REPORT

on

International Conference

Climate Smart Agriculture: The Way of Farming for 21st Century

October 08-09, 2018

Organized by

Department of Agronomy, MNS-University of Agriculture Multan, Pakistan

EXECUTIVE SUMMARY

Global warming due to increased greenhouse gases (carbon dioxide, nitrous oxide and methane) emissions since industrialization has caused rise in temperatures and an increased frequency of extremes weather events around the globe. The negative impacts of climate change have also been observed across the world. Specifically, food production systems are highly vulnerable to climate change and it is a serious threat to food security for an ever-growing human population especially in developing countries. Nearly all nations, including Pakistan, have already realized the issue and they all signed a historic Agreement (Paris Agreement-2015) to keep the planet's temperature rise well below 2 °C by the end of this century, by adopting massive climate change mitigation and adaptation strategies. Pakistan, the 6th most populous country is an agro-based economy where approximately half of the population is directly or indirectly dependent on agriculture for their livelihoods. Pakistan, due to its geographical and geopolitical location, falls under the top ten countries that are most prone to adverse impacts of climate change. During the past two decades, the country faced the effects of weather extremes, such as devastating floods (2010), droughts, heat waves, cyclones, smog (due to air pollution and dust because desertification/low rainfall) and temperature extremes. Erratic and unpredicted weather patterns, especially changes in rainfall distribution, and freshwater scarcity reduce agricultural productivity due to underperformance of existing farming systems. Risks due to unprecedented climatic changes and weather extremes have increased many folds due to lack of awareness to cope with situations or early warning system to avoid major losses. These situations are specifically damaging for small land holding farming communities. Existing technologies and approaches seem inadequate to minimize climate change led losses or to develop climate resilient farming systems to achieve sustainable production and food security.

The major challenges may be addressed by adopting climate smart agriculture (CSA) approaches. For instance, by reforming existing or developing new agricultural strategies that could increase the resilience of agricultural production systems. The CSA tackles the situation with three interrelated aspects, 1) sustainably increasing agricultural productivity and incomes to meet national food security, 2) adapting and building the resilience of agricultural systems to climate change, and 3) reducing greenhouse gas emissions and/or increasing carbon sequestration in soils to improve their fertility and hence resilience.

To explore recent advances adopted by developing/developed countries to cope with emerging climate change threats, the Department of Agronomy, MNS-University of Agriculture Multan

has organized an international conference on "Climate Smart Agriculture: The Way of Farming for 21st Century" in collaboration with Hochschule Geisenheim University, Germany on October 08-09, 2018. The conference brought together international and national experts from academia, i.e. researchers and scientists from allied agriculture institutions, progressive farmers, policy makers and other stakeholders to discuss and explore recent climate change mitigation and adaptation strategies. The experiences shared during this event would help to develop strategies and policies to mitigate the effects of climate change and increase agricultural productivity, to help ensure food security in the country.

The inaugural session of the conference was held on October 08, 2018 at 10:00 am. The conference was jointly inaugurated by Syed Hussain Jahania Gardezi (Provincial Minster of Punjab for Management and Professional Development), Syed Ibne Hussain (Former IG, Railway Police/Member PPSC), Prof. Claudia Kammann (Department for Applied Ecology/ Climate Change Research for Special Crops, Hochschule Geisenheim University, Germany) and Prof. Dr. Asif Ali, VC, MNS-UAM. Prof. Dr. Asif Ali welcomed everyone followed by address of Prof. Dr. Claudia Kammann and Prof. Dr. Axel Garcia from University of Minnesota USA, address by the Chief Guest Mr. Syed Hussain Jahania Gardezi Provincial Minister of MPDD and vote of thanks by Dr. Abdul Ghaffar, Chairman, Department of Agronomy, MNS-UAM. The conference continued on first and second day comprising following sessions at three venues of MNS-UAM with following themes.

a) *Plenary Session*
b) *GHGs and Carbon Sequestration to Mitigate Climate Change*
c) *Global Warming and Climate Change Impacts on Agriculture*
d) *Food and Nutrition Security (bio-fortification and related approaches)*
e) *Challenges and Opportunities of Precision Agriculture in Pakistan*
f) *Prediction and Decision Support Modeling*
g) *CSA Innovations, Strategies and Solutions*
h) *Resource Use Efficiency*
i) *Concluding Session*

Climate change effects on agriculture and environment were highlighted and different mitigation strategies and solutions were proposed in above mentioned sessions. Following renowned foreign and national scientists also delivered talks in different sessions

The foreign scientists included Prof. Dr. Axel Garcia y Garcia (USA), Prof. Dr. Claudia Kammann (Germany), Prof. Dr. Jiahua Zhang (China), Prof. Fabián G. Fernández (USA), Prof. Dr. Hans-Werner Koyro (Germany), Dr. Muhammad Asif (Turkey), Dr. Faheem Shahzad

Baloch (Turkey), Dr. Nasrin Salehnia and Mr. Sohrab Kolsoumi (Iran), Dr. Muhammad Shahbaz (Sweden), and Dr. Moustafa Selim (Germany). While the national scientists included Dr. Saghir Ahmad (Director Cotton Research institute, Multan), Dr. Tasneem Khaliq (UAF), Dr Fahad Rasul (UAF), Dr. Wajid Nasim (COMSATS) and other young scientists from all over Pakistan.

These sessions were presided over by the scientists who drafted final recommendations for each technical session after thorough discussion. The recommendations were presented by the session chairs individually.

In brainstorming sessions, effects of climate change on earth were highlighted and different mitigation strategies were proposed to cope with climate change and it was emphasized that farming practices should be modified in the light of following recommendations. Promotion of tree plantation could control temperature/increase precipitation/sequester carbon to mitigate climate change. Installation of more weather monitoring, forecasting and advisory systems for early warning about climate related disasters like heat or cold waves, floods (agro-meteorology – phenology and -pest models), Construction of water reservoirs/storage to reduce drought impacts. Crop rotations to break pest cycle, green manuring and use of biochar to increase soil fertility. Conservation agriculture can reduce global CO_2 emissions, degradation land, improve fertility and reduce cost of production. Diversification of bread basket by inclusion of stress-tolerant and versatile pseudo cereals and coarse grains like millets, quinoa, cheena. Legume crops (mungbean, cowpea, sesbania) can be successfully adjusted in summer gap (from last week of April to mid-July) for getting fodder, grain and biomass for green manure. Climate smart agriculture through models of bio-gas plants and use of solar dryers for fruit and vegetables processing, solar operated hand pumps and donkey pumps can be energy efficient. The Pakistan is in dire need of implementing the proposed recommendations because of changing climatic conditions, escalating human population, ever increasing insect pests pressure and diseases on crops and animals.

Inaugural Session

Arrival of guests and visit to MNS-UAM Experimental Farm, and Agriculture Complex

After the arrival of guests in the University, a tour was conducted to to Agriculture Research Farm (C-Block) of MNS-UAM. The guests were briefed about the role of MNS-UAM in the promotion of kitchen gardening and hydroponic vegetable production.

Arrival of international delegates

Visit of foreign guests to MNS-UAM Experimental Farm

Arrival of Guests at Conference Venue and Visit of Stalls

Honorable Chief Guest, Mr. Syed Hussain Jahania Gardezi along with Vice Chancellor of MNS-UAM Prof. Dr. Asif Ali and foreign delegation visited the stalls of following public and private sector organizations and departments.

1) Doaba Foundation

2) Pak Arab-Fertilizer Company

3) Bayer Cropscience

4) Sayban Group

5) Fauji Fertilizer Company

6) Evyol Group

7) Agricultural Mechanization Research Institute

8) Mango research Institute

9) Institute of Plant Breeding and Biotechnology

10) Department of Agronomy of MNS-UAM

11) Vegetable Nursery and Kitchen Gardening

12) Stall of Quinoa and Proso Millet Food Products

Chief guest along with foreign guests is inaugurating the conference

Chief guest is visiting different stalls

Vice Chancellor, Prof. Dr. Asif Ali, along with foreign delegation and chief guest Mr. Syed Hussain Jahania Gardezi joined the conference at 10:53 am. Stage secretary Mr. Naeem Toor welcomed the honorable guests.

Prof. Dr. Asif Ali along with Mr. Syed Hussain Jahania Gardezi, Prof. Dr. Claudia Kamman, Prof. Dr. Ibn Hussain, Prof. Dr. Hussain Mustafa, Prof. Dr. Hans Werner from Germany, Prof. Dr. Axel Garcia, Prof. Dr. Fabian from USA and Prof. Dr. Jiahua Zhang from China were invited on the stage by the stage secretary.

Recitation of Holly Quran

Hafiz Muhammad Saleem (Ph.D. Scholar, Agronomy) recited few verses from Holy Quran. Mr. Muhammad Bilal, 3rd semester, B.Sc. (Hons.) Agriculture offered Naat-e-Rasool Maqbool (PBUH).

Opening Remarks and Conference Overview

Prof. Dr. Asif Ali gave a comprehensive overview of the conference and thanked all the organizers and sponsors of this conference. He welcomed the foreign delegations and honorable Chief Guest Mr. Syed Hussain Jahania Gardezi for their arrival. He appreciated the efforts of Department of Agronomy for organizing the international conference to highlights the current and serious issue of this century. He said that research work on climate change is our top priority area and MNS-UAM is well aware of the current situation. This conference is an attempt to create awareness about this issue. He mentioned the IPCC PARIS Agreement and declared that this conference will play a key role to achieve the aims of Paris Agreement which is keeping the global temperature to rise below 2°C during this century.

He appreciated the efforts of Dr. Riaz Hussain Qureshi (Ex Vice Chancellor, UAF) for establishing the climate change cell in 2003 and ecological zones were defined in Pakistan by the aid of SUPARCO. He also mentioned the efforts of Dr. Ishtiaq and Dr. Mubashir to cope with the climate change. Prof. Dr. Asif Ali also mentioned about the 73 talks of this conference

out of which 17 talks were international. Prof. Dr. Asif Ali also mentioned the climate change cell which is under discussion in University surroundings. He also appreciated the "Clean and Green Pakistan" program of the Govt. to fulfill the aims of IPCC PARIS Agreement.

He elaborated that how MNS-UAM has been transformed in to an Agricultural Complex where research extension and education are at one place and forum. He also declared the South Punjab as a California of Pakistan due to having similarities in the diversity of agro-based industries, crops and languages.

Prof. Dr. Claudia Kammann from Hochschale Geisenheim University, Germany

Prof. Dr. Claudia Kammann delivered a comprehensive presentation on the topic of "Agriculture ecosystems as a key for combatting climate change and meeting 2°C goal of the Paris Climate Change Agreement". She highlighted the emissions of CO_2 which are increasing day by day due to burning of crop residues and emission of greenhouse gases from industries and vehicles. She also mentioned the disaster of heat wave in Russia and Pakistan in terms of forest fires and floods in 2010.

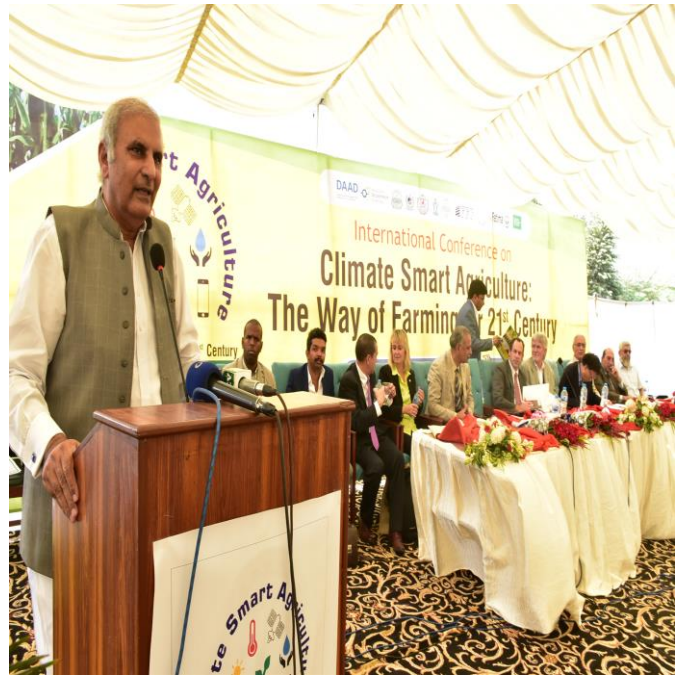
She also mentioned the dark earth zones which are increasing day by day due to climate change. To achieve the goal of IPCC PARIS Agreement, she urged to adopt the low emission technologies and promote afforestation. She stressed that instead of burning the crop residues, these should be converted into Biochar that will not only enhance the fertility of soil but also lower the emission of CO_2 in air and hence global temperature will be less affected.

Prof. Dr. Axel Garcia from University of Minnesota USA

Prof. Dr. Axel Garcia delivered a comprehensive presentation on "21st century farming: Is more food with less water possible?" He said that we are polluting our fresh water resources which are only 2.5% of the total water on the earth. Due to increasing population of world, we have to produce 50% more food in 2030. He presented the current situation of Pakistan where per capita water availability is declining day by day.

Pakistan's per capita water availability is only 1/3rd of that of China. He asked that according to current situation, we have to cultivate 600,000 ha more land to feed the population of over 200 million and 3 m^3 of water is needed per day per individual. To mitigate this situation, we have to adopt high water efficiency techniques and sub-surface drip irrigation is a potential technique which can mitigate this situation.

Address by the Chief Guest



Mr. Syed Hussain Jahania Gardezi (Provincial Minster of Punjab for Management and Professional Development) declared that climate change is a global issue and entire world should emphasis on it. He appreciated the University administration for organizing the international conference on this serious issue. He declared that water resource management, seed development and climate change are the three major issues of Pakistan agriculture sectors and we must adopt measure to meet the challenges. He mentioned the "Clean and Green Pakistan" program has been launched by Govt. of Pakistan to meet the challenges associated climate change. We should emphasis on the plantation of trees and improvement of technology to embrace CSA which is the only way to meet the food demands of an ever increasing population of Pakistan, he further added.

Presentation of Souvenir to Chief Guest

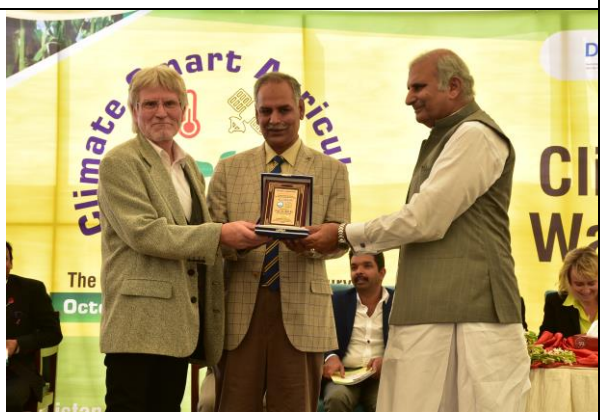
Prof. Dr. Asif Ali presented souvenir of appreciation to the Chief Guest, Syed Hussain Jahania Gardezi.

Worthy Vice chancellor Prof. Dr. Asif Ali is presenting the souvenir to Chief Guest, Syed Hussain Jahania Gardezi.

Vote of thanks and tea break

Dr. Abdul Ghaffar, Chairman, Department of Agronomy, MNS-UAM offered the vote of thanks to all the honorable guests, foreign delegations, heads of different institutes, participants, organizers, sponsors farmers and media for joining this conference.

Souvenirs were also distributed among the honorable guests by Prof. Dr. Asif Ali and Syed Hussain Jahania Gardezi. At the end, tea was also offered to the participant, organizers, sponsors and honorable guests.




DAAD

Prof. Dr. Asif Ali and Chief Guest Syed Hussain Jahania Gardezi presenting souvenirs among the honorable guests.

Plenary Session

Chair, Prof. Dr. Claudia Kammann, Co-Chair, Prof. Dr. Axel Garcia

Dr. Saghir Ahmed Director Cotton, Punjab

The topic of presentation of Dr. Saghir was "Agriculture Research in Changing Climate Scenarios". He discussed the agriculture research needs and achievements so far in changing climate scenarios of Pakistan. He briefed about climate smart agriculture research activities at

AARI Faisalabad like development of climate resilient varieties, evolving zone-specific varieties and use of biotechnological tools to incorporate stress tolerance in crops. He mentioned about drought tolerant varieties of cotton like FH-Lalazar, HF-942 and VH-327 and varieties of wheat like Gold-16, Ihsan-16 and Faisalabad-2008 etc. He also told about heat, disease and pest tolerance varieties of cotton and wheat. He discussed about area specific drought tolerant crop identification like barley in South Punjab, Pearl millet in rainfed area and gram in Thal area. Moreover, he further elaborated about soil salinity, its causes like high temperature, low rainfall and consistent use of brackish water, and salinity tolerant varieties of wheat and rice developed by AARI.

Prof. Dr. Fabian G. Fernandez from University of Minnesota USA

He presented his research work on "Making Efficient Use of Fertilizer". He talked about the challenges like the need of increased crop productivity to meet demand for food, fiber and fuel of a growing human population under limited available resources. He also discussed about balanced and judicious use of fertlizers especially the nitrogen. He concluded that local research based fertilizer guidelines have environmental and agronomic benefits but there is need to re-evaluate as changes in climate and agronomic variable, need greater understanding of processes in nitrogen cycle, and multiple tools and approaches are needed to improve nitrogen management.

Prof. Dr. Jiahua Zhang from institute of remote sensing and digital earth, China

He talked about progress in agriculture earth observation and stimulation for CSA development. He also discussed about estimation of maize yield using a processed based remote sensing and mechanism model in Southeastern plains of China. He postulated that without any mitigation strategy, global mean surface temperature might increase by 3.7 to 4.8°C over the 21st century.

Prof. Dr. Hans-Werner Koyro from Germany

His talk was about the impact of biochar on the performance of halophytic crops like quinoa. He reported that if we add organic amendments in soil, these will increase water holding capacity and water use efficiency. His research work showed that addition of biochar in soil not only increases the crop growth and yield; but also increases the enzymatic defense as compared to control plots.

Concluding remarks by the chair

Prof. Dr. Claudia Kammann and Prof. Dr. Axel Garcia appreciated all the speakers for their research work and comprehensive presentations. They concluded that development of heat tolerant crop varieties, cultivation of crops according to agro-ecological zones, judicial use and management of fertilizers are sustainable ways to mitigate the impact of climate change on agriculture. They also highlighted that, latest tools, like remote sensing can also help to manage the crops wisely under changing climate. Role of biochar in managing soil health under changing climate was also appreciated.

Technical Session I

Theme of Session: GHGs and Carbon Sequestration to Mitigate Climate Change

Chair, Prof. Dr. Claudia Kammann, Co-Chair, Prof. Dr. Hans-Werner Koyro

Following speakers talked on this occasion and highlighted different issues pertaining climate change and mitigation strategies.

Prof. Dr. Muhammad Fahim, Institute of Environmental Sciences and Engineering, NUST Islamabad, Pakistan

The topic of Dr. Fahim's talk was Climate change, atmospheric oxidants and crop yield in Pakistan. He briefed that he is exploring the plausible influences of climate change and atmospheric oxidants on crop production in Pakistan over the last decades. He further added that, this endeavor will be accomplished by using a mix of remote sensing data and statistical analysis of the two parameters namely climate (temperature, precipitation) and tropospheric ozone on crop production in various agro-ecological zones of Pakistan. The greater emphasis will be on hotspots identified through the IPCC Representative Concentration Pathways, and tropospheric ozone concentration mapping over the country. He explained that meteorological data will be acquired from Pakistan Meteorological Department (PMD), and crop production information will be obtained from Pakistan Bureau of Statistics & Pakistan Agriculture Council, whereas data regarding tropospheric ozone will be gathered through satellite and ground-based observations from selected sites in Pakistan. All data will be processed, mapped using GIS software and statistically analyzed to determine temporal trends and plausible causation among selected variables. At the end statistical model will be used to assess the decrease in crop yield over the years and consequent loss in revenue.

Dr. Hafiz Mohkum Hammad, COMSATS University, Islamabad-Pakistan

The topic of talk of Dr. Mohkum was Carbon sequestration potential of various land use systems under changing climate of arid region. Dr. Mohkum said that greenhouse gases (GHGs), especially carbon dioxide (CO_2) and consumption of fossil fuels on large scale are causing climate change on the earth in addition to other factors. He added that soil is one of the largest carbon (C) pools in biosphere and it has the greatest potential to sequester the C for the mitigation of climate change effects. Than he talked about his study which was designed to evaluate and compare the C sequestration potential of various land use systems (cropped land, orchards, agroforests and forests) in arid region of Pakistan. He explained methodology to achieve this objective, soil samples at the soil depths of 0-20, 20-40, 40-60 and 60-80 cm were collected and analyzed for soil chemical properties, soil organic matter (SOM) and C content. Results showed that the below ground biomass of SOM and SOC was found maximum 14.09 and 6.84 ton ha^{-1}, respectively in forest land at the depth of 0-20 cm with improved soil properties. Mango orchard showed maximum amount 12.38 and 6.79 ton ha^{-1}, respectively; while, citrus orchard showed the amount 11.76 and 6.10 ton ha^{-1} respectively at the depth of 0-20 cm. Cropland showed less amount of SOM and SOC (10.92 and 5.69 ton ha^{-1} respectively) at the depth of 0-20 cm as compared to all other land use systems. The amount of SOM and SOC decreased with increase in soil depths. Cropland showed the minimum amount 4.93-ton ha^{-1} of SOM at the depth of 60-80 cm; while, citrus orchard showed the minimum amount 3.04-ton ha^{-1} of SOC at the depth of 60-80 cm. He concluded that forest land significantly sequestered the maximum amount of SOM and SOC than other land use systems and forests are the net sink of carbon. Therefore, he emphasized to increase forest area of Pakistan.

Dr. Faheem Shahzad Baloch, Department of Field Crops, Faculty of Agricultural and Natural Science, Abant Izzet Baysal University, Bolu-Turkey

Dr. Faheem explained Future breeding strategies for dealing with climate change. He said that the focus of his presentation is on promising genomic tools and strategies that allow us to cost effectively breed for climate-resilient crop plants in a short period of time. He highlighted modern breeding strategies for developing climate-resilient crop varieties, such as high-density genotyping, whole genome resequencing, high-throughput and precise phenotyping, doubled haploids, genomics-assisted breeding e.g., genome-wide association studies, breeder-ready marker development, speed breeding, rapid-cycle genomic selection, marker-assisted recurrent selection, and crop modelling for genomic selection. He added that the strategies and

technologies being considered here are likely to address the concerns related to climate change affecting crop varieties. He said that we will give some brief examples about the uses of molecular markers in plant breeding for some adaptive traits such as identifying genes for dwarfing, vernalization, photoperiod and grain hardiness. The genetic diversity assessments in some important crops and identifying QTLs/genomic regions through bi-parental mapping population and Genome Wide Association Studies (GWAS) for traits of interest in some crops of economic importance. We also highlighted the recent trends of marker technology for increasing the efficiency of MAS through multiplex marker protocol in genomic selection. He explained that one hundred and eighty genes related to biotic and abiotic stresses as well as agronomic traits have been multiplexed through KASP technique and, its application in Turkish wheat breeding. He concluded that genomics-assisted breeding is benefiting from these advances, allowing rapid identification of genes associated to agronomic traits coping with climate change.

Prof. Dr. Muhammad Arif, Department of Agronomy, The University of Agriculture, Peshawar, Pakistan

The topic of talk of Dr. Arif was Improving productivity of cereal-based cropping systems through application of biochar and legumes into the summer gap. Dr. Arif said that biochar can improve soil quality, increase crop production and sequester C in agricultural systems; however, this now needs critical evaluation in a sustainable agricultural context. He added that in Pakistan, there is a gap in cereal-based wheat–maize–wheat cropping systems that lasts between 70–80 days. This "summer gap" can be used for growing short duration legume crops, which can provide valuable grain, fodder, or green manure and can provide a sustainable input of nitrogen into agricultural systems. Then he explained field-based study to determine the effect of biochar application to an alkaline, nutrient poor soil on the productivity of legume crops grown during the summer gap. He concluded that biochar application (50 t ha^{-1}) increased the productivity and yield of cowpea, mung bean and sesbania over two cropping seasons compared to unamended (non-biochar) control plots. At the end, he also suggested that the integration of biochar and legumes could be a useful strategy for improving the overall farm productivity of cereal-based cropping systems in Pakistan, by delivering a sustainable input of nitrogn to soil and providing increased yields from this additional summer gap crop.

Dr. Muhammad Asif, Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul, Turkey

The topic of talk of Dr. Asif was Interactive effect of elevated carbon dioxide, magnesium deficiency and drought stress on wheat. Dr. Asif said that elevated carbon dioxide (CO_2) and drought stress are two of important aspects of climate change. H added that elevated CO_2 increases photosynthetic efficiency of plants especially C3 species and ameliorates the adverse effects of drought stress. Furthermore, he highlighted importance of magnesium (Mg), Mg being central atom of chlorophyll molecule is very important for maintenance of photosynthesis it is very critical to reveal the effect of elevated CO_2 and drought on Mg nutrition of plants. He explained his study which was aimed at exploring the interactive effect of elevated CO_2, drought and magnesium deficiency on photosynthetic parameters, biomass formation of wheat. After explaining methodology of his study, he explained results that elevated CO_2 increased shoot biomass under adequate magnesium and water supply; however, impaired Mg supply nullified or minimized this effect. Impaired Mg supply reduced shoot biomass by 7% and 6% under ambient CO_2 conditions; however, this effect was increased to 29% and 34% in well-watered and drought stressed plants, respectively under elevated CO_2 conditions. Similar response was shown photosynthesis rate and chlorophyll content. Considering the results presented in his study he concluded that future climate with increased CO_2 and severe drought would precipitate adverse effect of impaired Mg supply and adequate Mg fertilization would be very crucial in mitigating the adverse effects of climate change.

Dr. Muhammad Shaukat, Department of Agronomy, University of Agriculture, Faisalabad-Pakistan

Topic of talk of Dr. Shaukat was Synthetic effects of biochar addition and nitrogen fertilization on greenhouse flux from anaerobic rice paddy. Dr Shaukat said that application of synthetic fertilizers is responsible for nitrous oxide (N_2O) emission, and rice cultivation is primary source of methane (CH_4) efflux. These both greenhouse gases have great potential to capture longwave solar radiation, and consequently leading to warming of the atmosphere of the world. Biochar application to agricultural soil is an appealing approach to N_2O and CH_4 emissions. Therefore, he made a study to mitigate N_2O and CH_4 by biochar addition and N fertilization in rice paddy under controlled conditions. In this study, 0, 2 and 4% (abbreviated as WBC, 2BC and 4BC, respectively) biochar were mixed in 3500 g unsterile soil along with 0, 70 and 140 kg N ha^{-1} (abbreviated as N0, N70 and N140, respectively) before transplanting of rice seedlings. He explained results that the mean CH_4-C fluxes ranged from 1.21 to 1.28 μg CH_4-C cm^{-2} d^{-1} from pots treated with 2BC and 4BC, respectively, and this emission rate was 87-97% higher as compared to control treatment. Moreover, the application of 2BC and 4 BC along with 70 kg

N ha^{-1} induced 112-132% and 35-40% higher CH_4-C emission rate over control and N70 treatments, respectively. Application of 2BC and 4 BC along with 140 kg N ha^{-1} induced 64-71% and 16-24% higher CH4-C emission rate than control and N140 treatments. The N fertilization treatments (N70 and N140) greatly accelerated 67-164% higher mean N_2O-N emission rate over control. The average N_2O-N emission was significantly reduced with the addition of BC as compared to sole N fertilization treatments in soil of paddy rice during the whole growing period. The N2O-N emission were ranged 0.13 to 0.17 μg N_2O-N cm^{-2} d^{-1} from pots treated with 4BC and 2BC, respectively. Interestingly N_2O-N emission from 4BC was 18% lower as compared to control treatment. In crux, the biochar addition could reduce the N_2O emission even under higher N fertilization and thus biochar is helpful in mitigating climate change.

Dr. Kashif Hussain, Pakistan Center for Advanced Studies in Agriculture and Food Security (USPCAS-AFS) UAF

Topic of Dr. Kashif was Future prospects: Adaptation strategies to diminish the effects of climate change on Livestock. Dr. Kashif highlighted the importance of livestock and said that it contributes 59% and 11% to agricultural and overall GDP of Pakistan, respectively. He added that demand for livestock products has increased globally; hence, it is time to uplift the livestock sector to fulfill the demand and to enhance the economy of our country. For this purpose, the number of livestock, their genetic potential, import of high producing breeds, their feed quality and management techniques are being enhanced but due to change in climatic conditions animals are adversely affected. He said that climate change directly causes heat stress which is one of the major issues of livestock and being responsible for more than 15% decrease in feed intake, decrease in milk and meat production (up to 30%), up to 27% fall in reproductive performance of animal, increase in health issues and mortality. Indirectly climate change leads to: decrease in quality and availability of feed (due to increase in temperature, level of carbon dioxide and alteration in precipitation pattern), reduce in quantity and quality of water (because of alteration in rainfall pattern, melting of glaciers, flow of river and underground water resources), manifestation in physiology (TPR and hypothalamic-pituitary-adrenal axis) and increase in livestock diseases (increase in propagation of different mortal pathogens and their vector). He added that different adaptive strategies are in use, but they are inefficient due to little research in Asia, absence of communal inquiry and association between climate change impacts and adaptation, lack of focus on agroforestry and mixed livestock crop system, no concern with monogastric livestock population and inappropriate use of quantitative

methods viz. impact assessment model and simulation model. Dr. Kashif emphasized that there must be research on impacts of climate change adaptation in livestock production beyond different topographical frameworks and find out significant vulnerable effects. For development of policy, it is pivotal to compare the adverse effects of livestock and adaptation strategies. He ended his talk by phrases that using modern techniques of biotechnology, need of the time is to locate and incorporate genes of native breed which are helpful in adaptation to climate change for sustainable growth of livestock.

After interesting presentations and discussion, the chair extracted following recommendations from this session.

1. Remote sensing and latest statistical packages should be adopted to quantify effect of temperature, precipitation and tropospheric ozone on crop production in various agro-ecological zones of Pakistan.
2. Forest can significantly sequester soil organic SOC than other land use systems and forests are the net sink of carbon. Therefore, it was emphasized by the chair to increase forest area of Pakistan.
3. Genomics-assisted breeding is benefiting, allowing rapid identification of genes associated to agronomic traits coping with climate change.
4. Integration of biochar and legumes could be a useful strategy for improving the overall farm productivity of cereal-based cropping systems in Pakistan.
5. Biochar addition in soil could reduce the N_2O emission even under higher nitrogen supplementation and thus biochar is helpful in mitigating climate change.
6. Genotypes of crops should also be screened on physiological basis.

Technical Session II

Theme of the Session: Global Warming and Climate Change Impacts on Agriculture

Chair, Prof. Dr. Axel Garcia y Garcia, Co-Chair, Dr. Bashir Ahmad

The session started with the talk of Dr. Dildar Hussain Kazmi from Pakistan Meteorological Department Islamabad. He spoke on the topic “Inter-annual variation of summer monsoon over Pakistan”. He proposed rainfall modeling to be an effective tool for predicting rainfall patterns. These predictive models help to mitigate the losses incurred by drought and heat stress in crops. The second speaker was Dr. Moustafa Selim from the Department of plant protection, Hochschule Geisenheim University, Germany. He delivered talk on “Effect of climate change

(mainly CO2) on grapevine-pest interactions". Dr. Moustafa studied the grapevine interaction with pathogen and insect pest. He examined the interaction of *Plasmopara viticola*, the causal agent of downy mildew of grapevine and insect pest *Lobesia botrana* at ambient and elevated CO_2 levels. He observed an increased in disease severity and insect pest population at elevated CO_2 which shows an alarming situation of insects and diseases in changing climate scenario.

Dr. Wajid Nasim from Department of Environmental Sciences, COMSATS University Islamabad (CUI), Pakistan shared his knowledge about the "Climate change Impacts on Water availability Regions of Pakistan". He explained the present and predicted future impacts of changing climate on the water availability in Pakistan. According to Dr. Nasim, the situation remains bleak and we must act and act in right direction before it is too late.

The next speaker was Dr. Nasrin Salehnia, a renowned Professor of the Department of the Water/Agro Meteorology, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran. She spoke on "Calculation Actual and Potential Evapotranspiration by developing a Tool for MODIS Product". She introduced audience with her tool to extract data from MOD16A2 to estimate the actual and potential evapotranspiration which could be extremely helpful in managing water resources.

Dr. Fiaz Ahmad, an eminent scientist of Central Cotton Research Institute, Multan-Pakistan presented his work "An assessment of morphological and physiological indicators of thermo-tolerance in field grown Cotton". He screened cotton germplasm for thermo-tolerance keeping in view the increased heat in cotton zone because of changes in climate. He observed pollen viability and relative cell injury percentage (RCI %) as a promising parameter to assess the thermo-tolerance of any cotton genotype.

A young researcher Syeda Dur e Najaf Rizvi presented her work in the session "Insecticidal response against *Plutella xylostella* (L.) (Lepidoptera: Pluterllidae) under host shuffling conditions in controlled environment". She informed the audience about her research work involving different insecticides targeting diamond backmoth on different host pants of *Brassicaceae* family. She concluded that crop rotation of cabbage, radish, turnip and broccoli increases the toxicity of insecticides and lowers the diamondback moth resistance against insecticides. Her work adds new dimension to the research of insecticidal resistance which needs to be further explored. The session had interesting discussion and evolved following recommendations.

1. Robust modeling tools should be employed to predict rainfall pattern which could be helpful in devising strategies to mitigate heat and drought stresses in crops.

2. High CO_2 concentration in the atmosphere is increasing spatial and temporal distribution of plant diseases and insect pests. The phenomenon needs to be investigated further in order to adopt effective integrated disease and pest management practices.
3. New technologies should be adopted to bring in use the sea water with precise irrigation techniques.
4. New tools based on new technologies are helpful and should be adopted in estimating the evapotranspiration.
5. New physiological parameters like relative cell injury percentage-based screening of heat tolerance in crops is an effective strategy.
6. Proper dosage and practices must be employed to control insect pests to avoid the development of resistance in insects.

Technical Session III

Theme of session: Food and Nutrition Security (bio-fortification and related approaches)

Chair, Prof. Fabian G. Fernandez, Co-Chair, Prof. Dr. Nazim Hussain Labar

Prof. Dr. Mohammad Akmal, Department of Agronomy, The University of Agriculture Peshawar-Pakistan.

Topic of presentation of Dr. Akmal was Validation of nitrogen fertilizer application rates and timings to wheat crop under the changing climate of Pakistan. Dr Akmal said that it has been proven that climate has changed with shifts in rainfall pattern and distribution with increasing trend towards early spring and summer (March-September) in Pakistan. He added that wheat (*Triticum aestivum* L.) being the staple food crop, occupies significant area of country. Due to low fertility status, wheat is heavily supplemented with N. With changes in the rainfall pattern, split N application could be more effective protecting environment and production cost. Therefore, their research group identified appropriate N split and rates and optimized time of application in wheat. He added that in their experiment phosphorus and potassium were applied as recommended i.e. 90 and 60 kg ha^{-1}, respectively, while, N application rates (NAR i.e. 0, 100, 120, 140 and 160 kg ha^{-1}) with N application timings (NAT_1 100% at seedbed preparation, NAT_2 50% at sowing + 50% 70 days after sowing (DAS), NAT_3 25% at sowing, 50% + 70 DAS and 25% 110 DAS and NAT_4 25% at sowing, 25% 70 DAS and 50% 110 DAS). Results indicated that better plants with healthy traits were observed for 140 kg ha^{-1} NAR broadcasted as NAT_2 and NAT_3 as compared to NAT_1. Treatment 140 kg N ha^{-1} showed the highest grain

and biomass to wheat in the area with healthy plant traits which contributed in biomass and yield. He concluded that two splits with 120 kg ha^{-1} is no more valid under the changing climate for crops grown in winter and harvested in summer especially the wheat and if fertilized with NAR of 140 kg ha^{-1} preferably for cereal based cropping system and the N shall be splits in three i.e. NAT_3 will ensures better yield with healthy traits and grains of higher quality that has a positive effect on the backing quality of produced.

Mr. Mazhar Iqbal, Executive Coordinator/Manager Programs, Doaba Foundation, Pakistan

Mr. Iqbal introduced Doaba Foundation of Pakistan. Doaba foundation was established in 1987. He said that Doaba works to improve the quality of life among disaster-prone communities through optimal utilization of available resources. Using a rights-based approach, Doaba seeks to build capacity of communities, focusing on vulnerable groups, for community-led disaster risk management, incorporating the same in programmes of sustainable development intervention. Doaba expands its influence through strategic partnerships and policy interventions. He stated vision of Doaba, that **"**Disaster prone communities becoming self-reliant in pursuit of their common interests. He highlighted some practices to combat malnutrition. i.e. diversified nutrient kitchen gardening in riverine and Thal areas, establishment of nurseries in riverine and drought areas and launch of campaigns to plant fruit, shady and fodder plants. Introduction and demonstration of climate resistant crops like, grams, vertical cropping and fodder, promotion of organic farming etc.

Mr. Nabeel Ahmad Ikram, Department of Agronomy, MNS- University of Agriculture Multan-Pakistan.

Mr. Ikram discussed different agronomic tools for biofortification of vegetables to combat hidden hunger. Mr. Ikram highlighted alarming facts that one third of the global population is estimated to suffer from hidden hunger which means people are not getting enough nutrients from the food. He added that these effects can be devastating, leading to mental impairment, poor health and even death. Many victims of hidden hunger live in developing countries and consume diets that do not give them the minerals and vitamins they need. Mr. Ikram presented world bank report that annually, Pakistan loses nearly US$3 billion in GDP to vitamin and mineral deficiencies. He also emphasized that addressing malnutrition would be cost effective. Costs of core micronutrient interventions are as low as 0.05–3.60 US$ per person annually while returns on investment are as high as 8–30 times the costs. He said that biofortification seems viable option combat hidden hunger. "Biofortification" or "biological fortification" refers to

nutritionally enhanced food crops with increased bioavailability to the human population that are developed and grown using modern biotechnology techniques, conventional plant breeding, and agronomic practices. Agronomic biofortification provides an immediate and effective route to enhancing micronutrient concentrations in edible crop products by application of mineral elements through root, foliar and seed application. Biofortification through agronomic methods requires physical application of nutrients to temporarily improve the nutritional and health status of crops and consumption of such crops improves the human nutritional status. Zinc, iron and iodine biofortification has been successfully accomplished in many crops; At the end Mr. Ikram summarizes the up-to-date knowledge on agronomic biofortification of Zn, Fe, I in different vegetable crops.

Mr. Muhammad Tahir Khan, Biotechnology Group, Nuclear Institute of Agriculture (NIA), Tandojam, Hyderabad, Pakistan)

Mr. Khan started his talk with phrases that green biotechnology can help sustainable crop production and food security in the era of climate change. He added that climate change has become the greatest threat to global food security in recent past. Pakistan, unfortunately, is among the most vulnerable spots of the world against this dilemma. He said that in such scenario, traditional breeding approaches are simply not enough to cope with the rising climate related challenges. Sustainable higher food production from lesser lands through genetic intensification is an essential. In Pakistan, the main setbacks on agricultural production will be because of the higher temperature, variations in monsoon, water-stress conditions, and soil degradation. Such factors can significantly diminish various major crops' yields. The production of sugarcane, rice, and cotton is projected to deteriorate because of the climate change. He emphasized that biotechnology can play vital role in supporting conventional breeding to combat the pace of climate change to ensure food security in the country. Role of biotechnology in climate smart agriculture can range from applications of markers assisted breeding in conventional breeding to transgenic crops, gene silencing, or cutting-edge genome editing tools such as *CRISPR-Cas*. He added that green biotechnology has already served the development of drought-tolerant maize, high yielding transgenic wheat; and biotic/abiotic stress tolerant, early maturing, and herbicide tolerant crops. Molecular breeding has already helped in achieving as high as five folds increase in rice and maize yields. Additionally, biotech-based agriculture can also help in biofuels production, carbon sequestration, and expansion of the farmable area into currently marginal lands. He said that in the light of his

talk, biotechnology could be a promising way-forward for mitigating the effects of climate change in agriculture.

Dr. Naeem Sarwar, Department of Agronomy, Bahauddin Zakariya University Multan-Pakistan.

Dr. Sarwar presented his study in which effect of combined application of organic and inorganic fertilizer was studied in wheat crop. Dr Sarwar added that over application of inorganic fertilizer for intensive crop production have created imbalance soil nutrient status which seems a major threat for sustainable crop production. Therefore, their team conducted a field experiment to evaluate sole application of inorganic and organic fertilizers or their combination with each other, or with mixing of biofertilizer. While presenting results, he said that that organic fertilizer alone and in combination with inorganic or biofertilizer significantly improved the root biomass and soil organic carbon (SOC) and this improved soil health and better root system lead better crop performance in term of plant height, productive tillers, 1000-grain weight and grain yield. He further added that sole application of inorganic fertilizer improved the crop yield but showed almost no effect on soil organic carbon. Moreover, root growth also enhanced the SOC in wheat soil. He concluded that, integrated nutrient management strategy comprising fifty percent application of organic and inorganic fertilizer along with biofertilizer resulted in improved wheat performance and soil health.

Mr. Rab Nawaz, Pir Mehr Ali Shah- Arid Agriculture University Rawalpindi, Pakistan.

Mr. Rab Nawaz talked about increased fruit fly infestation in citrus fruit (Kinnow Mandarin) under changing climate scenario in the Punjab Province, Pakistan. He added that recent trend of climate change has not only adversely affected physiology of citrus fruits, but it is also creating favorable conditions for different pests. Among damaging pests of citrus, fruit fly is potential one because it not only damage maturing fruit but also a quarantine pest that directly restrict export to global market. He further said that kinnow fruit is leading one in terms of area and production in Pakistan and earned $ US 222 million in year 2017-18. Due to global warming, a paradigm shift in climate of the region which resulted in rise of temperature, change in rainfall pattern and squeeze of winter period and prolongs summer that has provided suitable conditions for fruit fly infestation on the fruits but being a perennial crop, Kinnow fruit is more vulnerable to this pest damage. He said that we conducted a study in the three main citrus growing area namely Sargodha, Toba Tek Singh and Vehari districts of the Punjab Province, Pakistan and evaluated the damage of fruit fly infestation on Kinnow fruit in climate change scenario. Fruit fly infestation was comparatively higher in the districts Toba Tek Singh and Vehari than Sargodha in the months of October and November due to rise in temperature and

ripening stage of fruit for oviposition. Similarly, in the month of March, temperature rise in these two districts and first generation of fruit fly infestation on fruit bearing orchard is more damaging than Sargodha. Prolong summer and squeeze winter has allowed one more generation of fruit fly because Kinnow fruit in late summer is on ripening stage and peel is tender for fruit fly oviposition while in month of March, a mature fruit is available for first generation after winter hibernation. He concluded that, climate change favour fruit fly infestation due rise temperature in October- November and March.

Dr. Wazir Ahmad, Soil and Environmental Science, MNS-UAM
Dr. Ahmad talked about his conducted study, they studied comparative effects of salicylic acid and calcium carbide on morphological characteristics of sweet pepper. He added that polyethylene coated calcium carbide (PCCC) and salicylic acid (SA) affect plant physiology by regulating different physiological characteristics of plants. A series of laboratory and field experiments was conducted to evaluate the interactive effects of PCCC and SA on antioxidant activities, nutrient uptakes, growth and yield of sweet pepper. While presenting results of study, he said that application of SA combated growth inhibitory effects of PCCC. The combined application of SA and PCCC caused significant increase in water and fertilizer use efficiency due to changes in physiological and morphological characteristics of sweet pepper. He concluded that these improvements were linked to more mineral nutrients and antioxidants accumulation in leaves of treated plants compared to non-treated plants.

Technical Session IV

Theme of Session: CSA Innovations, Strategies and Solutions

Chair, Prof. Dr. Hans-Werner Koyro, Co-Chair Prof. Dr. Fabian

An interesting session “Climate Smart Agriculture Innovations, Strategies and Solutions” started at 09:15 AM. The session was presided by Dr. Hans-Werner Koyro and Dr. Fabian. The session kicked off with the scholastic talk of Dr. Nasrin Salehnia, Professor, Department of Water/Agro Meteorology, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran. She spoke on “Smart Agriculture through Computerized Tools under Climate Change Conditions”. She enlightened the audience with the new innovative technologies currently in use for precision agriculture. She urged the need to convince the farmers to reach a culture of smart agriculture through computerized methods, and obtain more and more yields. She told that information about weather data, climate variables, extreme events such as frosting, drought, and flood, and the interchange of them with the mentioned variables, can help in developing

applicable tools and models for monitoring the changes and impacts of them, in different spatial and temporal scales. The development of tools will lead to the increase in crop yields.

The second talk was by Prof. Dr. Nazim Labr, Department of Agronomy, BZU- Pakistan bout the "Possible Agronomic dimensions for Climate Smart Agriculture in Pakistan". He stressed upon the developing countries to transform significantly in order to meet the related challenges of food security and climate change. He said that effective climate-smart practices already exist and could be implemented in agricultural systems of developing countries by adopting an ecosystem approach, working at landscape scale and ensuring intersectional coordination and cooperation for effective climate change responses.

Dr. Muhammad Shahbaz, Department of Soil and Environment, Swedish University of Agricultural Sciences, Uppsala, Sweden shared his research titled "Impact of decadal nitrogen fertilization on total SOM and its pools stability estimated by 13C natural abundance after 17 years of maize grown on C3 soil". He told about the relationship between carbon (C) inputs and nitrogen (N) fertilization for soil organic matter (SOM) stabilization which is a key element in soil organic C dynamics. Dr. Shahbaz concluded that an increase in belowground carbon inputs due to nitrogen fertilization drives the changes in soil carbon cycling that are linked more to losses of young carbon (than stabilization within SOM) that cause a decrease in soil organic matter levels.

Prof. Dr. Bashir, Department of Agronomy, The University of Agriculture, Peshawar, Pakistan spoke on "Impact of seed production industry relationship on climate smart agriculture decisions for 21st Century farming Systems". He discussed the seed system of Pakistan and highlighted the significance of seed quality in combating adverse effects of climate change.

Mr. M. Arslan Khalid from Institute of Plant Breeding and Biotechnology, MNS-UAM shared the results of wheat research on "Developing climate smart wheat through GA sensitive Rht gene system". He highlighted the importance of Gibberellic Acid (GA) sensitive Rht genes which improve the wheat yield by reduced lodging, assimilates partitioning and resistance to biotic and abiotic stresses. He showed the promising results of GA-sensitive genotypes crossed with F_1 wheat hybrids which are under evaluation. Mr. Khalid shared plan to pyramid genes and restructuring of wheat plant to combine the GA-sensitive dwarfing genes, reduced plant height through reducing intermodal and peduncle length, reducing leaf area, increasing number of grains and grain yield/plant with increased resistance to biotic and abiotic stresses.

Dr. Hamid Nawaz from Department of Agronomy, The Islamia University Bahawalpur, Pakistan while speaking on "Bio-priming: a smart agronomic practice to mitigate drought stress in maize crop" underlined the need for sustainable management practices such as seed priming

with bacterial seed coating which is the simple and feasible strategy to mitigate drought stress. He bio-primed the hybrid maize variety HC9091 with *Rhizobium phaseoli-RS-1* and showed improvement in the performance of maize crop in terms of physiological parameters including's photosynthetic/transpiration rate, intrinsic water use efficiency, stomatal conductance, relative water contents and nutrient uptake subjected to normal and drought conditions. The last speaker was Mr. Saim Rashid from Go Green Organic Technologies. Mr. Rashid spoke on "Organic farming and Pakistan" and informed the audience about the global status of organic produce and progress in Pakistan. He told about the establishment of National Institute of Organic Agriculture (NIOA) at NARC in 2008 Under PARC. This institute did some work on organic wheat, organic mushrooms, organic sunflower, organic fertilizer, organic insecticides and organic herbicides. There is no federal or provincial body to certify organic produce in Pakistan which is a major obstacle in building export oriented organic market. In Pakistan, the organic farming needs serious effort to make it profitable and competitive in international market.

The session ended with the following recommendations.

1. The computer-based tools should be used in predicting drought patterns which could greatly enhance our capacity to fight drought globally saving precious life.
2. The diverse cropping patterns are essential for keeping soil productive in Pakistan. The farmers should opt for other crops keeping in view the changing climate.
3. The appropriate nitrogen application to the soil is important along with the plantation of crops which add organic matter to the soil.
4. The provision of quality seed is highly significant in climate smart agriculture.
5. The development of GA-sensitive wheat varieties should be encouraged because they could withstand the abiotic stresses.
6. Biopriming of seeds with nitrogen fixing bacteria and compost should be coupled to get maximum benefit.
7. Organic farming should be promoted in Pakistan whose export could add huge sum of foreign exchange in uplifting economy.

Technical Session V

Theme of Session: Challenges and Opportunities of Precision Agriculture in Pakistan

Chair, Prof. Dr. Jiahua Zhang, Co-Chair, Dr. Jehanzaib Cheema

Dr. Abbas Aziz (FFC, Multan) talked about 'Efficient use of fertilizers a key component of Climate Smart Agriculture'. The ever-increasing population demands 70% increase in crop production to ensure food security. Whereas, climate change is a threat for sustainable and profitable crop production. Climate change has caused severe droughts, floods and erratic rainfalls, which results in several losses including living and non-living. Climate Smart Agriculture (CSA) is an effective approach to mitigate climate change. 4R rule (Right dose, right source, right time and right method) very helpful in increasing production without harming the environment. FFC playing role in CSA by educating farmers, crop advisory and collaborating with other organizations.

Dr. Saddam Hussain, Assistant Professor from University of Agriculture Faisalabad (Department of Irrigation and Drainage) talked about 'Spray Droplet Uniformity'. Precision during spraying can help to mitigate climate change. Non-judicious use of sprays pollutes environment and causes financial losses as well. Latest hexa-copter drone system can help in precise spray of crops. Hexa-copter drone at 1.5-2 m height above the crop and 50-75% nozzle opening is recommended. This ensures uniformity of spray in field. Not much efficient in windy weather and the field surrounded by trees.

Dr. Tasneem Khaliq, Assistant Professor, University of Agriculture Faisalabad, while talking about 'Crop modelling a novelistic tool for risk management', said that, the CSA demands precision agriculture. For this purpose, crop simulation models have been developed. Crop models can be very helpful in predicting climate change. It can predict crop growth and yield. Crop models can be very useful in alleviating climate change by predicting site specific crop production and also predictions for the changes in future.

Dr. Saeed Ahmed Shah Chishti (Vegetable Research Centre AARI) talked about 'Mitigation of Drought, Temperature and viral diseases in vegetables'. Different vegetables need different environmental conditions. Any sudden change in these conditions can have adverse effects on the production of vegetables. In order to mitigate these effects two approaches namely Stress breeding approach and Non-breeding approach. Stress breeding approach involves the wild relatives or stress tolerant varieties to produce stress resistant varieties. Whereas non-breeding approach includes use of tunnels, protected nurseries, mulching, drips, insect traps, foggers and techniques like grafting and use of plant growth hormones.

Zeeshan Haider (Postgraduate Scholar UAF) talked about Precise droplets size measurement to mitigate pesticides climate issues. Pesticide issues can lead to serious environmental issues.

Therefore, droplet size and method of spray should be very efficient in order to minimize the pollution. In different experiments conducted in UAF, it is recommended that stainless steel nozzle at 3 bar pressures is very efficient compared to other methods. Precautionary measures should also be adopted. Never spray when wind velocity is high.

Tania Safdar (Postgraduate Scholar MNS-UAM) talked about 'Expression Analysis of Plasma Membrane Intrinsic Proteins (PIP) and Tonoplast Intrinsic Proteins (TIP) in Various Genotypes of Sunflower under Moisture Deficit Environment'. Sunflower is world's second most valuable oilseed crop. It is drought tolerant but oil quantity and quality is severely affected. Climate change has direct effects on water resources and Pakistan is 7th most adversely affected country. In sunflower water channel proteins have been explored and have been named as Aquaporins. They belong to family MIP and facilitates the movement of water, hence laying an important role in water relations of plant. It has also been found that aquaporins are very responsive to drought conditions. Therefore, manipulation of Aquaporins can be very useful against drought stress in field crops.

Engr. Dr. Azeem Khan Assistant Professor University of Agriculture Faisalabad talked about 'Big data for climate smart agriculture'. Big data has poor computing capability, data remains unattended and scattered, inability to acquire more knowledge in less time and lack of data clearing house. Farm analytics can add value to the lives of farmers. Farm management tool can translate that big data to actionable solution. Precision agriculture can enhance crop productivity. Precision in agriculture is brought by using data from satellites, using meteorological data before any action and using decision support tools and modelling for future predictions.

Technical Session VI

Theme of Session: Prediction and Decision Support Modeling

Chair, Prof. Dr. Axel Garcia y Garcia

Dr. Tasneem Khaliq (UAF) talked about 'Impact of Climate Change and development of adaptation strategies for Cropping Systems of Punjab, Pakistan'. In Pakistan mainly two cropping systems exist, viz. rice-wheat and cotton-wheat. A project AgMIP is an international collaborative effort to study the impact of climate change on agriculture sector. Climate change projections for both cropping systems have been compared with the help of AgMIP. It has been

estimated that earlier sowing of wheat and rice along with efficient use of fertilizers can increase the production.

Ammara Zahoor (PMAS ARID Agriculture University Rawalpindi) talked about 'Modeling The potential impacts of climate change extremes on rainfed cereal-based cropping systems'. Agriculture has a major share in GDP and employs about 42% labour. Agriculture is facing the challenge of climate change due to dforestation, fossil fuel consumption and uurbanization. Greenhouse gases are also responsible for the climate change. Consequences of climate change includes droughts, extreme heat waves and erratic rainfalls which are adversely affecting agriculture as well as human life. Adaptation or mitigation of climate change is the need of time to ensure food security. This can be done by equipping agriculture sector with latest technologies and to utilize every inch of barren area to produce food for ever increasing population. Rainfed agriculture and afforestation can reduce the impacts of climate change. Policies should be made to reduce the GHGs emissions and Agro ecological zones should also be revised.

Dr. Kashif Nazir Qureshi (Burewala Campus, University of Agriculture Faisalabad) while talking about 'Predicting Future Wheat Irrigation in Pakistan under Climate Change' said that, Due to climate change concentration of CO_2 is increasing along with global average temperature, global average sea level and Northern hemisphere snow cover. Several crop models have been developed to predict the implications of climate change and to manage the cropping systems before time. PRECIS climate model has been developed to study climate change impact assessments. STAMINA crop model is designed to simulate the effects of weather, soils and agronomic management.

Dr. Muhammad Mubeen Assistant Professor (COMSATS University Islamabad, Vehari Campus) talked about 'Studying Climate Change and Agriculture by using Remote Sensing in Pakistan'. Climate change has direct effects on temperature and precipitation while indirect effects on ecological and social disruptions and shifting patterns of disease vectors. Remote sensing can be very useful in obtaining information about agricultural crop production. It can help in crop identification, area estimation, yield forecast and soil mapping. There are some requirements for using remote sensing which include access to satellite image collections, processing of collected data and budgeting. Spectral data collected through RS can help to discover vegetation cover, biomass, weeds invasion and pest monitoring. This remote sensing

technique can help us to recognize the problem in very short time on long distance. Thus, results in timely application of inputs like fertilizers, pesticides and irrigations.

Dr. M. Abu Bakar Saddique (MNS-UAM) while talking about 'Multi-floret rice for yield stability in dry areas' said that, Rice is staple food in many countries and consumes almost 34-42% of total world irrigation water. This water can be saved by management practices, utilization of eco-contributors, exploitation of drought tolerant genotypes and increasing the yield potential of rice. Plant breeding is very efficient technique to conserve water in rice crop. Change in panicle architecture of rice can produce more florets. That can result in higher yields from the same plant.

Ms. Sabah Merrium (Postgraduate Scholar MNS-UAM) while talking about 'Phenotypic variation in leaf traits' said that, implications of climate change will become more severe in future. Pakistan is the 7th most vulnerable to climate change in the world. Water resources of the world are also declining which can increase the incidence of droughts. Wheat utilizes 29% of the irrigation water. Plant can adapt to drought conditions by several morphological changes. Semi erect and inward + outward leaf rolling helps to capture fog water. So, fog water can be used as a substantial source of water supply during fog events if wheat has such leaf traits.

Concluding Session

The concluding ceremony of the conference was graced by Mr. Muhammad Sibtain Khan (Provincial Minster of Punjab for Forestry, Wildlife and Fisheries). Mr. Sibtain applauded the efforts of MNS-UAM to boost agricultural development in this dynamic region. He promised unconditional support of all the departments at his disposal to the MNS-UAM. Prof. Dr. Claudia Kammann (Germany) and Dr. Tasneem Khaliq (Pakistan) presented the recommendations of the conference. It was decided that findings of the conference will also be shared to the farming community in local languages under the umbrella of a seminar entitled "Science for Farmers" as farmers are the main stakeholder.

CONFERENCE RECOMMENDATIONS

For Government and Administration

- Promotion of tree plantation to control temperature increase / increase precipitation / sequester carbon to mitigate climate change

- Installation of more weather monitoring, forecasting and advisory systems for early warning about climate disaster like heat and cold waves, or floods (agro-meteorology – phenology and pest models)
- Construction water reservoirs/storage to reduce drought impacts
- Investment on research and development sector e.g. establishment of climate change study centers in each region/division for development of climate smart agricultural tools and dissemination of knowledge
- Encourage carbon certification/organic farming schemes to connect local action to global carbon markets/ organic product markets
- Must launch a move for assessing the health vulnerabilities of communities in vulnerable areas (diversification of food resources & home gardening)
- Knowledge transfer: Investment on awareness, capacity building and efficient extension system for translation of research messages in to common man language
- After 18th amendment, we need provincial agriculture and climate policy. So, Govt. must pay attention to this aspect

For Scientists: Research and Development

- Exploring zone specific **alternate crops and their varieties** keeping in view the site-specific issues and challenges
- **Redefining crop zoning** in advance on the bases of global climate models' predictions and downscaling using Representative Concentration Pathways
- Use of biotechnological tools to incorporate stress (heat, drought, salt etc.) tolerance in crops
- Development of varieties which will be able to accumulate micronutrients especially zinc and iron in edible parts to combat malnutrition
- Disseminate climate smart production technologies to ensure food and nutritional security under changing climate
- Development of efficient water use technologies like deficit and drip irrigation, augmented furrow, and bed sowing of crops
- Research institutes should introduce climate smart products using remote sensing, crop models and publish the specific informative material in local languages on regional issues which can strengthen local capacities towards adverse effects of climate change

For Farmers and Communities

- Crop rotation to break pest cycle, green manuring and use of biochar to increase soil fertility
- Conservation agriculture can reduce global CO_2 emissions, degradation land, improve fertility and reduce cost of production.
- Diversification of bread basket by inclusion of stress-tolerant and versatile pseudo cereals and coarse grains like millets, quinoa, cheena
- Legume crops (mungbean, cowpea, sesbania) can be successfully adjusted in summer gap (from last week of April to mid-July) for getting fodder, grain and biomass for green manure.
- The CSA through models of bio-gas plants and use of solar dryers for fruit and vegetables processing, solar operated hand pumps and donkey pumps can be energy efficient
- The activities performed by Community Schemes Ombud Services like Doaba Foundation could be helpful for sustainable crop production in changing climatic conditions of Pakistan
- Being a responsible citizen, we must discourage use of plastic bags, and promote use of public transport, use of bicycles, adopting renewable energy sources
- Promote Tree plantation to control temperature increase / increase precipitation / sequester carbon to mitigate climate change.
- Adjustment of sowing time in wheat. Early planting to avoid terminal heat stress so that grain filling occurs during cooler temperatures.
- Weather monitoring, forecasting and advisory systems.

Chief Guest Mr. Sibtain Khan Provincial Minister for Forestry, Wildlife and Fisheries, Vice Chancellor and foreign guests giving concluding remarks

Shield distribution

LIST OF FOREIGN DELEGATES

1. Prof. Dr. Axel Garcia y Garcia — USA
2. Prof. Dr. Claudia Kammann — Germany
3. Prof. Dr. Jiahua Zhang — China
4. Prof. Fabián G. Fernández — USA
5. Prof. Dr. Hans-Werner Koyro — Germany
6. Dr. Muhammad Asif — Turkey

7. Dr. Faheem Shahzad Baloch	Turkey
8. Dr. Nasrin Salehnia	Iran
9. Mr. Sohrab Kolsoumi	Iran
10. Dr. Muhammad Shahbaz	Sweden
11. Dr. Moustafa Selim	Germany