

SUBJECT: PERFORMANCE/CONTRIBUTION IN TERMS OF OUTPUTS DURING CONTRACT PERIOD

Page #	Performance/Contribution	Status	Location	Date	Annexure
1	Round Table on Sugarcane Fertilisation	Completed	Lahore	21.09.2016	I
5	Conference on Sugarcane Knives	Completed	Research Farms, SRI, FSD	23.09.2016	II
6	Sugarcane Crop Protection "Round Table"	Completed	AARI, Faisalabad	26.04.2017	III
11	1st Int. Workshop: R & D activities on Sugarcane Plant improvement	Completed	Conference Room, SRDB, AARI	09.08.2017	IV
15	Modern Technologies for Sugarcane Plantation	Completed	Sadikabad	07.10.2017	V
16	Import of 19 sugarcane fuzz/clones from Canal Point, USA.	Completed	SRI, Faisalabad	31.04.2017	VI
17	Monitoring of SRDB Projects (3 rd Quarterly reports received)	In process	Faisalabad		VII (a) VII (b) VII (c)
	Draft of SRDB business rules for solicited and unsolicited projects	Completed	Faisalabad		VIII
	Draft of SRDB Vision	Completed	Faisalabad		IX
	Draft of SRDB Act	In process	Lahore		X
	Input on the National Sugarcane Policy	Completed	Faisalabad		XI
	Research paper presented in International Society of Sugarcane Technologists	Completed	ISSCT Thailand	5 to 9 Dec. 2016	XII

	(ISST) conference in Thailand.				
	Research paper presented paper in Pakistan Society of Sugarcane Technologists Workshops / Convention	Completed	Faisalabad, Lahore, and Rawalpindi		XIII
	Sugarcane Breeding Plan for Res. Inst. of Punjab	Completed	Faisalabad		
	Import of Germplasm (Commercial / Promising Clones / True Seed-Fuzz) from a research institute. of countries	In-process	USDA, SRI Sri Lanka, Guatemala, Visacan, and France		
	Draft Biological Material Transfer Agreement (BMTA)	Completed	USDA-ARS, USA		
	Publication of Pakistan Sugar Journal	In-process	SRDB, Faisalabad	July-Sept. 2017	
	SRDB website linked with Agri. Dept. website.	Completed	Faisalabad		

ANNEXURE-1 ROUNDTABLE SUGARCANE FERTILIZATION FUTURE NEEDS Round-Table, 21

September 2016 Lahore **Goals** – Increase in cane and sugar yields per unit area Improve efficiency fertilizers/agrochemicals Sustainable production system (including environment friendly approach, soil fertility & health, socio-economic aspects) SRDB arranged a “ROUND-TABLE” meeting with stakeholder to share and elaborate experiences on Sugarcane Fertilization and prioritizing Research & Development projects in this area. The following are the conclusions/suggestions of the event: **The Punjab soils:**

- Calcareous: Contain high quantities of Ca with carbonates or bicarbonates
- Alkaline; pH is high: mostly >8.5
- Very low organic matter (~0.5%)
- N Deficiency in 100% Soils
- P deficiency in >80% soils
- K deficiency >70% soils
- Zn & B deficiency in 50-70% soils
- Hot & dry weather
- Very low microbial activity

Fertiliser Use Efficiency in Pakistan

- Recommended NPK ratio: 2:1:1
- Actual NPK ratio being used 5:1:0.02

– N Use Efficiency <50% – P & K use Efficiency 20-25% – N losses –

Volatilisation; Leaching **SUGARCANE FERTILIZATION** Macronutrients include nitrogen (N), phosphorus (P) and potassium (K), known as the primary nutrients. Calcium (Ca), magnesium (Mg) and sulfur (S) are considered to be the secondary nutrients. Trace elements or micronutrients that form part of the tertiary group include zinc, copper, iron, manganese, boron, chlorine and molybdenum. Silicon is the 14th element that has received widespread attention in recent years, and although it is not essential to plant growth, sugarcane is a large accumulator of this element. Because of its functional importance, Si is termed a beneficial nutrient for sugarcane. **WHY**

FERTILIZE? Nutrient Removal from the Soil by Sugarcane Yield: 100T cane/ha N = 120 kg/ha, P₂₀₅ = 66 kg/ha, and K₂₀ = 330 kg/ha Pakistan Recommendations N = 168 kg/ha, P₂₀₅ = 112 kg/ha and K₂₀ = 112 kg/ha **Nitrogen Fertilizer** 1.2 – 1.6 kg N per ton millable cane: this is a general recommendation; higher rates may be applied for fields known to have high response to N **Fertilizer N use efficiency** does not exceed 30%; the sugarcane crop obtains more than 70% of its N needs from the soil N pool **Present recommendations in the Punjab (Kg/ha)**

Soil Fertility	Nitrogen	Phosphorous	Potash
Poor	296	170	124
Medium	227	114	124
High	170	57	62

Ratoon Crop Recommendations in the Punjab (kg/ha)

Soil Fertility	Nitrogen (N)	Phosphorous (P2O5)	Potash (K2O)
Poor	385	222	161
Medium	120	148	161
High	222	74	82

Source NFDC Islamabad Sugarcane N-dynamics: The Global Scenario

Country	Yield (tons/ha)	N application (kg /ha)	N removal (kg/ha)	N removal (kg/ton)	N-output: input
Brazil	80	60-100	47.78	0.60	0.6
India	69	150-400	41.34	0.60	0.3
China	73	100-755	43.90	0.60	0.1
Thailand	70		41.73	0.59	1.0
Pakistan	52	120-180	30.61	0.59	0.2
Australia	87	160	51.28	0.59	0.3

N removal on a stalk dry matter content, i.e. 30% and N content of 0.2% dry weight. Use of Sugarcane by-products as Fertiliser. Filter cake, filter mud, Distillery waste, Molasses as a fertiliser or microbial stimulator. A package of technology has been established by some mills like Ramazan Sugar Mills, Shakarganj Mills, and Al-Moez Sugar Mills on large scale composting of filter cake. The produce is rich and the cheapest source of organic matter and micro-nutrients, and can increase the efficiency of inorganic fertilisers. Biological fixation of Sugarcane plant 40-60% of plant N derived from BNF in the variety CB 47-89 (Lima *et al*). Urquiga *et al* calculated BNF contribution of several cultivars more than 70%. Boddy *et al* showed that BNF contributed 60% of N assimilation in sugarcane in Brazil using the 15N dilution technique. Asiset *al* found the role of BNF in Japanese sugarcane to be > 38%. The % Ndfa (N derived from atmosphere) was 26% for roots, 14% for the stem, 21% for the leaves. Bacteria, *Gluconacetobacter diazotrophicus* has proven their worth for BNF in sugarcane. Bio Fertilisers: Excellent supplement to chemical fertilisers. Live formulations of beneficial bacteria. Increase plant growth by direct and indirect mechanisms. PGPB Fortified Fertilisers – *An Innovative Bio Tech Solution*. Humic acid-based products – e.g. Humifirst (TradeCorp) Soil Nitrogen Mineralisation Potential Index in Pakistan: LOW. Research should focus on exploring the interaction between the sugarcane root system and Nitrogen Dynamics in the Rhizosphere to improve N Use Efficiency. Development should promote the

restoration of OM Organic waste recycling – Concentrated Molasses Stillage (CMS) from the Ethanol plant. Can be safely disposed of on sugar cane land with no influence on soil pH. Satisfies N and P requirements of sugarcane after enrichment with NP mineral fertilisers. As efficient as granular fertilisers, Chemical Fertilisers: Issues and Solutions. Fertilisers related Issues- Nitrogenous fertilisers. Farmers' application methods are conventional. 35 – 40% leaching and volatilisation losses in the case of urea, Lower use efficiency. Deteriorating already the imbalance use of N:P Phosphatic fertilisers. P use efficiency in soil is 20 – 25%. NP use ratio is 1:0.25 Vs recommended 1:0.5 and is widening. Imbalanced use accelerates P depletion from soil reserves. P is a limiting factor for yield in ~80% soils and is fast expanding. P limitations are affecting agricultural productivity of Pakistan Potential Solutions Option 1: Increase use of P fertilizers Raw material is fast depleting globally leading to higher price Disparity in price increase of fertilizers and agri commodities discourage use of P fertilizers Farmers not applying recommended dose even at lower price levels Affecting agricultural productivity of Pakistan Expensive option, increase crop production cost, difficult to implement Option 2: Introduce efficient P products Increase P availability to plants for longer period during crop cycle Same quantity can help increase N use efficiency Reduce and/or stop P depletion from soil Higher net back for farmers, encourage to invest more in crops Higher agricultural productivity and more contribution to GDP Economical for farmers and quick adoption is expected PGPB Fortified Fertilizers – Benefits Increases bioavailability of nutrients specifically P by solubilizing, increases root mass to enable plant for maximum nutrient uptake, stimulate nutrient uptake leading to healthy plant growth, Improve plant ability to tolerate biotic and abiotic stresses. Improve N use efficiency by increasing P availability during the crop cycle. Enhance yield and quality that results in better farmer income. SRI, Faisalabad, Summary of field studies on sugarcane fertilisation. Application of NPK fertiliser @ 300-200-125 kg/ha gave highly significant results. Application of standard fertilizer dose of NPK @ 168-112-112 kg ha⁻¹ gave statistically best economic yield and sugar recovery. Application of zinc (10 kg ha⁻¹) as a basal dose influenced the yield of sugarcane. If zinc could not be applied at the time of sowing, it should be applied at 45 DAS, which is also effective to increase yield. Soil application of Magnesium Sulphate @ 6 kg/ha along with the standard dose of NPK improved Sugarcane yield by about 01 %. CCS and sugar recovery were also found to be better over control with the application of Magnesium. Application of humic acid in granular form @ 7.50 kg ha⁻¹ along with standard fertiliser dose gave maximum sugarcane yield and sugar recovery as compared to application of humic acid in liquid form. The Way Forward: Immediately start research projects to determine thresholds for P & K. Study N Dynamics and processes in the various soils and rhizosphere. Assess the benefits of filter-mud + bagasse ash. Evaluate humic acid products such as Humifirst & other bio-fertilisers. Environmental projects on nutrients (nitrate) leaching in groundwater. Si studies for cane growth but resistance against borers, etc. Standardise Laboratory Methods and Centralised data for analysis & interpretation. There must be lesser reliance on inorganic and expensive NPK fertilisers. This can be achieved by integration of Legume Green Manuring as a component of the new cropping system, which ultimately results in a reduction of N-fertiliser inputs to sugarcane. The use of Controlled Release Fertilisers (CRF) is of ultimate need for economical and sustainable cane yield. Moreover, the agronomic effectiveness of industry wastes like filter cake or press mud, Concentrated molasses stillage

(CMS) or vinasse, bagasse, and burnt fly ash can be as partial substitutes for inorganic fertilisers. The use of BNF & Microbial Biotechnologies such as Rhizospheric and endophytic bacteria, VAM, PGPR bio-fertilisation and bio-control must be practically implemented in the production technology of sugarcane. The application of Phosphorus fertilizers must be explored beyond the conventional method. Mid-life Phosphorous application is needed to meet the phosphorus requirement of sugarcane. Phosphorus is most required by sugarcane plants at the stage of tillering. Phosphates are immobile and prone to fixation in alkaline soils. The use of humic acid increases Phosphorous availability. Potassium Fertilization of sugarcane can't be considered in isolation from the requirement of the sugarcane for other nutrients, particularly N. Inputs of N and K must be balanced to optimise sugarcane production. For high cane yield, K fertilisers are required in amounts equal to or greater than N and P. The role of Si in growth and other quality parameters of sugarcane must be explored thoroughly, along with critical emphasis on the role of micronutrients such as Zinc, Boron and magnesium, which must be investigated in order to obtain a sustainable increase in the yield and quality of sugarcane, economically.

ANNEXURE-2 "Training on Sugarcane Knives" by Sugarcane Research & Development Board

Dated: 23 September, 2016

ANNEXURE-3 Sugarcane Crop Protection “Round Table” by Sugarcane Research & Development

Board Dated: 26 April, 2017 Agenda Points:

1. Welcome and key note by Dr. Shahid Afghan Acting CEO, SRDB
2. Presentation on Contemporary crop protection by Muhammad Dawar & Mr. Sohail Nadeem from Farm Machinery & Chemicals (FMC)
3. Presentation on Population dynamics and cost effective biological control of sugarcane whitefly by Dr Nazia Suleman Principal Scientist, Nuclear Institute of Agriculture and Biology (NIAB)
4. Crop protection with Green revolution recommendations presentation by Mr. Ahmad Umair, CEO Green Revolution, Lahore
5. Sugarcane diseases and their management by Mr. Walayat Ali Khan, Plant Virologist, Sugarcane Research Institute, Faisalabad
6. Insect pests of sugarcane and their management by Mr. Munir Ahmad, Assistant Entomologist, Sugarcane Research Institute, Faisalabad
7. Harmful impact of biotic factors on potential yield of sugarcane and their strategic management by Mr. Abdus Sattar, R & D Manager, Sayban Group
8. Concluding remarks by Dr. Abid Mahmood, DG(R), AARI, Faisalabad
9. Vote of thanks by Dr. Shahid Afghan
10. Recommendations

Proceedings:

1. A Round Table seminar entitled “Sugarcane crop protection” was organized on April 26, 2017 in Ayub Agricultural Research Institute, Faisalabad by Sugarcane Research and Development Board. Meeting started with the recitation of Holy Quran by Mr. Hafiz Walayat Ali Khan. Objectives of the seminar was to foresee latest research strategies, trends and to find solutions of prevailing sugarcane development complications.
2. Acting Chief Executive Officer, Sugarcane research and development board welcomed all distinguished guest and addressed key note that included board’s technical support program, R & D activities, brief introduction of sugarcane in Punjab, major sugarcane producing limiting factors and role of abiotic factors hindering sugar production.
3. After the key note, Mr. Khuram Iqbal requested Mr. Muhammad Dawar and Mr. Sohail Nadeem of FMC crop sciences delivered presentation on “Contemporary sugarcane plant protection technology”. Speaker started its presentation with improved features of furadan and compared it with generic chemistry. They also claimed to have developed new chemical ferterra that is tough on pest and soft on environment. Weedicides and chemicals controlling sugarcane bug, pyrilla etc were also discussed.
4. Rana Maqsood Sb, GM Ramzan Sugar Mills raised the question of higher rates of FMC products, FMC representative answered that they are investing in R & D activities, furthermore product’s formulation is different and they have low residual effect that’s why their product is expensive.
5. Ghulam Mustafa Wains, Ex Agronomist, Sugarcane Research Institute questioned that a weed “Deela” is not effectively controlled by FMC products, representative replied that most farmers don’t follow instructions like proper application, use of proper dose, line

kera application, use at early stage and unawareness of chemical's mode of action hinders in taking desired results.

6. Nazia Suleman, Principal Scientist NIAB to presented her research work on "Population dynamics and cost effective biological control of sugarcane whitefly". Objectives of her presentation were dynamics of white fly population on sugarcane in different ecological zones of the Punjab, Pakistan, for this reason she conducted surveys and collected whitefly bio control agents during visits of Layyah, Ramzan, Shakarganj and Indus sugar mills. She is rearing seven spotted ladybird beetle and *Chrysoperla carnea* as bio control agents of sugarcane whitefly.
7. Khawar Jawad, Director Entomology said seven spotted ladybirds are not available in kharif season and is mostly seen in winters. Dr Nazia responded that her study was conducted in winters as seven spotted ladybirds were available at that time, she is also planning summer study to investigate insect climate tolerant stress levels.
8. Hassan Munir gave example of Mauritius sugar that they launched a bio control project to eliminate the residual effect of furadan and within four years they controlled sugarcane borers and now they are not using a single pesticide and supposed this is the time to develop biological franchises initially at sugar mill level.
9. Sohail Nadeem of FMC claimed that their products have very less residual effects, Dr Abid Mahmood said through trials at Sugarcane research farms and University of Agriculture, residual effects could be examined.
10. Ahmad Saleem said through proper biocontrol agents/technology like introduction and augmentation biological control process could provide desired results. Mr. Khuram Shahzad of Al Moiz sugar mill commented that pesticide companies are resisting in developing biological laws. Dr. Abid Mahmood focused the increasing trends of biological control. Dr. Shahid Afghan appreciated the steps of Layyah sugar mills in developing trichogramma cards in contrasts to stagnant approach of public biocontrol labs and asks for joint ventures for public private partnership.
11. Ahmad Umair of Green revolution presented "Crop protection with Green revolution recommendations". He started with the challenges sugar industry is facing that includes Weedicides are not providing proper control (Resistance development among plants), seed treatment is not common among farmers, use of carbofuran is under check need to switch for alternate solutions, use of alkaline inputs are increasing soil pH and inhabiting soil microbial activity, multi national's products mostly does not match Pakistan conditions and excessive use of urea reduces sugar recovery. To overcome these challenges, he showed improved chemical products of green revolution that can control pests without damaging soil health.
12. Ahmad Umair said he had come here with a vision that is working for the simultaneous improvement of soil health, introduction of efficient fertilizers leading towards balanced nutrition application, introduction of potent and safe herbicides & pesticides by acting as a bridge between Internationally Renowned Farmers, Sugar mills and research bodies. He claimed that standard operating procedure (SOP) is under process between government of Punjab and Green revolution for the use of drones for survey and

pesticide use. Acting CEO said business rules of SRDB is on the verge of completion and anybody with optimized research proposal are welcomed to work with us.

13. Ashiq Hussain, Assistant Agronomist, Directorate of Agronomy, said he had multiple years' research on controlling Bermuda grass in sugarcane, he supposed that common mesotrione/atrazine mixture will not control Bermuda grass whereas 2-time application of Topomezon/Atrazine in April and May is helpful in controlling Bermuda grass and field must not be irrigated before 15 days after weedicide application.
14. Hassan Munir said we are not focusing sugarcane genetics, there is a need to develop genetic coding, no vision could be successful without its co-relation with genetics of that crop.
15. Walayat Ali Khan, Plant Virologist, Sugarcane Research Institute, presented on "Sugarcane diseases and their management", he discussed brief detail of every disease starting from Red Rot, Sugarcane smut, rust, Pokha boeng and Helminthosporium leaf spot. He said red rot have huge infestation in Sargodha and Mandi Bahaudin districts due to continuous uses of susceptible varieties. Question was raised that all varieties after a certain time get susceptible to red rot, answer given was that red rot pathogen develops strains over a certain period of time and a variety resistant to one strain become susceptible to other strain of that pathogen. Annual release of new varieties can minimize red rot damage. He also urged that seed treatment against seed borne fungal diseases is not common and for the management of red rot, seed must be treated with thiophanate methyl.
16. Ahmad Saleem expressed that efficient strategy must be adopted for the disease management and fertilizer requirements for such crops that do not bear true seeds like sugarcane.
17. Muhammad Tayyab (progressive farmer) asked the chair to start farmer awareness campaign regarding early, mid and late maturing varieties, varietal identification, different insect pests economic threshold level (ETL) and this activity could be conducted through Sugarcane Research Institute, Sugar mill, Sugarcane Research and development board etc.
18. Insect pests of sugarcane and their management was presented by Mr. Munir Ahmad, Assistant Entomologist, Sugarcane Research Institute. Key points of his address include management of borers, army worm as new emerging pest, black bug, sugarcane pyrilla etc, he focused the role biological agents in managing pests. Rana Maqsood sb, GM Ramzan Sugar Mills told about the increasing population of black bug, Mr. Sohail Nadeem said Talstar is effective in controlling black bug with T jet 6'inch nozzle followed by heavy irrigation.
19. Abdus Sattar from Sayban group was the last presenter of the round table with title "Harmful impact of biotic factors on potential yield of sugarcane and their strategic management".

Concluding remarks: Dr. Abid Mahmood. He advised stakeholders to look through opportunities from public private interactions. There is a need to work hard to achieve possible advancements in biological control trends. Pesticide residual effects have been ignored in past and must be

considered in future studies. Ratoon cropping is common practice in sugarcane but it lacks the necessary research it requires. Next round table must include topics of trash management, sugarcane lodging, efficient use of irrigation water etc. **Vote of thanks:** Acting CEO thanked all participants for their result oriented participation and said he learnt something from every presentation. He emphasized participants to take keen interest in implementation of findings. **Recommendations:** Recommendations formulated for the control of sugarcane weeds, insect pests and diseases are given in Table No. 1

Sr. No.	Active Ingredient	Dose/acre	Recommended Target pest	Application
Weedicides				
1	Topomezon + Atrazine + witsit	750 ml/acre	Bermuda grass Khabbal	April-May
2	Atrazine 50% + Mesotrione 5% EC	1 Litre/acre	Narrow leaf Weeds (Dehla)	After the first irrigation to crop
3	Ametrine +Atrazine 55% SC	1 Litre/acre	Weeds (Broad Leaf)	2-3 leaf stage of weeds
Insecticides				
4	Thiamethoxam + Chlorantraniliprole	4 kg/acre	Borers	Economic threshold level (ETL)
5	Fipronil	6 kg/acre	Borers	Post Plantation
6	Carbofuran	16 kg/acre	Borer complex (Root, stem, Gurdaspur)	Economic threshold level (ETL)
7	Carbofuran	16 kg/acre	Borer complex (Root, stem, gurdaspur)	Economic threshold level (ETL)
8	Acetamaprid + Lambda	150g/acre	Black bug+ Pyrilla	Economic threshold level (ETL)
9	Chlorantraniliprole	16 kg/acre	Lepidopteron pests	Economic threshold level (ETL)
10	Chlorpyriphos + fipronil 18% CF	1Liter/acre	Black Bug, Termites, Pyrilla	Economic threshold level (ETL)

11	Lambda Cyhalothrin + Thiamethoxam	80 ml/acre	Pyrrilla	Economic threshold level (ETL)
12	Bifenthrin (Ratoon crop)	200-250 ml/acre	Black Bug	Economic threshold level (ETL)
13	Chlorpyriphos	2 Litre/acre	Pyrrilla, White fly, Termites	Economic threshold level (ETL)
Fungicides				
14	Carbendazim	80 g/acre	Seed-borne diseases	Pre-Plantation

ANNEXURE-4 1st International Workshop: R & D activities on Sugarcane Plant improvementDated: 09 August 2017 **Agenda Points:**

11. Inauguration: Dr. Jack C. Comstock
12. Welcome address: Dr. Abid Mahmood. DG (Research) AARI, Faisalabad
13. Introductory note: Dr. Shahid Afghan. Acting CEO, SRDB (Punjab)
14. Induction of Desired Characteristics in Sugarcane Plant through Breeding Techniques: Dr. Naeem Ahmad. Director, SRI, Faisalabad
15. R and D Activities at Fatima Sugar Research and Development Center (FSRDC): Dr. Syed Zia ul Hussain
16. R and D Activities at SSRI for Sugarcane improvement: Mr. Aamir Shahzad
17. Sugarcane Breeding at Murree: Mr. Farooq Ahmad, ARO, SRI, Faisalabad
18. Sugarcane Variety Development Program at SCRI, Mardan: Dr. Muhammad Tahir
19. Sugarcane Varietal situation in Sindh and role of NSTHRI for Development of new Varieties: Mr. Riaz Noor Panhwar
20. R & D Activities on Sugarcane at NIA, Tandojam: Mr. Muhammad Tahir Khan
21. Seedling; A Vital Contribution in Varietal Development Program at SRI, Faisalabad: Dr. Ijaz Tabassum, SRI, Faisalabad
22. Combined use of Distillery Spent wash and Chemical Fertilizers in Sugarcane: Mr. G. M. Kaloi

Proceedings:

20. An International workshop entitled "R & D activities on sugarcane plant improvement" was organized on August 09, 2017 in Ayub Agricultural Research Institute, Faisalabad by Sugarcane Research and Development Board. Meeting started with the recitation of Holy Quran by Mr. Hafiz Walayat Ali Khan. Objectives of the seminar was to foresee latest breeding strategies, trends and to find solutions of prevailing sugarcane development complications.
21. Acting Chief Executive Officer requested Dr. Jack C. Comstock to declare the session open. Dr. Jack C. Comstock inaugurated the session and told about his 15 years of affiliation with sugarcane advancement through fuzz/clonal exchange programs, then he discussed in detail about Sugarcane variety background in Pakistan. He put light on Census of Varieties with CP germplasm as breeding strategy, Yield of released and promising varieties, Potential of clones in the pipeline and Potential impact of these varieties. Dr. Abid Mahmood asked for identifying better place in Pakistan for sugarcane breeding, Dr. Jack replied flowering and hybridization can be grown both in Murree and Thatta with restructuring the available resources, scientist employed in these stations must be facilitated with infrastructure having temperature and light control systems. Dr. Abid Mahmood ordered Muhammad Farooq ARO, Sub-station Murree, to start the breeding process within this year according to the recommendations and conclusions made by Dr. Jack on Murree visit, it was also told to Muhammad Farooq to stay herein

Faisalabad to prepare budget so that the finances for breeding are released for early start of work.

22. Acting Chief Executive Officer, Sugarcane research and development board presented his key note by congratulating all stake holders for record sugar production in 2016-17. He identified flaws in the availability of early, medium and late maturing varieties in Pakistan. He proposed sugarcane selection breeding model in which Pakistan should have at least 100000 original seedlings in the first year. He urged different research institutions to start collaboration in exchange of material before National Uniform Varietal Yield Trials (NUVYT) preferably at advance line stage with around 500 clones. It was also told that SRDB is collaborating internationally with ARS-USDA, USA, CTC Brazil, CENGICANA Guatemala, Kasetsart University Thailand, SRI, Sri Lanka and Visa-cane CIRAD France for exchange of material both in terms of fuzz and clones.
23. Muhammad Naeem Director, Sugarcane Research Institute Faisalabad discussed Induction of desired characteristics in sugarcane plant through breeding techniques. He emphasized on the development of site specific varieties having pre-basic and basic seed standards. He debated the role of charapani breeding substation, Murree. Breeding methods in Murree are open pollination, hybridization, import of exotic fuzz and direct introduction. SRI Faisalabad & SSRI Jhang collectively had send 60 promising and commercial varieties to Sri Lanka for hybridization. They also have direct introduction varieties from Sri Lanka, Mauritius, Philippines and USA. Mr. Riaz Noor asked about the flowering intensity percentage of varieties at Murree and the answer was 40%.
24. Zia ul Hussnain, communicated their research and development activities at Fatima Sugar Research and Development Center (FSRDC). Their research sections include Plant pathology laboratory, Soil and water testing laboratory, Biological control laboratory, Cane quality laboratory and research farms. FSRDC is depending on import of cane fuzz for its sugarcane selection breeding program. They also provide hot water treatment facility to farmers. Dr. Jack asked about the efficiency of hot water treatment, Dr. Zia answered it is good for the management of red rot, borers and provides early germination to sugarcane.
25. Aamir Shahzad, Research officer, Shakarganj Sugar Research Institute, SSRI Jhang elaborated the functioning of institute, its history, their sections of research, advancement made with time, list of pipeline varieties with general characteristics, selection breeding program with import of fuzz from multiple countries. They are also undertaking NUVYT trails to assess varietal performance. Their institute also have pathology lab, bio control lab for the rearing of Trichogramma and Chrysoperla species, bio compost facility, tissues culture lab and soil and water advisory services. Dr. Jack asked about the exchange of material with other institutes, Mr. Aamir said they exchange their material with SRI Faisalabad, FSRDC Muzafargarh and PARC Thatta.
26. Muhammad Farooq, ARO SRI substation Murree, started his presentation with the objective to conduct sugarcane breeding program for developing promising clones/varieties that suit best to various agro-climatic regions of Pakistan. He discussed in detail about the process of breeding and showed results of previous year and asked

about financial assistance from SRDB is development of substation so that breeding may take place in controlled condition so that maximum germination in terms of seed and flowering is achieved. Dr. Shahid Afghan asked about difference between tunnel and control methods of breeding and the answer was that both processes have same results. Dr. Jack asked Mr. Farooq to contact him after workshop to help him in making of budget for breeding accessories.

27. Muhammad Tahir, Senior research officer, SCRI Mardan, argued sugarcane varietal program at Khyber Pakhtunkhwa. He told that they import fuzz from USA, South Africa and Australia for their breeding program and it has limitations that is why they need to develop their own breeding program. While developing local breeding station, local viable adequate fuzz could be produced. Pakistan Agriculture Research Center, (PARC), Islamabad, constructed three photoperiod chambers at sugarcane breeding station, Jabban, Daragai. He said he is willing to renovate this station as he is confident it has the potential to produce viable fuzz. Dr. Shahid Afghan asked about the source of fuzz for the development of Bannu varieties and requested to follow varietal nomenclature while naming varieties.
28. Riaz Noor Panhwar, Senior Scientific officer, PARC, Makli, Thatta presented Sugarcane Varietal Situation in Sindh and Role of NSTHRI in New Variety Development. He said currently 205 sugarcane varieties/genotypes are being maintained in germplasm for flowering behavior study and synchronization. 695.9 g fuzz (true seed) has been collected from different sugarcane varieties/genotypes. 7150 new sugarcane clones were developed through local fuzz. He explained that two new varieties have been approved by PARC namely Thatta-2109 and Thatta-326 and many other promising varieties are in pipeline. Dr. Shahid Afghan said you must be more explanatory while conducting and describing trails as 10000 and 25000 seedlings are giving same number of clones. Secondly, he pointed out that do not take brix data in September rather is must be taken in November. Thirdly, he said triton is very old variety and it must be discouraged for multiplication and breeding.
29. Muhammad Tahir Khan, Nuclear Institute of Agriculture Tandojam, said plant improvement is need of the hour because of conventional breeding, non-flowering or sporadic flowering with poor seed setting under natural conditions, if seed setting occurs, germination is very poor and mortality rate is very high and Lack of facilities for induction of flowering by artificial means and these limitations can be resolved by biotechnology, exotic germplasm evaluation and mutagenesis. They are also undergoing callus culture for genetic diversity and crosses were obtained from Sri lanka. They are using RAPD (Randomly Amplified Polymorphic DNA) Primers for genetic studies. Their future directions for research are Sugarcane white leaf disease, enhancement of stress tolerance in sugarcane in adverse climatic conditions and exploration of sugarcane genome and development of promising molecular markers for sugarcane breeding. Dr. Jack asked about the process and efficiency of soma clonal variations and Dr. Shahid Afghan suggested him about the inefficiency of RAPD markets and asked him to use latest markers for genetic studies.

30. Ijaz Tabassum, Assistant Botanist, SRI Faisalabad presented his views on Seedling; A Vital Contribution in Varietal Development Program. He found flaws or lack of facilities in breeding at Faisalabad as an independent laboratory, freezer -20C, germination test facility, mist irrigation system, man power and healthy environment is required. He shared the data of seedlings and advance clones attained as the result of breeding program. Performance of direct introduction varieties from USA and Philippines.
31. G. M. Kaloi, Senior Scientific officer, NSTHRI, PARC, Thatta was the last presenter of International workshop. His title was Combine use of distillery spent wash and chemical fertilizers in sugarcane. He gave the introduction of spent wash and its potential in agriculture and sugarcane in particular. He studies various combination and treatments of spent wash for increasing soil properties, cane quality and yield. His field study shows that 10% spent wash + 2/3rd NP fertilizer enhanced cane yield and sugar recovery.

Vote of thanks/MOU: Acting CEO thanked all participants for their result oriented participation and said he learnt something from every presentation. He emphasized participants to take keen interest in implementation of findings. He also thanked Dr. Jack C. Comstock for his interest in improving sugarcane pathology and breeding in Pakistan. MOU was served to all representatives of sugarcane research institutes to thoroughly read and to give their suggestions within 15 days after workshop for approval so that exchange of material between research institutes gets progress and efficient sugarcane breeding is started. **Recommendations:** Recommendations formulated by Dr. Jack C. Comstock was shared with all participants at the end of workshop:

- Continue to support foreign training of young Pakistani scientists
- Expand disease-free seed cane as rapidly as possible
- Initiate National Crossing and Variety Development Program in Pakistan in cooperation with SRDB (Punjab)
- Support for import of cane fuzz and germplasm for research institutes of Punjab
- Organize selection program to exchange promising clones of research institutes

Foster collaboration and cooperation both nationally and internationally.

ANNEXURE-5 TRAINING ON MODERN TECHNOLOGIES FOR SUGARCANE MECHANIZED PLANTATION

Training and field demonstration on sugarcane Mechanized plantation

Sr. #	Name of Institutes/Sugar Mills	Date	Participants
1	Sugarcane Research Institute, SRI, AARI, Faisalabad.	12.09.2017	300
2	Fatima Sugar Mills, Kot Addu.	23.09.2017	200
3	Layyah Sugar Mills, Layyah.	24.09.2017	180
4	Jauharabad Sugar Mills, Jauharabad.	25.09.2017	200
5	Arjumand Farms, Sadikabad.	07.10.2017	200
6	Arjumand Farms, Sadikabad.	08-10.2017	200

ANNEXURE-6

LIST OF VARIETIES IMPORTED FROM USDA-ARS, Canal Point, USA			
Sr. No.	NAME OF CLONE	NO. OF SETT	NO. OF BUDS ON EACH SET
1	CPCL 02-6448	One	3
2	CP09-1952	One	4
3	CPCL05-1791	One	4
4	CP01-1372	One	3
5	CP09-1822	One	3
6	CP07-2137	One	4
7	CP05-1526	One	3
8	CPOCL05-1102	One	3
9	CPCL95-2287	One	3
10	CP04-1935	One	3
11	CP03-1912	One	3
12	CP00-1101	One	3
13	CPCL05-1201	One	3
14	CP08-1110	One	3
15	CP06-2400	One	3
16	CPCL02-0926	One	3
17	CP09-1430	One	3
18	CP07-2320	One	4
19	CP09-1385	One	2

ANNEXURE-7 (a) Project Title “Rezoning the agro-climatic regions for sustainable sugarcane production in Punjab”. Executing Agency: University of Agriculture Faisalabad Starting date: 01-08-2016, Duration: 12 months Project costs (6.99 millions) Project technical and scientific staff – names of Project Coordinator and of main staff **Principal Investigator:** Dr. Fahd Rasul (University of Agriculture, Faisalabad) Address: Assistant Professor, Department of Agronomy, University of Agriculture, Faisalabad.38040, Pakistan. Contact: + 923227881778 Email: drfahdrasul@gmail.com **Names of co-Principal Investigators:**

1- Dr. Khalid Hussain

Assistant Professor, Agronomy, University of Agriculture, Faisalabad 2- Dr. Hassan Munir Assistant Professor, Agronomy, University of Agriculture, Faisalabad **DESCRIPTION OF THE WORK IMPLEMENTED IN THE PERIOD** **Project feasibility analysis and development:** A visit and meeting of Chief executive officer during the reporting period helped the project to be go ahead with more precise action and activities were further streamlined. A presentation was made to show the achievements on the project and updated him about the activities going on. There were several suggestions by the chief executive officer of Sugarcane research and development board about the project activities and to achieve the next milestones very good directions were provided for which the project executing team is highly thankful for timely help provided by the CEO-SRDB. It was suggested by the CEO to take benefit of the SUPARCO 's Satellite's data which passes over Pakistan fortnightly and is launched by the French space agency, Some additional parameters of variety selection and evaluation for specific agro-ecological zones were suggested to be considered as baseline. Furthermore, twelve meetings of PI, team members and Co-PIs were held mostly at University of Agriculture Faisalabad, to evaluate the activity based execution plan and further development of strategies to achieve the milestones for field work at various locations of Punjab. Field surveys and samplings are pre-requisite for establishing the basis of agro-ecological zones and to achieve this target various categories of questions have been put together and a comprehensive questionnaire has been developed. Data on different parameters of soils has been acquired for further in depth analysis. Sugarcane major growing areas visits and sampling plan were carried out as per the schedule of availability of team members and some of the visits of the team members have been done in the southern Punjab, some sugar mills have been visited for sugarcane data collection as well discussing the ongoing project activities. **Project planning:** The project required baseline scenario generation for the soil maps of the Punjab's and climate data with characterization of daily weather including the various types of temperature measurements (T_{min} , T_{max} , T_{avg}), soil's data of various types is being acquired partially from the soil fertility research institute's head office in Lahore and sugarcane crop management data as per crop needs will be assessed from farmer's data to be collected through extensive surveys. The irrigated area production potential for sugarcane under recommended levels of production practices as per the agriculture department, govt. of Punjab will be assessed and compared with the farmer's data that is being carried out at various locations of Punjab and started from Faisalabad with the support of graduate students as project staff. Soils series maps of Punjab, by the soil survey department of

Pakistan were being superimposed with climate data along with soil data and area using the geo-referencing techniques and Google earth's latitude, longitude mapping application also supported by real time GPS measurements for ground truthing of data from selected sites is being executed. Furthermore, the assimilation of this data along with the synchronization of climatic parameters for sugarcane growing seasons and specific areas are being defined to explore the optimum sugarcane growth requirements by the measurements of dry matter accumulation and normal yield of major growing durations corresponding to zones which have been previously defined by the National agricultural research center Islamabad. Data is being acquired from different research experiments already conducted on various areas for their phenotypic behavior, growth responses and yield attributes along with sugar recovery being the most important factors while also keeping in view the soil based sugarcane specific practices in the major growing areas by fitting the data sets for estimation in Decision support system for agro-technology transfer and famous as DSSAT. The cane grow model is being optimized and various input datasets have been searched out through literature for the work published about Punjab. Certain characteristics of interest for sugarcane's superior production and crop health will be taken into account by processing of remotely sensed data which will be applied in image processing software for impact exploration on sugarcane. The long permanence of the crop in the field increases the chance of acquiring images via drones, which are fundamental for mapping the cultivated areas, monitoring the harvest and evaluating the land use change dynamics in selected areas under study.

Operational planning: The rezoning of agro-climatic zones for sustainable sugarcane production is depending on the agro climatic conditions of the area which have been selected by the stratified sampling process while the alternate consideration is based on the location of sugar mills in Punjab and the area that is served by the sugar mills in a certain geographical locality along with keeping in view the canal's command area which has also been considered using support of GIS, remote sensing and modeling techniques. The areas with higher production reported by the statistical bureau and characteristics of the high yielding varieties have been taken into account for the rezoning process. The temperature sensitivities of optimal growth of sugarcane are critical threshold for determining the yields of sugarcane in various agro-climatological zones and consequently the weather data will be used for the assessment to give a final shape. The following steps are being taken to execute the project.

- Literature has been searched and relevant information is being extracted for the smooth execution of project.
- Postgraduate students of agricultural extension have been hired for crafting a questionnaire which can evaluate the production, agronomic management, climate perspectives and sugarcane market's drive that stimulates farmers to grow more and efficiently.
- The Punjab's major irrigated cane growing area's data of weather for last 30 years has been acquired for integrated assessment of cane yield potential using DSSAT (Decision support system for agro-technology transfer) and optimization of various factors will be tested.
- The canal command areas and water supply systems play an important role for successful growing of cane and improved practices can also be adopted on the basis of

this important input, the data for the canals discharge and its distributaries are being obtained for the use in water resource management and to assess the water availability in particular seasons of cane growth.

- By using a sophisticated software with advance features of mapping like QGIS and ARC GIS are being sorted out for their features comparison and cost for licensing is being evaluated.
- The methodology for the cane production potential assessment using spatial and temporal imagery of whole Punjab province will be acquired from SUPARCO and processed using specialized software as mentioned above. This data will be mainly focused with the sugar mills and adjacent areas specially to deliver site specific information to various stakeholders of SRDB and also useful for policy making for the Punjab Province.
- Output in the form of maps for the rezoning of agro-climatic zones for sugarcane are planned and will be worked out thoroughly to give out long lasting useful information.

ACTIVITY WISE LISTING: 1-Literature survey 2-Collection of weather and soil data 3-Equipment identification and purchase 4-Trials/Field tests/Field surveys 5-Analysis of results/Modeling/GIS etc. **1- Literature Survey:** More relevant literature has been found and previous database has been updated, with offer from the CEO to use their Library at Shakarganj sugar research institute, Jhang has been appreciated. Summary of papers is being prepared for a deep insight with reference to sugarcane zoning. **2-Collection of weather and soil data** The required data has been partially obtained and more data is required for covering the whole Punjab 's weather but there is limitation of weather observatories in certain districts so more data is being acquired from various global databases on basis of latitude and longitude of areas. The preliminary data of soil surveys and analysis along with already reported work has been considered as baseline for the further establishing of agro-ecological zones which will be supported by synchronizing it with remotely sensed data for various temporal and spatial variations. The vector and raster data of satellite imagery has been merged with the GIS supported data and Punjab map will be superimposed with these data layers in final stages to get a pictorial output of the agro-ecological zones. These zones will give an insight into the major, normal and minor can growing areas of the Punjab with perspective of sustainable productivity. **3-Equipment identification and purchase:** The equipments has been identified and specifications of the equipments by various companies and vendors are being compared. The final models of the equipments with detailed specifications has been almost finalized during the meeting of investigators and the process of procurement is being worked out as per govt. procurement instructions. **Permission from UAF Management:** The permission for flying drones to have the field overviews and aerial data collection is being sought from relevant authorities. **Resources available for implementation:** The Agricultural information management system (AIMS) lab under the climate change cell (in collaboration with SUPARCO and FAO) has been allocated for partial sharing on cost sharing basis for the rezoning project. The link with SUPARCO at this facility makes it an ideal place to execute rezoning project activities. **EXECUTION OF THE WORK PLAN** **Work Plan Review**

Year	Month	Milestones	Tasks
1 st	November 2016-January 2017	1-Equipment identification and purchase 2- Trials/Field tests/Field surveys 3. Analysis of results/Modeling/GIS etc.	1-Equipments specifications has been developed. Vendors identified and Procurement through government rules is going on. 2- Some of the trials have been conducted and met farmers for survey of area and data collection. 3- Yet the data is not complete so the finalization of the process will take time.

CRITICAL ANALYSIS OF PROGRESS TOWARDS THE ACHIEVEMENT OF OBJECTIVES

Field activities can be critical to the objectives achievements in due time. This extensive work have been executed with the help of labor hired and soil samples taken. Procurement official processes that are laid down to follow the government rules of procurement implemented in university through the directorate of procurement and inventory control (DPIC). Previous work done has been exhibited to the Executive manager and acting CEO of the board for further guidance. FUTURE ACTIVITIES PLAN: The data analysis and field activities will be reported as soon these will be completed to give a concise information useful for stakeholders. Spatial and temporal variation from SUPARCO and their processing through the Image processing software has been started. Water data is being acquired for canal's command area and various data layers will be superimposed and maps will be developed for real time analysis based on integrated assessment for sustainable sugarcane production with a clear view to support sugar mills for their area and for capacity building of mills staff as well as policy makers

ANNEXURE-7 (b)

Title of the project:	Mitigation of drought stress effects through physiological approaches
Duration of the project:	36 months (August 01, 2016 to July 31, 2019)
Project Cost:	PKR 6.774 Million
Executing Agency:	University of Agriculture Faisalabad

PROJECT TECHNICAL AND SCIENTIFIC STAFF:

Principal Investigator:	Dr. Hassan Munir, Address: Assistant Professor, Department of Agronomy, University of Agriculture, Faisalabad.38040, Pakistan. Contact: + 923216671998 Email: hmbajwa@gmail.com
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Names of Co-Principal Investigators:

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DESCRIPTION OF THE WORK IMPLEMENTED IN THE PERIOD

Objectives of the project: Objectives:

- To screen available elite sugarcane germplasm for their tolerance to water stress
- To map the sugarcane physiological attributes to varying moisture regimes
- To augment the knowledge regarding cane root morphology and development for its typical response under varying soil types and water stress
- To develop new physiological strategies to induce tolerance in local sugarcane genotypes to water scarcity

PROJECT PLANNING & DEVELOPMENT:

Two meetings of PI and CO-PIs were held at the office of the P.I., Department of Agronomy, University of Agriculture, Faisalabad, to discuss and plan the project activities as follows.

Committed activities to date:

Sr.	Operation planning		Project research planning		
	Activity I	Activity II	Activity III		Activity IV
			Study I	Study II	
1	Hiring of scientific and field staff	Purchase of equipment and consumables	To initiate Screening of sugarcane clones for their tolerance to varying Field capacity levels	To initiate a study of cane water deficit tolerance by growing at different soil types	To initiate a study of the root architecture of sugarcane in response to water stress

Operational planning and execution: Opening of Project account: A separate account has been opened for the project in MCB bank at the UAF campus with the help of the office of the treasurer, University of Agriculture, Faisalabad. Account Officer Pre-audit and Disbursement, Office of the Treasurer, University of Agriculture Faisalabad will issue the bank checks for disbursement of funds on getting approval from the resident auditor of the university. **Activity I: Purchase of equipment:** Weighing balance, spade and hoeing tools, sett cutters (toka), Data collection /measuring tools are purchased and are in supply process. Purchase of equipment is in process of price realization and will be purchased on completion of codal formalities. **Activity II: Purchase of consumables: Purchase of the Consumables:** Pots, pot media (different types of soil), fertilizer, plastic pipe for watering, RACINE-2 or any other suitable Software (Process initiated with UAF's Directorate of Procurement & Inventory Control). **Hiring of scientific staff:** Hiring of one research Associate is in process and will be completed as per university rules. **Hiring of contractual labor:** Two Daily Paid laborers are engaged for project activities. **Research planning and execution:**

Study I: Screening of sugarcane clones for their tolerance to varying Field capacity levels A total of 15 cane genotypes collected from Sugarcane Research Institute, Ayub Agricultural Research Institute, Faisalabad were sown in pots during first week of October, 2016 to induce drought stress. Cane seedlings will further be exposed to drought levels as described in the project PC-I. An analysis of the pot medium (Soil) has also been initiated. Furthermore, the physiological and biochemical attributes will also be studied on induction of drought through maintaining planned field capacity levels. Replication of this experiment under field conditions will be executed at the Agronomic Research Area or at the Postgraduate Agricultural Research station for which allocation of land is in process and layout plan is being scrutinized for sowing in accordance with subject purpose during February 2016. **Study II: Cane water deficit tolerance by growing at different soil types** For the subject study, various soil types and pots have been collected/purchased. Sowing has been planned during first week of November, 2016. A total of twenty genotypes are in process of procurement from Sugarcane Research Institute, Faisalabad. The setts of these accessions will be sown in three replicates using different types of pot media (soils). Germinated seedlings will be exposed to different level of water deficit and data will be collected in respect of physiological and biochemical parameters as listed in the PC-I. For field study, two soil types are under selection process in order to understand physiological, agronomic and economic responses of cane to varying soil textures under drought conditions. **Activity IV: Study of root architecture of sugarcane in response to water stress** In line with the activity III study II, cane genotypes obtained from SRI, Faisalabad will be planted in pots using medium with equal ratio of sand, silt and clay and will be exposed to drought levels for study of cane root behavior during November 2016. Operational planning will help ensure availability of needed tools in this regard. Traits like seedling root and shoot length & weight, root density, average root distance and cane height with respect to root morphology will be assessed by simple washing of roots with water flow. For field study, cane plantation will be done at the allocated place during February, 2017 and root related traits will be observed in the light of induced drought levels using appropriate tools.

ANNEXURE-7 (c) Project Title: Population dynamics and cost-effective biological control of sugarcane whitefly. *Aleurolobus barodensis* (Mask.) (Aleyrodidae: Homoptera) in Punjab.

Summary of progress for this report period: **Objective 1:** Population dynamics of white fly population on sugarcane in different ecological zones of the Punjab, Pakistan. **Activity 1:** Survey & collection of whitefly and its biocontrol agents (BA) from different regions were done. So far localities of Jhang, Chiniot, Layyah and Rajanpur have been visited. Initially two regions have been selected for data recording on whitefly population. Regular visits are therefore being done to the selected farm area in Chiniot with cooperation of Ramzan Sugar Mills (RSM) and in Layyah with the help of Layyah Sugar Mills (LSM). Further consultation with SRDB is in progress for selection of two more localities in other Punjab zones.

1. Shakarganj Sugar Mills and surrounding locality

A visit to the Shakarganj Sugar Mills and its surrounding area was conducted on 04-10-2016. Following five locations were visited.

1. Chak Ghumnana, Toba Road, Jhang:

The farmer's field that was visited was of three acres. Mature standing crop was observed for infestation of whiteflies. Sugarcane variety HSF 240 was grown with a crop height of approximately 117 inches. Along with whitefly, the natural enemies that were observed in this locality mainly included spiders, ants, adult and larvae of ladybird beetle species of genus *Brumoides*, *Serangium* and others.

2. **Chak No. 268 JB:** The field visited in this locality was of two acres with a mature crop of the same sugarcane variety (HSF 240). The average height of crop at this location was 130 inches. Severe whitefly infestation was observed in patches. Natural enemies observed at this location consisted of coccinellid beetle larvae, spiders, ants and *Chrysoperla* spp.
3. **Chak No. 457 JB:** The field visited in this locality was of four acres with mature sugarcane variety HSF 240. The average crop height at this location was around 122 inches. The whitefly infestation was in patches and natural enemies included coccinellid larvae and adult beetles of *Serangium*, spiders and *Chrysoperla* spp.
4. **Chak No. 453 JB:** The field area visited at this location was of ten acres. Mature crop variety *-CPF 237 with an average height of 150 inches was observed. Whitefly infestation was severe but in patches. The natural enemies observed at this location mainly included *Chrysoperla* spp., adult and larvae of *Brumus* and other coccinellid larvae.
5. **Chak No. 479 JB:** The visited farmer's field at this location was of six acres. Sugarcane variety CPF 237 with an average height of 155 inches was observed for whitefly infestation. Natural enemies observed in this field included mostly coccinellid and *Chrysoperla* larvae. Collections were made and specimens were brought back to NIAB for further identification.

6. Ramzan Sugar Mills (RSM), Chiniot and surrounding locality

In connection with the research activities visits to RSM were conducted on 04-10-2017, 17-10-2017, 31-10-2016, 15-11-2016, 29-11-2016 and 14-12-2016. On first and second visit, different locations that were visited included Zaheer Farm, Ramzan Sugar Mills, Muhammadi

Sharif 1 and Muhammadi Sharif 2. At first location, mostly the mature sugarcane crop variety 246 with an average height of 165 inches was observed. There was no whitefly infestation but the crop was badly affected by web mite and few plants had black bug infestation. Only spiders were present in the field as natural enemies. Same locality also had crop varieties CPF 237 and CPF 247 with a crop stand of 180 and 190 inches respectively. Few patches of whitefly were also observed on the other side of the field. Very small orange coccinellid beetle *Serangium*, some coccinellid larvae, and *Chrysoperla* larvae were recorded. Three different farmers' fields were visited at second and third location consisting of four, six and five acres respectively. Crop variety being sown at all these locations was HSF 240. The average crop height at these locations was 160, 165 and 170 inches approximately. Mostly the crop was affected by web mite, red mite, whitefly and black bugs. Root and top borer infestation was also observed. Natural enemies observed from these locations included small coccinellid beetles adult and larvae, and few cocoon of *Epipyrops*. Some ratoon and September sown crop fields were observed at the farms of Ramzan Sugar Mills. Two acres of ratoon, three and four and a half acres of September sown crops were visited. Sugarcane varieties CPF 237 as ratoon and CPF 77400 were sown as September crop there. The height of ratoon crop was 30 inches and September sown crops were of 60 inches height. Although there was no whitefly infestation at this stage but flying whitefly adults were observed in the field. At one month age, this crop mostly had infestation of black bugs inside their whorls. Some small coccinellid beetles were also observed. For the research activities related to the ongoing project, a field of 4.5 acres was designated to NIAB team by the management of RSM. This field has September 2016 sown crop varieties CP 77400 & HSF 240. As per discussed plan with RSM management, this plot will not get any pesticide treatment unless suggested by the PI of the project. So far, four visits have been made fortnightly to the designated field for data recording on the population dynamics of pests and their natural enemies. Only occasional whitefly adults have been seen that probably migrated from mature crop. On first visit of 31-10-2016, adults of sugarcane early shoot borer were recorded and the management of RSM was advised to start releases of the egg parasitoid *Trichogramma* on fortnightly basis to avoid any devastation by the borers to the crop. They acted upon on our advice and prompt releases of the said parasitoid were done which are being carried out every alternate week routinely. Also, the attack of black bug was observed in few patches. On the second visit of 15-11-2016, watering of the field was suggested owing to the condition of the crop. There were also few patches of black bug infestation recorded again but it was recommended to the management of RSM to avoid any chemical treatment and let the crop sustain the attack without any interventions. A few adults of predatory beetle *Brumus* were recorded in the field. On the visit of 29-11-2016, the overall condition of crop seemed good except the attack of the whip smut disease and a few plants had borer infestation. Also the attack of blackbug was very negligible. Few predatory spiders and adults of *Brumus* were also noticed in the field. The status of crop on the visit of 14-12-2016 has been found satisfactory. Only a few more plants infected by whip smut were recorded but the situation is better than the previous sampling week. Also, with the timely releases of *Trichogramma* cards by the management of RSM, the borer attack is now under control and negligible plants were noticed to have borer infestation from previous weeks. Good number of predatory ladybird beetle *Brumus* has been recorded which is very positive sign and shows the

thriving of a very healthy crop ecosystem. The cooperation of the RSM management is commendable. Their efforts and understanding of the scientific work being done are very encouraging. We look forward working with RSM for betterment of crop in this region.

1. Layyah Sugar Mills and surrounding locality

A visit to Layyah Sugar Mills and its surrounding locality was done from 2-11-2016 to 3-11-2016. Two main regions Nasheb and Thal were visited with seven sub localities in Nasheb and five localities in Thal region. Main sugarcane varieties in Nasheb region were CPF 246, HSF 240 and CP 77-400. Only one location had September sown crop, the rest of the observed fields were of mature crop. The crop was mainly infested by sugarcane stem and root borers, whitefly, mealybug, leaf hoppers and leaf eating beetles. Minor infestation of grass hoppers, crickets, black bug and *Pyrilla* was also observed. Natural enemies recorded in this region mainly included different species of spiders. A few blow flies were also observed that might be acting as pollinators. In Thal region, out of five locations visited, only one was of mature crop, the rest were September sown. The crop varieties observed included CPF 246, US 127, US 633 and US 658. One field of sugar beet was also visited. The main pest attack of borers and whitefly was observed on mature crop. The September sown crop had minor attack of early shoot borer, leaf hoppers, leaf roller, weevils and leaf eating beetles. Natural enemies recorded in the fields mainly included spiders, and a few predatory seven spotted ladybird beetles, rove beetles and *Chrysoperla*. The visit was very useful and the management of Layyah Sugar Mills offered us a field of two acres that belongs to a progressive grower for future experimental work in Thal region. Again, the experimental plot allocated through LSM was visited for data recording and collection of insect specimens on 21-11-2016.

1. Indus Sugar Mills (ISM), Rajanpur and surroundings

In Rajanpur, the area of Kot Bahadur in the vicinity of ISM was visited on 22 and 23, Nov. 2016. Nine different locations were visited for examining the crop and pest attack. Mature crop varieties grown in that region mainly included CPF 244, 246, 234, 213, and 324. Average plant height was around 200 inches for mature crop. There was no attack of whitefly in this region but crops were infested at some location by another sucking insect pest called *Pyrilla*. At some spots, heavy infestation of this pest was seen. At some locations heavy damage by sugarcane stem and root borer was also observed. A large acreage of sugarcane crop was also visited at two different farms of ISM. Although, farmers in this locality are majorly depending upon chemical applications for borer and *Pyrilla* attacks, but the spots where there was heavy damage by *Pyrilla*, adults of green lacewings, *Epipyros* and coccinellid beetles were also recorded indicating the prevailing biological control in the fields. We encouraged the growers and sugar mill staff for application of *Trichogramma* cards for borer attack and persuaded them for less reliance on use of chemicals. We also visited the biological control laboratory being run by ISM and the quality of the cards being prepared was examined. Overall the visit was very useful and the management personnel of ISM were very cooperative for conducting field surveys and collections. **Activity 2: Identification:** Samples collected from fields include both pest and natural enemies. Based on morphological features and following insect identification keys whitefly samples collected are of *Aleurolobus barodensis* (Mask.) (Aleyrodidae: Homoptera). Its molecular identification is under progress. The natural enemies collected from field for this whitefly **mainly** included

1. Green lacewing *Chrysoperla*
2. Brumous ladybird *Brumoides saturalis*
3. Reddish brown beetle *Serangium parcestosum*
4. Seven spotted ladybird beetle *Coccinella septempunctata*
5. Predatory spiders from families Clubionidae, Liniphidae, Salticidae, and Oxyopidae

Activity 3: Laboratory Rearing of Biocontrol Agents: Out of collected samples, we are currently rearing green lacewing *Chrysoperla* and coccinellid beetle *C. septempunctata*. Some predatory spiders are also being reared. Culture of whitefly has been maintained for recording the predatory potential of these biocontrol agents on whitefly. For this purpose, some plants of sugarcane were obtained from RSM management and are being maintained at NIAB.

Sr. No.	Item	Sanctioned amount	Spent amount	Balance Rs. (+) (-)
1	Consumables	1,00,000	65,794	+ 34,206
2	Equipment	1,00,000	31,700	+ 68,300
3	Salaries	2,40,000	NIL	+ 2,40,000
4	Local Travel	1,50,000	79,005	+ 70,995
5	Documentation/Publication	50,000	NIL	+ 50,000
	Total per activity	6,40,000	1,76,499	4,63,501