-type: none"> - Applied Biosciences - Arid Lands Resource Sciences - College of Agriculture and Life Sciences - College of Architecture, Planning and Landscape Architecture - College of Science
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	<ul style="list-style-type: none"> - Institute of the Environment - Water Resources Research Center
<i>Contacts with others outside the organization:</i>	<p>Denver Museum of Nature and Science, Denver Colorado</p> <p>Central Arizona College</p>
<i>Contacts with others outside the United States or with an international organization:</i>	

APPENDICES

APPENDIX 1. ESSENTIAL RESEARCH

Documents Included

1. **Ray Lab: Essential Research** – Description and justification provided to the University of Arizona Plant Sciences Department to designate SBAR research as “essential” during the immediate COVID-19 response. (1pg)

RAY LAB – ESSENTIAL RESEARCH

Addressing the Question: *Why are the Ray lab research activities “essential” during the COVID-19 shutdown?*

Continuation of research in support of the SBAR (Sustainable Bioeconomy for Arid Regions) Center of Excellence: as an integral part of the Feedstock Development and Production group, we provide materials and data to other teams such as Education, Extension, Sustainability, and Post-Harvest Logistics and Co-Products.

In issuing his Executive Order on March 23, Governor Ducey has deemed agriculture an essential operation. Our industry partners, Bridgestone Americas in Eloy, AZ, continue to operate while observing CDC social and physical distancing measures. USDA research collaborators in Albany, CA have also been exempted from Governor Newsom’s stay-at-home order and continue operations on a reduced scale.

According to the April 1 memo from Dr. Betsy Cantwell, essential research/activities include research involving plants as well as long-term data collection (some experiments are in years two and three out of five) and “significant harm to a long-term program, the continuity of which is essential.” The continuation of the SBAR grant is dependent on our work for Feedstock Development so that when all research resumes, we will have lost a minimal amount of time. For these reasons, field and greenhouse activities involving long-term care of plants should also continue.

There is only one lab member (lab manager Valerie Teetor) who is a full-time staff employee with access to the Forbes building and the Ray lab (room 207). While research was ongoing before being shut-down, she observed social and physical distancing while on campus and can continue to do so if approved. The main equipment to be utilized is an Accelerated Solvent Extractor (ASE) which, once programmed with the day’s samples, does not need an operator present to complete a run. Sufficient solvent supplies are present in the lab, and nitrogen cylinders can be obtained from the Cryogenics and Gas Facility on Tuesdays and Fridays, according to their website.

APPENDIX 2. MEETING AGENDAS

Documents Included

1. **SWIAA 32nd Annual Conference Program** – Agenda for three-day field event hosted at the Aquarius Casino in Laughlin, Nevada, targeted to Arizona Tribal producers. 20-23 January 2020. (8pp)

“SWIAA Enabling & Supporting Successful Native American Agriculture Producers”



Conference Program **www.swindianag.com**

**SWIAA 32nd Annual Conference Program
January 20 – 23, 2020
Aquarius Casino
Laughlin, Nevada**

Monday - January 20, 2020
SWIAA Board of Directors Meeting

Pisces Room
9:00 am – 12:00 pm

Monday - January 20, 2020
Rural Business Development Workshop

1:00 PM to 4:30 PM

GEMINI I ROOM

- 1:00 pm Introduction to SWIAA Business Promotion and Assistance Program/Needs Assessment**
Speaker: Jing Luo, PhD, PE/Jesus Solis, Apex Applied Technology, Inc.
- 1:30 pm Contracting with The University of Arizona & Agriculture Business Basics**
Speaker: Izetta Morris, Contract Analyst Sponsored Projects & Contracting Services
- 2:15 pm Break/Networking**
- 2:30 pm Business Book Keeping**
Speaker: Trent Teegerstrom, Arizona FERTP Project Director and Associate Specialist University of Arizona, Department of Agriculture & Resource Economics
- 3:30 pm USDA Business and Cooperative Programs**
Speaker: Clint Kaasa, USDA Rural Development, Arizona State Office
- 4:00 pm End of Session**

Tuesday - January 21, 2020

PAVILION B

8:00 am – 5:00 pm Registration

- 9:00 am Conference Opening**
- Opening Remarks Mr. Homer Marks Sr., President/CEO, SWIAA, Inc.**
- Welcome Mr. Johnny Hill Jr. Colorado River Indian Tribes**
- Invocation Mrs. Dorothy Sunna, Gila River Indian Community**
- Posting of Colors Pee Posh Veterans**
- National Anthem Ms. Zoey Sharp, Colorado River Indian Tribes**

- 9:15 am SWIAA Annual Membership Meeting**
Speakers: Homer Marks, Sr., President/CEO, SWIAA, Inc.
- **President's/CEO Report**

- Southwest Indian Agricultural Association, Inc. Update
- Treasurer's Report
- Nominations & Election of New Board Members
 - Native American Individual – Farm
 - Native American Individual – Livestock
 - Native American Individual – Livestock
 - Native American Organization – Livestock
 - Native American Youth

(Tuesday - January 21, 2020)

◆ ◆ 10:00 – 10:15 am ◆ ◆ Refreshment Break ◆ ◆

Raffle Prize Drawing No. 1 –
Donated by -

Raffle Prize Drawing No. 2 –
Donated by -

10:15am “Native American Agriculture Fund”
Speaker: Dr. Joe Graham, Regional Director & Education Liaison NAAF

11:00am “Traditional Gardens”
Speaker: Jacob Butler - Salt River Pima-Maricopa Indian Community

◆ ◆ 12:00 – 1:30pm ◆ ◆ Lunch (on your own) ◆ ◆

1:30pm “Approving Your Farm/Ranch Bottom Line”
Speaker: Ruby Ward, Professor and Extension Specialist – Agricultural Economics
Utah State University

2:15pm “Agriculture Veterans USDA NIFA”
Speaker: Dr. Mark Sorensen (PDI) and Homer Marks, Sr., President/CEO, SWIAA,
Inc.

Raffle Prize Drawing No. 3 –
Donated by -

Raffle Prize Drawing No. 4 –
Donated by -

◆ ◆ 3:00 PM – 3:15 PM ◆ ◆ REFRESHMENT BREAK ◆ ◆

3:15 pm “Solar Technology for Agriculture”
Speaker: Dr. Edward Franklin, University of Arizona
Solar Demonstration Location: 3rd Floor: Between AZ Tower and Calif. Tower.

4:00 pm End of Session

(Tuesday - January 21, 2020)

5:00 – 7:00 pm SOCIAL HOUR – SCORPIO ROOM

**Raffle Prize Drawing No. 5 –
Donated by -**

**Raffle Prize Drawing No. 6 –
Donated by -**

www.swindianag.com

Wednesday – January 22, 2020

PAVILION B

9:00 am Call to Order: Mr. Andrew Antone Sr., Vice-President, SWIAA, Inc.

Invocation: Homer Marks Sr., President & CEO, SWIAA, Inc.

9:10 am “Arizona Parasitology Concerns in Arizona”

**Speaker: Dr. Shujuan Li, Extension, Public Health Intergrated Pest Management &
Dr. Paula Rivadeneria, Assistant Specialist, Environmental Science**

9:40 am “Climate Changes and It’s Impacts on the Southwest”

**Speaker: Dr. Michael Crimmins, Professor & Extension Specialist, Climate
Science Department of Environmental Science**

◆ ◆ 10:15 PM – 10:30 PM ◆ ◆ REFRESHMENT BREAK ◆ ◆

**Raffle Prize Drawing No. 7 –
Donated by -**

**Raffle Prize Drawing No. 8 –
Donated by**

(Wednesday – January 22, 2020)

10:30 am “Instinctive Migratory Grazing School”

Speaker: Robinson Honani – Hopi Range Management Office

11:15 am “Rebuilding Health & Sustainable Communities”

Speaker: Lillian Hill, Executive Director, Hopi Tutskwa Permaculture

◆ ◆ 12:00 NOON - LUNCHEON ◆ ◆

MASTER OF CEREMONIES

Andrew Antone Sr., Vice President, SWIAA, Inc.

DR. ROE B. LEWIS SCHOLARSHIP AWARD

MARIO MARKS TRAVELING SCHOLARSHIP AWARD

2020 SWIAA AWARDS

Gerald Moore

Jing Luo

Alexendra Carlisle

Kristy Kinlicheenie

Christopher Honahnie

Gabriel Mendoza, Sr.

Louis R. Lopez

MEMORIAL AWARD

DR. ROE B. LEWIS SCHOLARSHIP RECIPIENTS

1:00 pm “Scholarship Winner”
Speaker: Alexendra Carlisle, University of Arizona

1:15 pm “Scholarship Winner”
Speaker: Kristy Kinlicheenie, University of Arizona

1:30 pm “Scholarship Winner”
Speaker: Nadira Mitchell, University of Arizona

(Wednesday – January 22, 2020)

2:15 pm “Grass Casting”
Speaker: Dannele Peck – Director of the North Plains Climate Hub

◆ ◆ **3:00 PM – 3:15 PM** ◆ ◆ **REFRESHMENT BREAK** ◆ ◆

3:15 pm “Feral Swine Program Update”
Speaker: Ms. Valerie Burton, Supervisory Wildlife Biologist

Arizona Wildlife Services

4:00 pm “National Animal Disease Preparedness and Response Program”
Speaker: Terry W. Clark, DVM, Deputy Director, Office of National Tribal Liaison,
USDA, APHIS

4:45 pm End of Session

Raffle Prize Drawing No. 9 –
Donated by –

Raffle Prize Drawing No. 10 –
Donated by -

Raffle Prize Drawing No. 11 –
Donated by -

Raffle Prize Drawing No. 12 -
Donated by -

Raffle Prize Drawing No. 13 –
Donated by –

Thursday – January 23, 2020

PAVILION B

9:00 am Call to Order: Homer Marks Sr., President/CEO, SWIAA, Inc.
Invocation:

9:10 am “Tribal Agriculture Leases”
Speaker: Staci Emm, Extension Educator; University of Nevada Cooperative
Extension & Chair, Indian Lands Tenure Foundation Board of Director
University of Nevada Reno

9:40 am “SBAR Project Update”
Speaker: Dr. Kimberly Ogden, Professor, Chemical and Environmental Engineering,
Director, Institute for Energy Solutions, University of Arizona

◆ ◆ 10:15 – 10:30 AM REFRESHMENT BREAK ◆ ◆

10:30 am “Native American Nutrition Conference” (Invited)
Speaker: Joshua Preston, San Xavier Coop Farms

11:15 am “Trade Impacts on Agriculture”
Speaker: Dr. Russell Tronstad, Extension Specialist, Agricultural and Resource

Economics, University of Arizona,

**Raffle Prize Drawing No. 14 –
Donated by – SWIAA, Inc.**

**Raffle Prize Drawing No. 15 – Bull (Hereford/Angus)
Donated by – Brian Davis Sr., SWIAA, Inc.**

11:50 am End of Conference

◆ ◆ 12:00 Noon ◆ ◆ Lunch On Your Own ◆ ◆

Thursday – January 23, 2020

Beginning Farmer and Ranchers Workshop Program

- 1:00 Introduction: UA Beginning Rancher/Farmer Grant
Speaker: Dr. Russell Tronstad, Extension Specialist, Agricultural and Resource
Economics, University of Arizona**
- 1:15 Ranch Horse Wrecks ... Are you Liable?
Speaker: Dr. Betsy Greene, UA Equine Specialist**
- 2:00 Challenges and Solutions to Operating a Small-Scale Beef Processing Plant.
Speaker: Paul Schwennesen, Owner, Double Check Ranch**
- 2:45 BREAK**
- 3:00 Starting and Growing Direct Beef Marketing Channels.
Speaker: Paul Schwennesen, Double Check Ranch**
- 3:45 Tools and Ingredients to Produce and Market Local Fresh Produce
Speaker: Lina Austin, Future Forward Foundation**
- 4:30 Feedback and Prioritization of Beginning Rancher/Farmer Issues by Region**
- 5:00 End of Workshop**

PISCES ROOM

**SOUTHWEST INDIAN AGRICULTURAL ASSOCIATION, INC. EXECUTIVE BOARD MEETING
THURSDAY, JANUARY 23, 2020 – 1:00 PM**

The SWIAA Board would like to recognize and thank the following individuals for all of their time and effort to make this year's conference so successful:

**Homer Marks Sr.,
Andrew Antone Sr.**

**President/CEO
Vice President**

**Tohono O'odham Nation
Tohono O'odham Nation**

Robert Sotomayor
Mike Lejero
Agnes Joaquin
Gerald Sunna
Chris Honahnie
Gabriel Mendoza Sr.
Gerald Pablo
Trent Teegerstrom
Brian Davis Sr.
Stanley Stephens
Alberta Ray
Sadie Marks
Brenda Antone
Dorothy Sunna
Jing Luo

Secretary
Treasurer
Coordinator

Associate Board Member
Tohono O'odham Nation
Tohono O'odham Nation
Gila River Indian Community
Hopi Nation
Tohono O'odham Nation
Tohono O'odham Nation
University of Arizona
Gila River Indian Community
Tohono O'odham Nation
Tohono O'odham Nation
Tohono O'odham Nation
San Carlos Apache Tribe
Gila River Indian Community
APEX Applied Technology Inc.

***If we missed anyone who assisted to make the Southwest Indian Agricultural Association, Inc.
Annual Conference a success, we apologize***



COLLEGE OF AGRICULTURE
AND LIFE SCIENCES
COOPERATIVE EXTENSION



APPENDIX 3. EXTENSION OUTREACH EVENTS

Documents Included

1. **SBAR Outreach Log – New Mexico Cotton Conference** – Outreach data capture for extension tabling event. 29 January 2020. (1p)
2. **SBAR Outreach Log – New Mexico Chili Growers Conference** – Outreach data capture for extension tabling event. 3-4 February 2020. (1p)
3. **SBAR Outreach Log – New Mexico Organic Conference** – Outreach data capture for extension tabling event. 21-22 February 2020. (1p)
4. **SBAR Outreach Log – New Mexico Alternative Crops Conference** – Outreach data capture for extension tabling event. 10 March 2020. (2pp)

SBAR Extension Outreach Capture

Name of person completing this form: John Idowu

Date that outreach occurred: January 29th, 2020.

Type of outreach (please circle or highlight all that apply):

General SBAR information distribution (i.e. tabling event)

Specific presentation on SBAR by Extension/Outreach team member

Crop demonstration

Arranged meeting with individual or group to discuss SBAR related issues

Spontaneous meeting with individual or group to discuss SBAR related issues

Other (please describe below)

--

If the outreach activity was part of a specific event/conference, please fill out the information below:

Event Name:	Event Date:	Event Location:	Approximate Total # in Attendance
NM Cotton Conference	January 29 th , 2020	Ruidoso, NM	80

Approximate breakdown of audience, regardless of type of outreach:

Type of stakeholder	Estimated #
Growers/Farmers	40
Industry/Corporate professionals	30
Researchers	5
University students	5
K-12 students	
General Public	

Significant Outcomes:

Participant had the opportunity to see SBAR table displays and many took copies of the flyers and publications on the table.

Important Contact Information: About **80 contacts** were made during this conference.

SBAR Extension Outreach Capture

Name of person completing this form: John Idowu

Date that outreach occurred: February 3-4, 2020.

Type of outreach (please circle or highlight all that apply):

General SBAR information distribution (i.e. tabling event)

Specific presentation on SBAR by Extension/Outreach team member

Crop demonstration

Arranged meeting with individual or group to discuss SBAR related issues

Spontaneous meeting with individual or group to discuss SBAR related issues

Other (please describe below)

--

If the outreach activity was part of a specific event/conference, please fill out the information below:

Event Name:	Event Date:	Event Location:	Approximate Total # in Attendance
NM Chile Growers Conference	February 3 – 4, 2020	Las Cruces, NM	350

Approximate breakdown of audience, regardless of type of outreach:

Type of stakeholder	Estimated #
Growers/Farmers	200
Industry/Corporate professionals	50
Researchers	30
University students	40
K-12 students	
General Public	30

Significant Outcomes:

Conference participant had the opportunity to see SBAR table displays and many took copies of the flyers and publications on the table.

Important Contact Information: About **80 contacts** were made during this conference.

SBAR Extension Outreach Capture

Name of person completing this form: John Idowu

Date that outreach occurred: February 21-22, 2020.

Type of outreach (please circle or highlight all that apply):

General SBAR information distribution (i.e. tabling event)

Specific presentation on SBAR by Extension/Outreach team member

Crop demonstration

Arranged meeting with individual or group to discuss SBAR related issues

Spontaneous meeting with individual or group to discuss SBAR related issues

Other (please describe below)

--

If the outreach activity was part of a specific event/conference, please fill out the information below:

Event Name:	Event Date:	Event Location:	Approximate Total # in Attendance
NM Organic Farming Conference	February 21 – 22, 2020	Albuquerque, NM	960

Approximate breakdown of audience, regardless of type of outreach:

Type of stakeholder	Estimated #
Growers/Farmers	650
Industry/Corporate professionals	200
Researchers	30
University students	40
K-12 students	
General Public	40

Significant Outcomes:

Conference participant had the opportunity to see SBAR table displays and many took copies of the flyers and publications on the table.

Important Contact Information: About **300 contacts** were made during this conference.

SBAR Extension Outreach Capture

Name of person completing this form: John Idowu

Date that outreach occurred: March 10th, 2020.

Type of outreach (please circle or highlight all that apply):

General SBAR information distribution (i.e. tabling event)

Specific presentation on SBAR by Extension/Outreach team member

Crop demonstration

Arranged meeting with individual or group to discuss SBAR related issues

Spontaneous meeting with individual or group to discuss SBAR related issues

Other (please describe below)

--

If the outreach activity was part of a specific event/conference, please fill out the information below:

Event Name:	Event Date:	Event Location:	Approximate Total # in Attendance
NM Alternative Crops Conference	March 10 th , 2020	Ruidoso, NM	50

Approximate breakdown of audience, regardless of type of outreach:

Type of stakeholder	Estimated #
Growers/Farmers	15
Industry/Corporate professionals	10
Researchers	10
University students	10
K-12 students	
General Public	5

Significant Outcomes:

Participant had the opportunity to see SBAR table displays and many took copies of the flyers and publications on the table.

Important Contact Information: About **50 contacts** were made during this conference.

Survey Results:

Topic	% of participants that increased knowledge	Level of knowledge increased
Agronomic optimization of Guar	96.4%	1.98 times
Guar contracting processes	92.6%	2.14 times
Economics of alternative crops	92.1%	1.83 times

APPENDIX 4. EDUCATION OUTREACH MATERIALS

Documents Included

1. **SBAR Science Education Partnership** – Flyer announcement for recruitment of teacher partners to implement SBAR lessons in classrooms in Arizona and New Mexico. (2pp)

Middle School Science Educators

Sustainable Bioeconomy for Arid Regions (SBAR) Center for Excellence
seeks educators for a year-long partnership



Partnership promotes:

- ☒ Learning about cutting-edge science research and applied uses related to agriculture, renewable energy, plant genetics, and other innovations that could shape arid lands farming in the Southwest
- ☒ Community and cultural integration of science learning
- ☒ Creating and integrating innovative place-based science lessons for 6th to 8th grade classrooms
- ☒ Participation in a learning community with other educators from Arizona and New Mexico

Partnership includes:

Training

ONLINE Summer PD // 30 hours // June 22 - 26, 2020

CTU Credit through University of Arizona

Collaboration

Educators are paired with a Graduate Fellow who will provide online and in-person support: Research // Prep // Presentations

Local 4-H office will provide support to implement SBAR lessons

Support

Stipend \$500 for PD // Stipend up to \$500 for academic year activities

Classroom supplies budget of \$300

For information email:

Arizona ~ Corey Knox, PhD cknox@arizona.edu

New Mexico ~ Catherine Brewer, PhD cbrewer@nmsu.edu

Learn about SBAR at <https://sbar.arizona.edu>



SBAR Science Education Partnership



Training

SBAR will provide a one-week, 30-hour, online professional development training. This innovative model of PD will take place via distance education with live interactive sessions every morning from 9:00-10:30 and approximately 4-5 hours per day of independent research, lesson design, peer review and collaboration, and real-world investigation in your own community!

This 30-hour training is free and qualifies for CTU PD credit through University of Arizona

PD Topics include

- ★ Cutting-edge science research on arid lands, sustainable agriculture, and bioeconomies
- ★ Curriculum mapping and design
- ★ Community investigation leading to creating place-based science teaching
- ★ Pedagogical exploration and application in place-based, NGSS, culturally responsible pedagogy, action inquiry and learning, science through story and narrative, and crossover learning (connecting learning in informal settings with school-based learning and vice-versa)

Collaboration & Support Activities

All educators will be paired with a University of Arizona or New Mexico State University graduate student "Fellow" who will provide research support, lesson preparation, and in-person or virtual presentations. In addition, educators will receive support from the local 4-H office to implement lessons and more.



Stipend Support

This training is free of charge and all educators who complete the training and commit to a yearlong partnership will receive a \$500 stipend for the one week PD training and up to a \$500 stipend for the academic year activities, plus a \$300 budget for classroom supplies will be allotted. This support is for preparing and implementing SBAR related units; participating in online discussions 2 times per semester; virtually hosting a UArizona or NMSU Fellow in the planning, preparing and implementation of lessons.

For information email: Arizona ~ Corey Knox, PhD cknox@arizona.edu

New Mexico ~ Catherine Brewer, PhD cbrewer@nmsu.edu

Learn about SBAR at <https://sbar.arizona.edu>

