

Tenth International Conference on Development of Drylands

Meeting the Challenge of Sustainable Development in Drylands under Changing Climate – Moving from Global to Local

12-15 December 2010, Cairo, Egypt

Abstracts of Presentations



International Dryland Development Commission
December 2010

Tenth International Conference on Development of Drylands
***Meeting the Challenge of Sustainable Development in Drylands under Changing Climate –
Moving from Global to Local***

12-15 December 2010, Cairo, Egypt

The International Dryland Development Commission (IDDC) is an autonomous nongovernmental nonprofit organization established in 1987 by the individuals and institutions interested in and concerned about the sustainable development of dry areas. It is promoting all aspects of dryland studies by fostering cooperation, collaboration and networking between various international, regional and national organizations. One of the important modus operandi of the networking of IDDC has been to hold a major scientific conference every three to four years to provide opportunity to participants from around the world to exchange research results and experiences in dryland development and combating desertification. In pursuance of this objective the IDDC has organized in the past eight international conferences.

The Tenth International Conference on Dryland Development (ICDD) on “**Meeting the Challenge of Sustainable Development in the Dry Lands under Changing Climate – Moving from Global to Local**” is being held on 12-15 December 2010 in Cairo, Egypt. It is being organized under the auspices of the International Dry Lands Development Commission (IDDC) and sponsored by the Agriculture Research and Development Council of the Ministry of Agriculture and Land Reclamation of Egypt and other national and international organizations.

Partners/ Co-sponsors:

- Association of Agricultural Research Institutions in the Near East and north Africa (AARINENA)
- Asia Pacific Association of Agricultural Research Institutions (APPARI)
- Agricultural Research Center (ARC), Egyptian Ministry of Agriculture and Land Reclamation
- Arid Land Research Center (ALRC), Tottori University, Japan
- Chinese Academy of Sciences (CAC), China
- Desert Research Institute (DRI), Nevada, USA
- International Center for Agricultural Research in the Dry Areas (ICARDA)
- International Fund for Agricultural Development (IFAD)
- International Development Research Center (IDRC-Canada)
- Japanese International Research Center for Agricultural Sciences (JIRCAS)
- Japanese International Cooperation Agency (JICA)
- United Nations University-Institute for Water, Environment and Health (UNU-INWEH)
- World Meteorological Organization (WMO)

Table of contents

1. Opening Address	1
2. Plenary Session Presentations	3
Plenary session 1:	5
1.1. Adaptation to the natural and social impacts of regional climate change - <i>Charles F. Kennel</i>	5
1.2. Pursuing triple wins within the context of climate change - <i>Per Pinstrup-Andersen</i>	6
1.3. Agriculture in an era of climate change and resource scarcity. Are we ready? - <i>Cary Fowler</i>	7
1.4. Adaptation strategies to climate change in dryland agriculture of southwest Western Australia - <i>Kadambot Siddique et al.</i>	7
Plenary session 2:	8
2.1. Climatic mitigation, adaptation and dryland food production - <i>Gareth Wyn Jones</i>	8
2.2. How S &T can help farmers cope with climate change to enhance food security - <i>Mahmoud Solh</i>	9
2.3. Building food security in the face of climate change: an integrated approach - <i>Bruce Campbell</i>	9
2.4. Climate change and desertification - increasing the focus on adaptation - <i>Zafer Adeel</i>	10
Plenary session 3:	10
3.1. Mitigating climate change by combating desertification - <i>Rattan Lal</i>	10
3.2. Land degradation and climate change - <i>Manav V.K. Sivkumar</i>	11
3.3. Climate change mitigation in drylands - <i>Atsushi Tsunekawa</i>	11
3.4. Managing water resources for sustainable use in Arab arid lands - <i>Farouk El-Baz</i>	12
Plenary session 4:	13
4.1. Regional landscape responses to climate change in drylands of the Western USA - <i>Stephen G. Wells</i>	13
4.2. Climate Change Information Center - a regional perspective - <i>Ayman Abou-Hadid</i>	13
4.3. The impact of climate change and humans on aeolian desertification in Northern China - <i>Wang Tao</i>	14
4.4. Assessment of losses for managing risks in dryland livelihoods - <i>Jagir S. Samra and A.K. Sikka</i>	14

Plenary session 5:	15
5.1. Promoting sustainable desert development to mitigate global warming effects in Egypt - <i>Adli Bishay</i>	15
5.2. The role of traditional hydro-technology in a changing world - <i>Iwao Kobori</i>	15
5.3. Influence of climate change on agriculture and natural resources of Kyrgyzstan - <i>Dzhamin Akimaliev</i>	16
5.4. Resilience and adaptation strategies to climate change, IFAD's work in drylands - <i>Ghassan Y. Al-Baba</i>	16
5.5. Greening the landscape in the drylands using new technologies of treating domestic wastewater and using the unutilized soil moisture - <i>Shinobu Inanaga, Takehiko Matsui and Shigenori Morita</i>	17
Plenary session 6:	18
6.1. The impact of climate change on aquatic resources in dryland regions and coping strategies to enhance socio-ecological resilience - <i>Steve J. Hall</i>	18
6.2. A new Nile Co., an integrated sea water agriculture system project - <i>Nina Fedoroff & Tamer M. Nasser</i>	18
6.3. Competence of alien genetic resources for wheat breeding in drylands - <i>Hisashi Tsujimoto</i>	19
6.4. Adapting <i>Pongamia pinnata</i> to dry area environments for bio-fuel production - <i>Mohan C. Saxena</i>	19
6.5. Management of abiotic stress research in climate change scenario: an Indian experience - <i>K.P.R. Vittal and S.K.E. Raina</i>	20
3. Concurrent Session Presentations	21
Theme 1: Assessment of climatic change in arid lands	23
1. Rapid measurement of dust emission: Implications for the assessing impacts of global climate change on wind erosion and dust emission - <i>Eric V. McDonald & S.N. Bacon</i>	23
2. Rangeland vegetation assessment in the Eastern and Western regions of Libya - <i>Fahim Ghassli et al.</i>	23
3. Relationship between AVHRR NDVI and precipitation in Northern China - <i>Guo Jian, Wang Tao & Xue Xian</i>	24
4. Long-term trend analysis in heavy and extreme events in semi-arid rainfall station, as an indicator of climate change - <i>Khaldoon A. Al-Qudah</i>	24
5. Developing an index based on surface temperature for assessment of moisture availability over vegetated land - <i>Abdelmonein A. Mohamed, R. Kimura and M. Shinoda</i>	25
6. The role of modeling tools in researching pest/plant interactions in relation to climate change - <i>Mohamed A. Fahim et al.</i>	25

Theme 2: Local impact of climate change on the natural resources of water, land, and biodiversity and the productivity of agriculture (including fishery) in the dry areas	26
1. Ecological and physical response and feedbacks to fires in Western North American Deserts - <i>David S. Shafer et al.</i>	26
2. Climate change impact on highland dry farming agriculture of Iran – <i>Abbas Keshavarz and H. Dehghanisanij</i>	26
3. Changes of water resources and their impact on ecological environment in Minqin Basin - <i>Cui-Hua Huang et al.</i>	27
4. Climate change impact on water resources management and agricultural water productivity in irrigated area of Karkheh River Basin - <i>Hossein Dehghanisanij, A. Keshavarz, M. Akbari and T. Oweis</i>	27
5. Responses of some rangeland and crop plants of Uzbekistan to climate changes - <i>Muhtor Nasyrov</i>	28
Theme 3: Enhancing resilience of local agricultural communities in the drylands through adaptation strategies	29
3a: Agronomy and water management	
1. Climate change and water resources: strategies and practices for improved water management in arid countries - <i>B.S. Choudri and M. Ahmed</i>	29
2. Performance and adaptation of the Vallerani mechanized water harvesting system in degraded Badia rangelands - <i>Issa A. Gammoh & Theib. Y. Oweis</i>	29
3. Laser guiding system for the contouring of the Vallerani mechanized micro-catchment water harvesting - <i>Issa A. Gammoh & Theib. Y. Oweis</i>	30
4. Impact of microcatchments water harvesting on plant diversity in Jordan Badia rangelands - <i>Nisreen Alshawahneh et al.</i>	30
5. Assessing suitability and location of water harvesting & supplemental irrigation using SWAT model - <i>Ahmed Al-Wadaey et al.</i>	31
6. Effects of simulated rainfall on seed germination and seedling emergence of two desert shrubs - <i>Peng Fei et al.</i>	31
7. Deficit Irrigation as an alternate option under water shortage conditions in the Egypt's Delta - <i>Atef Swelam et al.</i>	32
8. Magnetic water technology, a novel tool for improving crop production - <i>Mahmoud Hozayn et al.</i>	32
9. Mediterranean olive growing system adaptation to climate changes: Water use management optimization using biosensors as a water state monitoring device - <i>Dalenda Boujnah et al.</i>	33
10. Impact of water stress and nitrogen fertilizer levels on cotton under high temperature in Upper Egypt - <i>Said Abd El-Tawab Farag Hamada</i>	33
11. Improving growth, yield and quality of pea (<i>Pisum sativum</i>) grown on sandy soil by phosphorus fertilizer with biological seed treatments to control root rot and damping off - <i>Samir Osman El-Abd et al.</i>	34
12. Developing an adaptation strategy to reduce climate change risks on wheat grown in sandy soil in Egypt - <i>Samiha A. H. Ouda et al.</i>	34
13. The annual organic carbon requirement for sustainable crop production in the Sahel, West Africa - <i>Satoshi Nakamura et al.</i>	35
14. Conservation agriculture to control carbon emission enhancement of crop productivity under drylands – <i>Ayman Al-Ouda</i>	35

15. Olives mill waste waters spray: An organic amendment for the structural stability improvement and wind erosion reduction in the southern Tunisian arid zones - <i>Mounir Abichou et al.</i>	36
16. Potential of protected agriculture to enhance water and food security in the Arabian Peninsula - <i>Ahmed T. Moustafa, Abdullah Al-Shankiti, and Arash Nejatian</i>	36
17. Productivity and water use efficiency of five grasses in United Arab Emirates - <i>Ahmed E. Osman, M. Makawi and R. Ahmed</i>	37
18. Approaches and efforts on mitigating aeolian desertification in Northern China - <i>Wang Tao and Xue Xian</i>	37
3b: Animal production and pasture management	38
19. Genetic variation for tolerance to abiotic stresses in Egyptian desert sheep and goats raised under the hot-dry conditions - <i>Adel M. Aboul-Naga et al.</i>	38
20. Effect of local feed alternatives on milk fatty acid composition of fat-tailed Awassi ewes - <i>Souheila Abbeddou et al.</i>	38
21. Effects of seed density and treatment on the germination and establishment of different halophyte shrub species under semi arid conditions of Syria - <i>Mounir Louhaichi and Fahim Ghassali</i>	39
22. Cactus: a crop to meet the challenges of climate change in dry areas - <i>Ali Nefzaoui and Mohamed El Mourid</i>	40
3c: Stress physiology	40
23. The ability of sedum plant to tolerate different environmental stresses - <i>Ahmed Al-Busaidi et al.</i>	40
24. Alleviation of the potential impact of climate change on wheat productivity using arginine under irrigated Egyptian agriculture - <i>Amany A. Abd El-Monem & Mahmoud Hozayn</i>	41
25. Seed priming: A promising tool to improve crop production under different environmental stress conditions - <i>Hamdino M. I. Ahmed and Amal Z.A. Higazi</i>	41
26. Effect of artificial Zeolite on growth under saline irrigation in Qatar - <i>Mina Yamada et al.</i>	42
27. Appropriate crop selection to match quality of irrigation water under expected climate changes in Gulf countries - <i>Nazir Hussain et al.</i>	42
3 d: Crop improvement (breeding and biotechnology)	43
28. Development of crop varieties resistant to drought and heat stresses in Egypt - <i>Ahmad Hamdi et al.</i>	43
29. Enhanced adaptation of lentil to rain-fed farming systems in South Asia - <i>Ashutosh Sarker et al.</i>	43
30. Differences in response to water deficit stress among some lines of chickpea - <i>Henda Mahmoudi, N. Ben Hmida Labidi, and C. Abdelly</i>	44
31. Engineering antioxidants in transgenic potato (<i>Solanum tuberosum</i> L.) confers greater tolerance to various environmental stresses - <i>Amin Elsadig Eltayeb et al.</i>	45
32. Identification and expression analysis of salt and drought stress responsive genes from <i>Leymus mollis</i> , a coastal wild relative of wheat (<i>Triticum aestivum</i>) - <i>Mohamed Elsadig Eltayeb Habora et al.</i>	45
33. Collection, characterization and identification of drought, salinity and heat tolerant <i>Sinorhizobium</i> nodulating alfalfa for adaptation to climate change - <i>Imane Thanmi Alami and Sripad M. Udupa</i>	46

Theme 5: Blending indigenous/traditional knowledge and heritage with modern science in the sustainable dryland development under changing climate	47
1. Climate change and local adaptation strategies in the Middle Inner Mongolia, northern China - <i>Shulin Liu and Tao Wang</i>	47
2. Adaptation of mountain villages to glacier loss – pilot research in western Tajikistan - <i>Stefanie Christmann and Aden Aw-Hassan</i>	47
3. Performance assessment of farmers’ management for tertiary level irrigation in arid region (Case study: Irrigation improvement in Egypt) - <i>Ahmed Mohsen Aly et al.</i>	48
4. Economic benefits of integrating forage shrubs in dryland agricultural systems: an Australian case-study- <i>Marta Monjardino, D. Revell and D. Pannell</i>	49

Theme 6: Socioeconomic, institutional and policy considerations for development of dry areas under impact of climate change	49
--	-----------

1. Alternative futures: Community involvement in planning and policy in the Southwestern United States with reference to climate change and water - <i>David Mouat et al.</i>	49
2. Managing drought in Indian arid zone: Future strategies - <i>Murari M. Roy</i>	50
3. Policy and institutional impact on sustainability of highland agricultural system in Iran and recommended strategies - <i>Abbas Keshavarz and H. Dehghanisani</i>	50
4. Intensification of small ruminant production is essential to save rangelands: Case study of Syria’s dry lands - <i>Farouk Shomo and Aden Aw-Hassan</i>	51
5. Grassland conservation in China reviewed from the standpoints of environmental and ecological economics - <i>Kunio Hamamura & W. Han</i>	51
6. Rangelands deterioration and sheep production - <i>Oula Kanawaty and Farouk Shomo</i>	52

1. Poster Presentations	53
--------------------------------	-----------

1. Indigenous knowledge of water harvesting for sustainable rainfed farming systems in North Yemen- <i>Ahmed Al-wadaey and Abdulrahman Bamatraf</i>	55
2. Improving water productivity for high value crops under protected agriculture in Emirates - <i>Ahmed T. Moustafa, Arash Nejatian and , Hamalan Abu Al Kabash</i>	55
3. Root development and carbohydrate reserves as related to persistence of some desert grasses – <i>Ahmed E. Osman and W. Tsuji</i>	56
4. Accumulation of quaternary ammonium compounds in plant species growing in around Taklamakan desert of XinJiang region, China - <i>Ailijiang Maimaiti, N. Yamanaka, F. Yamamoto, N. Mori and Q. YuNuSi</i>	56
5. Challenge of concurrent biofuel and food production - a case study of <i>Jatropha</i> cultivation by small scale farmers in Mexico - <i>Ando Takayuki</i>	57
6. An estimation of the probability distribution of Wadi Bana flow in the delta Abyan of Yemen - <i>Khader B. Atroosh and Ahmed Moustafa</i>	57
7. Importance of improved wheat varieties for enhancing the adaptive capacity of agro-ecosystems to climate change - <i>Ayman AL-Ouda</i>	58
8. Osmolyte accumulation in <i>Tamarix</i> species growing under various soil conditions in the Southwestern USA - <i>Fumiko Iwanaga, S. Imada, T. Taniguchi, K. Acharya, N. Mori, F. Yamamoto, and N. Yamanaka</i>	58
9. Long-term effects of dust storms for nomads in Mongolia - <i>Haosheng Mu, S. Otani, K. Onishi, T. Hosoda, M. Okamoto, and Y. Kurozawa</i>	59

10. Biodiversity conservation of multi-purposes species across the Libyan Mediterranean rangelands - <i>Hassan Estita, Amin Khatib Salkini, Suleiman Belkhir and Mounir Louhaichi</i>	59
11. Soil fertility improvement in the Sahel with use of indigenous organic resources - <i>S. Tobita, H. Omae and O. Ito</i>	60
12. Effects of Na ⁺ and Ca ²⁺ on root cell wall composition in two soybean cultivars differing in salt tolerance - <i>Yin Lina, Shiwen Wang, Amin Elsadig Eltayeb, Hisashi Tsujimoto, and Kiyoshi Tanaka</i>	60
13. <i>Boswellia sacra</i> a high value traditional plant in dry land Southern part of Oman - <i>Mohsin Alaamri</i>	61
14. Groundwater resource sustainability in Wadi Watir, Gulf of Aqaba, Sinai, Egypt - <i>Mustafa A. Eissa, James M. Thomas, Maher I. Dawoud, Greg Pohll, Mohamed A. Goma, Kamal A. Dahab³ and Ron Hershy</i>	61
15. Influence of trehalose treatment on the stress tolerance of <i>Elaeagnus oxycarpa</i> seedlings - <i>Naoki Murata, Fumiko Iwanaga, Kiyoshi Tanaka, Ailijiang Maimaiti and Norikazu Yamanaka</i>	62
16. Assessment of GHG emission and relevant agricultural policies in Egypt - <i>Mohey S. Kadah, M.A. Fahim, M.K. Hassanein and A. F. Abou Hadid</i>	62
17. Effects of the Asian dust events on healthy subjects in Japan - <i>S. Otani, K. Onishi, H. Mu, and Y. Kurozawa</i>	63
18. Expression of drought-related traits of <i>Aegilops tauschii</i> accessions and their corresponding synthetic hexaploid wheat - <i>Q. Sohail, T. Inoue, H. Tanaka, and H. Tsujimoto</i>	63
19. Olive mill waste water valorisation in agriculture: Effects on the soil proprieties and barley yield - <i>Raja Dakhli, Houcine Taamallah, Ridha Amouri and Kamel Nagaz</i>	64
20. Prediction of tomato yield under climate change conditions by using simulation models - <i>S.M.K. Abou-Shleel, M.H. Edriss, A.A. Abdou, M.A. Medany and S.M. Saleh</i>	65
21. Optimum water application for buffel and Rhodes grass in Oman - <i>Safaa Al Farsi, Ahmed Al Bakri, Abdullah Alshankiti and A. Osman</i>	65
22. Effect of A-shaped NFT system orientation on strawberry production and quality - <i>S.M. Singer, S.H. Ahmed, U.A. El-Behairy and A. F. Abou-Hadid</i>	66
23. Changes in precipitation patterns in Syrian semi arid, arid, and extreme arid regions over last five decades - <i>Michael Skaf and Shifa Mathbout</i>	66
24. Effect of drought stress on post-anthesis assimilation and grain yield of synthetic wheat derivatives - <i>T. Inoue and P. An</i>	67
25. Sodium dynamics of invasive <i>Tamarix ramosissima</i> in the lower Virgin River, Nevada - <i>S. Imada, K. Acharya, Y. Li, F. Yamamoto, F. Iwanaga, T. Taniguchi, and N. Yamanaka</i>	67
26. Natural regeneration of native biodiversity following climate change related wildfire in a desert blackbrush community in Nevada USA - <i>Stephen F. Zitzer and David Shafer</i>	68

Opening Address

Importance of local assessment of climate change for dryland development

Adel El-Beltagy¹

¹Chair International Dryland Development Commission (IDDC) & Chair Agriculture Research and Development Council (ARDC0, Egypt; Email: elbeltagy@optomatica.com

Climate change is occurring at the rate faster than anticipated as revealed by the studies done by the Intergovernmental Panel on Climate Change (IPCC). The adverse impact of unfolding changes are no where as great as in the dry areas of the world with highly fragile natural resource base and predominately inhabited by poor. With a highly vulnerable system in which the dry area communities live, the sustainability of their livelihood would depend on developing appropriate coping strategies, particularly those related to agriculture. They may require developing new crops and crop cultivars, cropping systems and management practices and integration of cropping with livestock production and fish culture.

A prerequisite for developing the coping strategies is sufficient knowledge to understand the system that is characterized by great spatial and temporal variations. Global assessment of the impact of climate change fails to reveal the actual changes occurring at regional and local levels and how they affect the production system and livelihoods of the people there. Thus, there is a need for more precise local assessment. To enable this, models and methodologies will have to be developed that can help in better understanding the impact under different ecological conditions so that targeted adaptation strategies could be developed. This subject has received great attention in the preparation of the fifth report of IPCC.

Developing countries having large dryland populations will have to start preparing themselves now and establish linkages with the international scientific community working on climatology to get appropriate assessment, on which will depend the development of coping mechanisms to enhance the resilience and reduce vulnerability of their people.

Plenary Session Presentations

Plenary Session 1

1.1. Adaptation to the natural and social impacts of regional climate change - Declaration of the second special session of the Forum on Science and Technology in Society, Kyoto, October 2, 2009

Charles F. Kennel¹

¹*Scripps Institution of Oceanography and Sustainability Solutions Institute
University of California, San Diego, USA; e-mail: ckennel@ucsd.edu*

In October 2009, the Forum on Science and Technology in Society convened its first special session on adaptation for regional climate change. Its declaration reproduced below will be the topic of this presentation.

Declaration of the Special Adjunct Session of the 2009 Science and Technology in Society Forum “Developing a Framework for Regional Climate Change Impact Assessments and Local Action”, Kyoto, October 3, 2009

- Climate change, already here, will increase in coming decades. Greenhouse gas emissions are running ahead of the worst-case scenario of IPCC, so that temperature will increase more rapidly than expected. Aerosols, because they reflect sunlight back to space, have offset the temperature increase expected from the greenhouse gas accumulation to date; as we reduce air pollution for health and environment reasons, we will see an unavoidable increase of perhaps 2 degrees C, regardless of what we do to reduce future emissions.
- Mitigation aims to cut off global warming at its source by reducing emissions of greenhouse gases, primarily carbon dioxide. Mitigation now seems harder than we once thought. Not only are there serious political and economic difficulties, but it will take decades to deploy new energy technologies on a global scale.
- In these circumstances, NAS President R. Cicerone proposes that our strategy must be to “avoid the unmanageable, and manage the unavoidable”. As we continue our vital efforts on mitigation, we will have to adapt to the changes we cannot prevent.
- Assessment of the impacts of present and future climate change is the first step to adaptation. Assessment for adaptation differs from assessment for mitigation in one important aspect: key adaptation decisions will be needed from very many local leaders, rather than from the relatively smaller number of international leaders dealing with mitigation policy.
- This fact defines the basic question before this special session of world leaders in science and technology. How should the tools and institutions deployed to assess global climate change be adapted to the needs of local decision-makers in hundreds of regions around the world? What new social, institutional, technical, and financial innovations are needed?
- Regional climate change impact assessments bridge the global and local, and can enlist local decision-makers in direct and culturally appropriate ways. Regional assessments help local leaders see what the future holds for the things their populations care about, understand the decisions they will need to make, and support their public communication. In addition, local knowledge and monitoring are required to identify the uncertainties and critical triggers of the climate system and anticipate the impacts.
- Each region has a unique combination of interacting environmental, economic, and social factors, and its own ways of reaching decisions. Local participation is essential, as is communicating in terms local people understand. To earn the trust of local populations, each region should design and carry out its own assessments, with international support but not direction.
- Climate change is only one of the problems local leaders face. It often appears less pressing than ongoing environmental degradation and resource depletion, or the need for social and economic development. Even so, the universality of the climate problem has called forth a global community of researchers and practitioners whose social techniques and technical tools can help local leaders deal with the great problems of environment and development with which

climate change is intertwined.

- Adaptation requires a systems approach that links the physical and biological aspects of climate change to social response. It cannot be managed top-down. Integrated solutions should be sought through linked innovation in science, technology, policy, politics, institutions, and finance. It will have to be a distributed effort that is guided but not directed.
- *Knowledge Action Networks* that focus on specific regions and impacts can link the global science, technology, and policy communities to local initiatives. These are sponsored social networks connecting the generators of pertinent knowledge with local decision makers. Modern information techniques can ensure good communication within and between the global, regional, and local levels.
- Every region has knowledge leaders who can forge relationships with local decision-makers, but often there aren't enough of them. The critical mass sufficient to characterize the multiple impacts of climate change and communicate them to decision makers is often lacking. Capacity building is therefore a critical issue. Moreover, even where there is adequate human capacity, regional science and policy communities often lack access to information and tools because of bureaucratic obstacles and government security concerns. In these cases, independent organizations that provide trustworthy information are needed. Here as elsewhere, there is room for non-governmental initiatives.
- Regional assessments and adjustments in action plans will be needed throughout this century. Each region will have to monitor, model, assess, and decide, again and again. This need will spark continuous improvement of observations, models, and information systems in order to dissect and forecast the ongoing interacting changes.
- We believe that global climate change assessments should be supplemented by a mosaic of regional assessments of the impacts of climate change on natural and human systems.
- We should not expect that the globe can be sub-divided neatly into non-overlapping

regions with sharp boundaries nor the regions to define the same geographical area for the different assessments they need. Each physical, biological, and human system has a natural spatial configuration that must be respected: the boundaries of assessment regions will be adapted to the problem. We should think, therefore, of forming a complex, hierarchical network of loosely connected, self-assembled regional assessments.

- We need a new institutional framework for regional assessments and the knowledge action networks that will carry them out. An international fund is needed to encourage the assembly and support of these networks. The international science, technology, and policy community should help with capacity building and technology transfer; standards and certification; and provision of data, models and observations.
- We suggest starting with water, because of its dominant role in human consumption, food security, health, and natural disasters. The capacity to model and monitor exists, and can be translated relatively easily. Moreover, every region and locality manages water, so there are working decision makers with whom scientists can interact.
- Understanding how different regions deal with science-based decision making for water may provide insight into how the even more complex problems of ecology, health, and human development can be addressed.

1.2. Pursuing triple wins within the context of climate change

Per Pinstrup-Andersen¹

¹*H.E. Babcock Professor, Cornell University and Professor, Copenhagen University
p.pinstrup-andersen@cornell.edu; pp94@cornell.edu*

Widespread and increasing hunger and poverty, increasing demand for food due to population growth and dietary changes and unsustainable management of natural resources, along with

climate change and the threat of increasing food price volatility, call for renewed policy action by national governments and international institutions to achieve the goal of sustainable food security for all. As the world population continues to grow, water becomes scarcer, soil erosion accelerates and the negative consequences of climate change become more visible; doomsday prophecies have once again found fertile grounds. Can the triple wins of reduced hunger and poverty, expanded food supplies and sustainable management of natural resources be achieved or will obligatory trade-offs among them make it necessary to prioritize among them? That is the focus of this presentation. Following a brief description of the current situation and expected trends, the presentation will suggest a set of policies to be pursued in attempts to achieve the triple wins which, the author concludes, can be successful but only with enlightened policies and accelerated application of science. This will require real changes in national and international priorities and not just another set of summits and development goals not pursued. The biggest risk to the future food and natural resource system is not lack of the earth's productive capacity but complacency and inappropriate priorities among policy makers.

1.3. Agriculture in an era of climate change and resource scarcity. Are we ready?

Cary Fowler¹

¹Executive Director Global Crop Diversity Trust c/o FAO Viale delle Terme di Caracalla, 00153 Rome, Italy; e-mail: melly.preira@croptrust.org; cary.fowler@croptrust.org; www.croptrust.org

If anything, policy makers and climate scientists alike have underestimated the impact climate change, water, energy and nutrient constraints will have on food production. Most adversely affected will be those areas that are hot and dry today. Today's agricultural environments are about to become extinct; in country after country, crops will face growing conditions never before experienced. While many actions will be required to address

such issues, no one can doubt that preparing crops in the field to deal with new conditions there has to be a first order priority. National and global preparedness, however, is woefully lacking. While significant capacity exists, there are serious gaps in the pipeline from the collection, conservation and screening of genetic resources, to information systems, to plant breeding and seed delivery. Both subsistence and highly productive input-intensive agricultural systems will be hard pressed to adapt quickly enough to avoid major dislocations. Given the long lead time in plant breeding, preparations should now begin in earnest to get agriculture ready for the significant climatic changes predicted as early as 2030. Elements of such a strategy will be outlined in the talk.

1.4. Adaptation strategies to climate change in dryland agriculture of southwest Western Australia

Kadambot H.M. Siddique¹, H. Bramley¹, J.A. Palta² and S. Asseng²

¹The UWA Institute of Agriculture, The University of Western Australia, 35 Stirling Highway, Crawley WA 6009, Australia. Email: kadambot.siddique@uwa.edu.au; helen.bramley@uwa.edu.au

²CSIRO Climate Adaptation Flagship, Private Bag No.5, Wembley WA 6913, Australia. Email: Jairo.Palta@csiro.au; Senthold.Asseng@csiro.au

The grain belt of southwest Western Australia has a Mediterranean-type climate, characterised by cool, wet winters and hot, dry summers. The majority of grain crops are sown late in the autumn and harvested in late spring. Grain production in much of the region contends with low fertility and hostile sub-soils, low rainfall and inter-seasonal rainfall variability, with terminal drought in spring causing the greatest reduction in yields. In addition, global climate change is already impacting southwest Western Australia through lower average winter rainfall and within season droughts. Despite these constraints, grain production increased during the twentieth century due to improved agronomic practices, new cultivars and diversification of farming systems. However, climate change and

variability threaten further improvements in the region through increased risk of prolonged drought, higher average temperatures (particularly during the critical stage of grain filling) and more extreme temperatures. With high seasonal variability in rainfall it is essential that maximum grain yields are achieved in average and better seasons. Simulation models can assist with forecasting, development of decision support systems and identifying management strategies that may optimise potential grain yields. Crop simulation models have been widely used to assess the impact of climate change, but the lack of adequate experimental data hinders the accuracy of predictions. The greatest advances in addressing the challenge that climate change/variability presents will come from research leading to a better understanding of crop physiology and genetics that can be used for germplasm improvement and breeding new cultivars. Focussed research is urgently required to develop crop species and varieties adapted to the future climate in targeted growing regions together with relevant agronomic packages.

Plenary Session 2

2.1. Climatic mitigation, adaptation and dryland food production

Gareth Wyn Jones¹

¹CAZS - Natural Resources, Bangor University, Wales, UK;
Email: gwj@pioden.net

Within the international agricultural research (ARD) community, especially in the arid and semi-arid regions, the dialogue naturally emphasises the capacity to adapt production systems to future demand and probable environmental conditions. It is recognised the global climate change will impose an additional threat to systems already burdened by climatic stochasticity and water shortages, by increasing competition for available water and land, by land degradation and by increasing demands due to continuing population growth and changing diets. Regions such as West Asia & North Africa (WANA), are already major importers of staple

foods e.g. grains and edible oils and are acutely aware of their exposure to international market price rises and potentially to shortages of supply.

Understandably mitigation of the climate change impacts of land use practices and of the whole food chain from field to plate receives little attention. This situation contrasts markedly with that which pertains in some temperate, developed countries such as the UK. In the later there is a vociferous and influential lobby stressing the contribution of agriculture and land use to greenhouse gas (GHG) emissions. The consensus data suggest that food production accounts for about 20% of current national greenhouse gas emissions in a wide range of countries. Lobby groups concerned at tropic forest destruction to provide soya and other animal feeds maintain an even higher figure. Others however emphasise the potential role of improved land management in creating major carbon sinks such as in soil organic matter and trees (and long use sequestration in timber products).

Agriculture and land use differ from most other human activity sectors in that nitrous oxide (N₂O) and methane (CH₄) are major greenhouse gases (GHGs). The former is emitted as a result of microbial metabolism of applied fertilizer nitrogen (both organic and inorganic) especially in partly anaerobic soils. Nitrogen fertilizer application itself is of course an essential component of modern food production systems linked to its basic metabolic role including in RUBISCO, the enzyme responsible for all net CO₂ fixation and consequently growth and yield. In turn methane emissions arise from both enteric ruminant fermentation and anaerobic degradation of manure and other wastes. Thus methane emissions are an essential component of all low-intensity range-land systems (as well as of intensive feed-lot systems) and a source of GHGs. There are no alternatives to pastoral ruminant agriculture in most semi-arid and upland/mountain regions on which large human populations depend. A further important source of atmospheric CH₄ is anaerobic microbial activity in rice paddies.

Prime facie there is major dilemma in that current technologies to maintain food security especially

in dry lands depend on applied N and animal-based agriculture which themselves may be aggravating climate change and resource depletion. This paper will seek to place the GHG agricultural emission in their global context and consider [a] if in the event (unlikely?) of the major global cuts in CO₂ emission from hydrocarbon combustion (i.e. cutting current mean emissions from some 5t CO₂ per person per year to > 2t CO₂ per person per year and global population of 9 billion), what will be the global implication for methane and nitrous oxide emissions from agriculture? [b] Are there potential technologies and interventions for limiting emissions while increasing production to maintain food supply? [c] Should mitigation as well as adaptation feature in the international ADR agenda?

2.2. How science and technology can help farmers cope with climate change to enhance food security

Mahmoud Solh¹

¹Director General, International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria; Email: m.solh@cgiar.org

Climate change has already serious implication in dry areas, which cover 41% of the earth's surface, and are home to the majority of the World's poor. Climate change will have significant impacts on food production in these already frequently food-insecure regions. The multiple constraints to agriculture in dry areas – frequent drought, low and erratic rainfall, natural resource degradation and others – will be exacerbated by climate change. This paper describes how science and technology can help rural communities to cope with climate change through adaptation to enhance productivity and manage risk while using natural resources sustainably. It focuses on successes achieved by ICARDA in collaboration with its partners in various areas of research: biodiversity conservation and use, crop genetic improvement (varieties tolerant to drought, heat, salinity and other stresses), integrated pest and disease management, improved water productivity, diversification and sustainable intensification of productions systems,

integrated crop-livestock production systems, rehabilitation of degraded pastures, and better land management. It also describes the integrated methods used, such as the benchmark-site approach to study water and land management within a watershed, and better understand the processes and driving factors from field to basin level. The paper highlights the importance of capacity development and institutional support, enabling policies, and partnership building, in order to create diversified livelihood options for the rural poor.

ICARDA's agro-ecosystem integrated approach involves natural resource management, crop and livestock improvement and social and economic aspects of agricultural production systems. It addresses a range of food and forage crops in various environments (including high-value crops produced under protected agriculture), as well as small ruminants (sheep and goats), which are key sources of income to improve livelihoods in marginal rainfed areas. Socio-economic and policy research (SEPR) is a key component of the integrated approach, helping to draw attention of policy makers to policy options, and to develop strategies for food security, poverty eradication and improving livelihoods. Monitoring and measuring the impacts of research outputs on food security, rural welfare and the ability of communities to cope with climate change is an integral part of SEPR.

2.3. Building food security in the face of climate change: taking an integrated approach

Bruce Campbell¹

¹Director, Challenge Program on Climate Change, Agriculture and Food Security, CCAFS Secretariat, University of Copenhagen; Email: brca@life.ku.dk

Climate change represents an immediate and unprecedented threat to the food security of hundreds of millions of farmers, fishers, livestock keepers and forest users – both women and men. At the same time, agriculture also contributes to climate change, by intensifying greenhouse gas (GHG) emission and altering the land surface.

Business as usual is not an option. It is imperative to initiate immediate actions to deal with climate change, otherwise the MDGs and global food security will not be achieved. Effective agricultural adaptation and mitigation activities offer the prospects of win-win outcomes, though there are key trade-offs to tackle. The climate change, food security and rural development agendas need to be coherent. The presentation proposes a set of integrated activities to tackle the major gaps in knowledge, and to bridge the research-action divide.

2.4. Climate change and desertification - increasing the focus on adaptation

Zafer Adeel¹

¹Director, United Nations University - Institute for Water, Environment & Health
Chair, UN-Water, 175 Longwood Road South, Hamilton, Canada; e-mail: adeelz@inweh.unu.edu

A closed, interactive loop exists between climate change, biodiversity impacts and desertification. Changes to the climate in drylands can drive the degradation of land resources, which can in turn amplify climate change through destruction of land cover and resources. The IPCC projects that impacts of climate change in many parts of Africa, Central Asia and the Middle East are going to be severe; the most significant impact being on the distribution of water. For example, parts of Northern Africa and Southern Africa are projected by the IPCC to be significantly drier by up to 20% (in terms of the water run-off) by the year 2050. However, the impacts of climate change must be viewed in the broader context of the developmental challenges related to food security, human health and wellbeing, safe drinking water and sanitation, land degradation, and poverty. Efforts for provisioning of safe drinking water and adequate sanitation could potentially be impacted by the water-resource scarcity, in addition to the existing challenges in mobilizing financial, human and institutional resources. The water scarcity can also impinge on food production and cropping patterns,

and lead to adverse impacts on food security; this may be further exacerbated by other extraneous factors like the increase in diverting farming lands to biofuel production. While we do not fully understand how these factors interplay into human migration patterns, some recent studies argue that serious consideration should be given to the role of environmental challenges in these movements. The current global dialogue on climate change is focused primarily on negotiating a worldwide deal on mitigation efforts. However, it can be argued that the global development dialogue must include much greater attention to climate change adaptation in order to cope with present and future climate change impacts in drylands.

Plenary Session 3

3.1. Mitigating climate change by combating desertification

Rattan Lal¹

¹Carbon Management and Sequestration Center, Ohio State University, Columbus, OH 43210, USA, e-mail: lal.1@osu.edu

Land area prone to degradation and desertification is estimated at 35×10^6 km² (23.5% of the Earth's land), affects 1.54 billion people (23.9% of the world's population in 2007), resulting in a total annual loss in net primary production (NPP) of 41.5 Tg C/yr. Another estimate, based on spatial databases of global soils and climates, shows that land area prone to human-induced desertification is 7.1×10^6 km² at low risk, 8.6×10^6 km² at moderate risks, 15.6×10^6 km² at high risk and 11.9×10^6 km² at very high risk. The land area prone to very high risk was a home to 1.4 billion inhabitants in 2000. Based on the GLASOD methodology, the area affected by different processes of soil degradation (i.e., erosion by water and wind, salinization, nutrient depletion) has been estimated to be 19.65×10^6 km². Risks of soil erosion have increased by about 17% because of increase in arable land area over the 20th century. Risks of soil degradation and desertification may be exacerbated with increase in radiative forcing

of 3 to 8 W m⁻² corresponding with CO₂ increase to 540 ppm and 960 ppm respectively by 2100. The terrestrial biosphere may become a major source of CO₂ by enhancing decomposition of soil organic matter and the associated release of soil carbon, especially that from the soils of northern latitude. An important characteristic of these degraded and desertified soils is the severe depletion of their ecosystem C pool because of the loss of C in soil and the biomass. Thus, these ecosystems contain as low as only 20 to 25% of the antecedent C pool. Consequently, the large technical/potential C sink capacity can be realized through conversion to a restorative land use and creation of positive C, H₂O and elemental budget. Water conservation, erosion control, soil fertility improvement, establishment of vegetation cover, and increase in NPP are essential to improving the ecosystem C budget in soils and vegetation. Even with the modest increase in ecosystem C budget of 1 mg C/ha/yr, restoration of 3.5 billion hectares of degraded/desertified soils has a technical potential of sequestration of 3.5 Pg C/yr. This potential is >80% of the net annual increase in atmospheric pool of 4.2 Pg C/yr predicted by WMO. In addition to mitigating climate change, C sequestration through restoration of degraded/desertified soils has numerous co-benefits. Important among these are enhancement of soil quality, improvement in use efficiency of inputs, increase in agronomic productivity, and advancement of global and regional food security. This being a truly win-win strategy, the time to act is now.

3.2. Land degradation and climate change

Mannava V.K. Sivakumar¹

¹World Meteorological Organization, 7bis Avenue de la Paix, 1211 Geneva 2, Switzerland, E-mail: msivakumar@wmo.int

The land area of the Earth covers a total of more than 140 million km² and land resources are finite and fragile in some regions, especially in the arid and semi-arid regions. Land degradation leads to a significant reduction of the productive capacity

of land and will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Climate impacts vegetation type, biomass and diversity. Evidence from observations of the climate system has led to the conclusion that human activities are contributing to a warming of the earth's atmosphere. Observed climate change and future climate change according to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) are described.

Characteristics of the land surface are an important part of the climate system and changes of vegetation type can modify the characteristics of the regional atmospheric circulation and the large-scale external moisture fluxes. Land-use and land-cover change and global environmental change form a complex and interactive system linking human induced use/cover change to environmental feedbacks to their impacts and human responses. To better understand the linkages between climate change and land degradation, it is important to identify the sources and sinks of carbon, aerosols and trace gases. Climate change and the impact of the variability in the various climatic elements such as rainfall, temperature, evaporation etc., on land degradation are highlighted. The challenge to double food production in the next 25 years to feed the growing human population puts additional pressure on land and hence the issue of controlling land degradation merits a serious consideration. Sustainable land management practices are needed to avoid land degradation. Technologies, policies, and measures to address the linkages between climate and land degradation are discussed.

3.3. Climate change mitigation in drylands

Atsushi Tsunekawa¹

¹Director of Arid Land Research Center, Tottori University 1390 Hamasaka, Tottori 680-0001, Japan. E-mail: tsunekawa@alrc.tottori-u.ac.jp

Mitigating global climate change requires policies

to reduce greenhouse gas (GHG) emissions and enhance sinks. The fourth IPCC assessment (2007) describes means of mitigation in the short to medium (until 2030) and long (after 2030) terms. There are many mitigation approaches, including solutions in the fields of energy supply, transportation, residential and commercial buildings, industry, agriculture, forestry, and waste management. Solutions must be selected based on environmental conditions (*e.g.*, climate), economic level (*e.g.*, developed vs. developing), and energy situation (*e.g.*, oil importer vs. exporter). In rural areas, reducing GHG emissions includes measures such as restoring an ecosystem's carbon sink function through improved cropland and grazing land management, afforestation, avoidance of deforestation, improved forest management, biofuel production, and reducing energy use through more efficient heating. The clean development mechanism (CDM) and other tools may help promote these measures in developing countries, where mitigation may benefit other important policies related to rural sustainable development such as food security and poverty reduction by providing financial and technical aid. Such solutions are particularly important in drylands, which cover large areas of the Earth and are vulnerable to climate change. In this context, it is necessary to seek synergies and avoid trade-offs between climate change mitigation and other issues related to sustainable development in drylands. However, little is known regarding the linkages between climate change mitigation and sustainable development or how to attain synergies while minimizing trade-offs. To fill this gap in our knowledge, it will be necessary to encourage new studies in dryland science and technology so as to clarify linkages between climate change and agriculture, forestry, energy security, and health policies, thereby providing scientific evidence to support the development of appropriate mitigative technologies for drylands, especially for long-term mitigation, and building capacity for technology transfer and diffusion.

3.4. Managing water resources for sustainable use in Arab arid lands

Farouk El-Baz¹

¹*Center for Remote Sensing, Boston University, Boston, USA; e-mail: farouk@bu.edu*

The Arab region encompasses the largest belt of arid lands on Earth. The scarcity of surface water is complicated by extreme variability of rainfall in both location and time. Under such conditions, proper management of the meager resources becomes essential by both water users and policy makers. Increased economic development and societal modernization have resulted in the loss of ancient knowledge of best practices in water use. In times past, populations were more attuned to the environment and its changes, with particular attention to the sustainability of water from oases, springs and *aflaj*. However, modern drilling techniques and groundwater withdrawal did not take into account this native wisdom. The loss of that knowledge can be counteracted, at least partly, by the use of advanced methods and techniques of the space age. Examples are given of the use of space image data in establishing the potential of groundwater resources in the Arab region. These data include: (1) multispectral images that clearly depict surface features and allow the deduction of their geologic history; (2) thermal images that show the location of rain water accumulation just below the surface, which may replenish groundwater aquifers. They are also used to identify groundwater seeps along faults in coastal zones that can be harvested before entering the sea; (3) radar data that penetrate the sand cover to reveal buried courses of ancient rivers; and (4) elevation data that depict surface water flow in the past and the present. Correlations of such a dataset in a geographic information system (GIS) allow defining the best methods to locate and sustainably use the water resources.

For proper regulations, policy makers need details from such a database, including answers to the following questions: what are the boundaries of each groundwater basin or aquifer?; how much of the water is to be used in situ or transported for both agriculture and human use?; and what are the safe pumping rates that would assure sustainability? If such knowledge-based policies are widely instituted we would assure the longevity of water resources in the Arab region, and similar arid lands worldwide.

Plenary Session 4

4.1. Regional landscape responses to climate change in drylands of the Western USA

Stephen G. Wells¹

¹Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512 USA; e-mail: sgwells@dri.edu

Complex interactions among geologic, hydrologic, and biologic conditions give rise to *earth system services* that act to sustain productive landscapes and support human livelihood. Impacts of climate change and increasing human interaction on earth system services leads to rapid changes in landscape processes and environmental sustainability of a landscape. Fluvial landscapes (valley floors and rivers) form a critical element in sustaining human livelihood in drylands. In the drylands of the USA, historical changes in climate are combined with increasing demands on resources and rapid environmental changes in these fluvial landscapes. Convergence of these stresses on the earth system services of drylands presents challenges in distinguishing among changes that occur naturally or are caused or exacerbated by human activity. The geologic history of landscape changes over the past 10,000 years provides critical information on the natural variations of environmental change to the valleys and rivers in response to prehistoric climate change and can be used to distinguish the relative roles of climate change and human impacts.

In this paper, case studies from different regions and ecosystems within the drylands of western North America are used (a) to compare regional variations in fluvial landscape responses to climate change over the past several thousands of years, (b) to demonstrate strategies used to distinguish among environmental changes that occur naturally as opposed to those related to or exacerbated by human activity, and (c) to illustrate the impacts of historic (past 100-150 years) environmental changes in response to climate change and human interventions as well as strategies that have been used either to address, mitigate or “live with” these variations and related impacts.

4.2. Climate Change Information Center - a regional perspective

Ayman F. Abou Hadid¹

¹President, Agricultural Research Center, Giza, Egypt; e-mail: abouhadid@arc.sci.eg

The CWANA region is one of the most vulnerable areas to climate change. The available information indicates several impacts that would affect agricultural activities. Increased temperature can reduce crop productivity and limit biodiversity. Sea water rise could result in salinization of agricultural lands that would reduce crop productivity. Lack of water will have a further impact on agricultural and rural development activities. The adaptation options should depend on both availability of information as well as a trained staff and qualified scientists to design timely action plan and cooperate with national and regional agricultural research organizations in conducting an effective research to assess the impact and develop adaptation measures for possible climate change. The collective efforts of the national activities could be supported by a regional ‘Climate Change Information Center’ capable of collecting information, suggesting ways for future agricultural development and facilitate the exchange of research needs and findings in a cost-effective and sustainable manner.

4.3. The impact of climate change and humans on aeolian desertification in Northern China

Wang Tao*¹, Wu Wei² and Ta Wanquan¹

¹Key Laboratory of Desert and Desertification, Cold and Arid Regions Environmental and Engineering Institute, Chinese Academy of Sciences, Lanzhou, 730000, China.

*Corresponding author e-mail: wangtao@lzb.ac.cn; ²Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing, 100085, China

Aeolian desertification is land degradation characterized by wind erosion in arid, semiarid and sub-humid regions mainly resulting from pressure of excessive human activities on natural resources. The aeolian desertified land in Northern China is located mainly in Xinjiang, Inner Mongolia, Tibet, Gansu, Qinghai, Shaanxi, Ningxia, and Hebei provinces (autonomous regions). The desertified lands in the above eight provinces account for 98.45% of the total desertified area in China. The total aeolian desertified area covered 400,000 km² in Northern China by 2000. Collection and analysis of the information on impact of climate change and human driving factors on aeolian desertification revealed that the climate change played an important role in promoting aeolian desertification through wind erosion and rainfall variation, and the human activity further accelerated the process through destruction of landcover by exploitive land use. Soil erosion by wind, for example, could increase 4 times because of human factors in contrast to that occurring because of natural ones.

4.4. Assessment of losses for managing calamities and risks in dryland livelihoods

Jagir S. Samra¹ and A.K. Sikka²

National Rainfed Area Authority, Government of India, A-Block, NASC Complex, DPS Marg, Pusa, New Delhi -110012, India, ¹e-mail: jssamra2001@yahoo.com; ²e-mail: aloksikka@yahoo.co.in

Dryland livelihoods with resource poor base are complex, diverse, uncertain, vulnerable, risk/distress prone and under-invested. Climate change, especially the increase in extreme weather events, is further compounding risks and investment decisions of policy makers and farmers. Potentials of latest technologies are not being fully realized due to lack of extension, adaptations, mitigation and adequate safety nets. The traditional assessments and relief measures for extreme weather events and disasters generally serviced by the State Revenue Departments, based on field surveys, are time consuming, subjective, arbitrary and do not focus on enhancing productivity, production, efficiency, income and livelihoods.

The century old relief system of India of food for work, arranging fodder, feed and cattle camp was augmented by crop insurance, initially in cash crops since 1972 and further extended to loanee farmers. Weather based insurance products with settlement of claims within weeks are being pilot tested by bankers and insurance companies. Assessment of losses to livestock, perennial crops, horticulture, natural resources and environmental externalities are more complicated for designing risk management. The governments, bankers and insurance companies require weather- index based ready reckoners for arriving at premium rates and claims at smaller spatial scales. This requires research on losses-triggering thresholds and rates due to abiotic or biotic stresses during different phases of growth of crops, perennials, livestock etc.

Internalization of RS, GIS, GPS, modelling of crop growth, modern communication tools and almost real time exchange of information including mobile phones has been argued in this paper for quick assessment of losses and prompt relief. Rural employment guarantee scheme of payments of about US\$ 8.8 billion per annum through banks and post offices since 2006 for rainwater management, land development, and other tangible assets is quite progressive risk management. Revisiting of traditional safety nets and harmonization with technological development is also called upon.

Plenary Session 5

5.1. Promoting sustainable desert development to mitigate global warming effects in Egypt

Adli Bishay¹

¹Chairman, Friends of Environment and Development Association (FEDA), Cairo, Egypt, e-mail: feda@ids.net.eg

The world in the 21st century is facing a number of challenges due to both environmental and economic factors. On the one hand, the tremendous increase in the use of fossil fuel in the developed and some developing countries has resulted in the release of huge amounts of CO₂ in the atmosphere, which is considered to be a major cause of the climate change. On the other hand, the depletion of oil reserves, as well as its increasing prices, has prompted some countries to convert food grains into biofuels, reducing the exports of grain and thus causing a major problem for countries which do not enjoy food sufficiency. These changes in environmental and socio-economic conditions can be dealt with by ensuring the sustainable development of desert lands based on a holistic approach where agricultural, technological, socio-economic and environmental concepts are implemented in an integrated manner. One of the expected global warming effects on Egypt is the submergence of parts of the delta area by the Mediterranean Sea, leading to the loss of agricultural land, industrial areas, housing, and domestic facilities. This would trigger migration of people from the affected area to new areas. With the delta and Nile valley being already overpopulated, sustainable desert development is the only solution to rehabilitate the displaced people. For this to be achieved, it is necessary to save enough water from our present share from the Nile and other sources through increasing water use efficiency in the irrigation and cultivating systems of the delta and the Nile valley by decreasing water losses through water conveyance and distribution systems, changing the present flood irrigation system to more efficient techniques, and promoting regulations that would encourage farmers to use less amounts of water through proper choice of appropriate

crops and management practices. It is proposed to create viable multipurpose communities based on a particular water basin serving reclaimed desert land, and industrial and agro-industrial as well as urban activities which would cover the needs of the people displaced from areas of delta affected by the rise of sea level due to the changing climates.

5.2. The role of traditional hydro-technology in a changing world

Iwao Kobori¹

¹United Nations University, Tokyo, Japan, e-mail: Kobori@unu.edu

Traditional hydro-technology in drylands such as Qanat is now facing critical situation, although it is still used widely in various countries. The author has been working on this subject for almost half a century in Eurasia, Africa, and Latin America, and now feels some anxiety about the future of Qanat. In the past 20 years, the author has supported and assisted in organizing several important scientific meetings (e.g. in China, Iran, Egypt, Syria, Algeria, Morocco, Spain, Italy and Japan) on the topic and has been emphasizing the importance of preserving the traditional hydro-technology for the coming post-petrol era. Fortunately, some countries (such as Iran, Algeria, Oman, and China) have recognized the role of Qanat in drylands. Interest among these countries is common, i.e. how to conserve this traditional technology against modern technology and educate new generation for the hard task to rehabilitate or restore it. Thanks to the initiatives of UNESCO and the Iranian Government, we now have the International Center on Qanat and Historic Water Resources at Yazd, Iran, where the capacity building of the younger generations from the adjacent countries is being done. In Algeria, Wilaya de Adrar decided to restore old Qanat (Foggara) investing prefectural funds. In Oman, where Falaj (Qanat) was nominated as world cultural heritage, they have already published intensive inventory with an Atlas. In China also, whole inventory of Karez (Qanat) in Xinjiang has been published in three languages (Uyghur, Chinese, and English).

However, there is little contact between these countries and almost no exchange of information except individual contacts. European Commission has also supported a 3-year research project on Qanat in the Mediterranean area but there is no linkage of this study with China or Iran. Traditional hydrological system is also susceptible to natural hazards; for example, in Belbel Oasis in the Algerian Sahara the system was affected in early January 2010 by heavy inundation by flash floods, perhaps a manifestation of climate change, and most of the vertical shafts of foggara were buried. In Aoulef oasis, the capital of Tidikelt, many foggara had dried up because of recent droughts, again because of the changing climate. In the past (1961-1963), atomic explosion near Reganne brought radioactivity into the adjacent foggara and inhabitants near-by might have been affected. In 1964, 16mm rainfall for two days demolished mud-brick houses in Aoulef. It is currently difficult to forecast 'climate change' in the extreme dry areas such as the Sahara, but local weather phenomena and climatic events surely show some definite signs of climate change. In this report, the author would like to present his views on traditional or indigenous technology and climate change mainly based on field studies in the Sahara and adjacent regions.

5.3. Influence of climate change on agriculture and natural resources of Kyrgyzstan

Dzhamin Akimaliev¹

¹Former President Kyrgyz Agrarian Academy, General Director of Kyrgyz Agricultural Research Institute, Kyrgyzstan; e-mail: krif@mail.kg

An examination of the average annual temperature in Kyrgyzstan in the last 100 years shows that it increased in the 20th century by 1.6° C, and it is considerably above the global warming of about 0.6° C. The greatest warming was observed in the winter (2.6° C) and the least in the summer (1.2° C) season. The climate in Kyrgyzstan has therefore gradually become warmer from the beginning of the 20th century. The precipitation for this period

has slightly increased, by 23 mm (6 percent on the long-term average). By 2100, it is expected that the increase in average annual temperature might range from 2.5 to 3° C. At the same time there will be also an increase in the annual precipitation by 10-15 percent in comparison with the average for 1961-1990. However, it will still lead to increase in the dryness of the climate of Kyrgyzstan as slight increase in precipitations will not be able to compensate the effect of rise in air temperature. Thus the area and volume of mountain glaciers will sharply be reduced, which will lead to reduction of discharge in the rivers feeding the most habitable and economically important valleys in the country, Chuj, Fergana, Talas and Issyk-Kul. The same problem is likely to be encountered in the near future in whole of Central Asia. The number of mountain glaciers in Kyrgyzstan in 1965-1974 was 7628 with a total area of 8107 km²; there are now only 5237 glaciers with the area of 6336 km². A severe shortage of drinking and irrigation water would be the main threat to the stability in the Central Asia by 2050. Under such a situation the agriculture in the drought afflicted Central Asia, which is mainly dependent on irrigation, will be severely affected causing the problem of food security as in this strategic region about 90 percent of consumed fresh water is used in agriculture.

5.4. Resilience and adaptation strategies to climate change, IFAD's work in drylands

Ghassan Y. Al-Baba¹

¹Director, Arab Gulf States Liaison Office/OPV, International Fund for Agricultural Development (IFAD), Via Paolo di Dono 44, 00142 Rome, Italy; e-mail: g.albaba@ifad.org; www.ifad.org

The International Fund for Agricultural Development (IFAD) is an international financial institution and specialized United Nations agency dedicated to supporting poor rural women and men in developing countries to achieve higher incomes and improved food security. IFAD operates through grant and loan instruments to finance agricultural and rural development programs and

projects. Promoting resilience of small farmers to climate change is at the center of these efforts. IFAD is increasingly becoming “climate smart” by continuing to prioritize and mainstream adaptation into its operations as expressed in its new Climate Change Strategy that was approved by the IFAD Executive Board in April 2010. IFAD’s operations in drylands are highly relevant to this vision and to the implementation of the UN Framework Convention on Climate Change which recognizes the adverse effects of climate change on these particular ecosystems. Degradation of land reduces the land’s resilience to climate variation and increases the vulnerability of poor communities to the harmful effects of climate change and their ability to adapt. From 1999 to 2005, IFAD committed approximately USD 2-billion to programs and projects related to objectives of the UN Convention to Combat Desertification. IFAD’s efforts primarily support four types of adaptation activities: (i) diversifying livelihoods to reduce risk; (ii) improving agricultural techniques and technologies; (iii) strengthening community-based natural resource management; and (iv) preparing for risk and coping with disaster. Africa, a severely affected continent in terms of poverty, desertification, and climate change is discussed using IFAD project efforts in Mauritania (Sustainable Oasis Development Project) and Sudan (Gash Sustainable Livelihoods Regeneration Project). The conclusion addresses (i) tools and approaches for adaptation mainstreaming at the national and grassroots levels; (ii) Climate smart investment and climate proofing of rural development projects; and (iii) Partnerships diversification and knowledge management.

5.5. Greening the landscape in the drylands using new technologies of treating domestic wastewater and using the unutilized soil moisture

Shinobu Inanaga¹, Takehiko Matsui² and Shigenori Morita³

¹President, Tottori Institute of Industrial Technology (TIIT), 7-1-1, Wakabadai Minami, Tottori, 689-1112, Japan. E-mail: inanaga@pref.tottori.jp; ²Researcher, IC Net Limited, Japan; ³Professor, The University of Tokyo, Japan

Many of dryland countries have been continuing their remarkable progress in economic development and urbanization, which has required the utilization of large amounts of water. Fresh water resources, however, are limited in these countries. Therefore, it is necessary to find new water resources for keeping the progress and establishing the green belt so essential for human life. Among possible new water resources, we focus on two kinds: the treated water from the domestic wastewater, and the unutilized soil moisture (rechargeable moisture contained in soil layers at several meters depth). Regarding purification of domestic wastewater, we investigated a new treatment method, the ‘Freeze Concentration Method’ (FCM), as a substitute for the conventional treatment. Regarding the use of unutilized soil moisture, we have developed a cultivation method, called ‘Deep-rooted Seedling’ (DRS) cultivation, that permits the utilization of the rechargeable soil moisture present in the soil layers several meters below, which otherwise remains unutilized or underutilized. The paper presents the results of our studies on these two aspects.

Plenary Session 6

6.1. The impact of climate change on aquatic resources in dryland regions and coping strategies to enhance socio-ecological resilience

Stephen J. Hall¹

¹ Director General, The WorldFish Center, Penang, Malaysia; e-mail: s.hall@cgiar.org; <http://www.worldfishcenter.org>

This paper has two objectives. The first is to review the likely impact of climate change on the fisheries and aquaculture sector in the world's dryland regions and to place these impacts in context with other drivers of change that are likely to affect these sectors over the coming decades. The second is to offer practical suggestions for researchers, managers and policy makers on how to develop responses to the challenges climate change will bring and to support communities to better cope and adapt to them. Although this paper will focus in particular on climate change, the suggested approach to analysis and dialogue needed to identify policy alternatives and management approaches are equally applicable for developing responses to the other drivers that challenge fisheries and aquaculture systems.

6.2. A new Nile Co., an integrated sea water agriculture system project

Nina Fedoroff¹ & Tamer M. Nasser²

¹ Willaman Professor of the Life Sciences and Evan Pugh Professor, Penn State University; Distinguished Visiting Professor, King Abdullah University of Science and Technology. Email: nvf1@psu.edu; ² Regional Vice President, Energy Allied International, Maadi, Cairo, 11431, Egypt. Email: tnassar@energyallied.com

Meeting the food, feed, fiber and fuel needs of a still-growing global population in a changing climate is one of the great challenges of the 21st century. The initial effects of climate change, a

still-expanding human population of growing affluence, overexploitation of ocean fisheries and the new and growing demand for biofuels demand new approaches. Integrated aquaculture and agriculture systems, both fresh-water and saline, offer the opportunity to optimize nutrient cycling and minimize ecological impacts. New Nile Co combines Egypt's abundant resources of desert land, seawater and labor to address many national and global challenges—such as freshwater scarcity, food shortages, arable land depletion, unemployment and urban congestion—through the development and operation of Egypt's first commercial scale Integrated Seawater Agriculture System (ISAS) project, NNC Red Sea (“Red Sea Project”). ISAS is a completely closed loop, fully integrated system that combines untreated seawater with arid, desert lands to facilitate the practice of aquaculture and agriculture, yielding both biofuels and food. Simply put, a series of manmade seawater rivers and canals are used for aquaculture operations, the effluent from which is then used as a natural fertilizer for halophyte-based (i.e. naturally salt tolerant plants such as salicornia and mangroves) agriculture operations. Collectively, these interdependent aquaculture and agriculture operations yield biofuels (liquid and solid), seafood (fish and shrimp) and a host of co-products including biomass, protein meal, animal feed and salt.

Working together with the Ministry of Agriculture and the Governorate of the Red Sea, New Nile Co has selected a site located west of Gebel El Zeit. The Red Sea Project will commence with an initial phase of 20,000 hectares, and eventually encompass 50,000 hectares (~123,000 fedan). The project area will include one hundred sixty kilometers of seawater rivers and a myriad of smaller irrigation, supply and drainage canals, production operations (aquaculture, agriculture, wetlands and salt), processing operations (liquid and solid biofuels, seafood, animal feed, protein meal, building materials and salt) and infrastructure (administrative, accommodation, medical, vocational training, R&D, storage and power generation). With an estimated value of up to US \$750 Million, New Nile Co is poised to create over

6,500 permanent employment opportunities and produce hundreds of thousands of tons of goods to meet the country's national and international biofuel and food security targets.

6.3. Competence of alien genetic resources for wheat breeding in drylands

Hisashi Tsujimoto¹

¹Laboratory of Genetics and Breeding Science, Faculty of Agriculture, Tottori University, Tottori 680-8553, Japan.
E-mail: tsujim@muses.tottori-u.ac.jp

While the world population is rapidly increasing, the gain in the annual cereal production is slowing at rates far from keeping pace with the expanding population. Despite the great success of the traditional breeding in increasing the yield and overall per capita cereal production, solving the global food crises by only conventional breeding is becoming more difficult. There is an urgent need for new ideas and technologies to be exploited and adopted.

A breakthrough might be achieved through marker-assisted selection based on genome sequencing information, discovery of excellent genes and their transformation, and/or hunting, integrating and utilizing novel traits present in the cereal wild species that have not been used in the past. We have crossed wheat with several wild species and developed wheat lines with alien chromosomes or genomes. Additionally, we have built a valuable collection of lines that had been developed by other researchers. We analyzed several of these lines for various aspects and dug out novel traits such as fertilizer-use efficiency, high yield potential, high mineral contents, drought tolerance, good bread-making-quality and disease resistance. Our efforts are expanding to introduce chromosomes from more distantly related species such as pearl millet into wheat. This presentation reviews the recent status of wide crossing in wheat based on our studies and discusses the appropriateness of this strategy for wheat breeding for dryland development.

6.4. Adapting *Pongamia pinnata* to dry area environments for bio-fuel production

Mohan C. Saxena¹

¹Executive Secretary, International Commission for Dryland Development and Senior Advisor to the Director General, ICARDA, Gurgaon, Haryana, India. Former Visiting Professor, Arid Land Research Center (ALRC), Tottori University, Tottori, Japan; E-mail: m.saxena@cgiar.org ; mohan.saxena@yahoo.com

Use of biofuels to supplement and eventually replace the petro-based fuels is considered as an important mitigation strategy for retarding the process of climate change. However, the production of feedlot for biofuels should not compete with production of food. The biofuel plants should therefore be able to grow on lands which are marginal for sustained food production. *Pongamia pinnata* is a leguminous tree species that grows under tropical conditions and is capable of providing good quality oil for biodiesel production. It grows under humid and subhumid conditions but there are possibilities of adapting the species to marginal agroecological conditions of semiarid tropics. Studies were carried out in the glass house conditions to test the possibility of raising the seedlings of this species on dune soils at the Arid Land Research Center of the Tottori University, Japan using irrigation water high in salt content or boron content. Results showed that the seedlings of the Indian ecotype used in the study were able to withstand irrigation with marginal quality waters for several weeks without showing any reduction in growth. However, prolonged irrigation resulted in the development of symptoms of toxicity on old leaves, which eventually dropped off. Nevertheless, the apical growth continued. When the soil was leached with water simulating the rainfall common in the semiarid tropics, the plants showed quick recovery. The results suggest that the species can be grown on degraded land under semiarid environments when irrigated with marginal quality water during the dry season. There is thus a possibility of enhancing adaptation of this species to marginal environments in the semiarid topics.

6.5. Management of abiotic stress research in climate change scenario: an Indian experience

K.P.R. Vittal¹ and S.K.E. Raina²

¹Director National Institute of Abiotic Stress Management; e-mail: niamdirector@gmail.com; ²National Institute of Abiotic Stress Management (NIAM)

Baramati- 413 115, Maharashtra, India

Abiotic stresses are natural. They are of environmental origin and include temperature stress (heat, cold, chilling, frost); radiation stress (UV, ionization radiations); stress from toxic gasses; water stress (drought, water-logging / hypoxia, sea water inundation etc.); soil stress (salinity, alkalinity, acidity, mineral deficiency/toxicity, heavy metals, pesticides, gaseous toxins, poor water quality, etc.), and mechanical stress (aerosols, wind, shifting sands, etc.). They generally occur conjointly and affect crops, livestock and fishery. With ongoing and future climate change, their adverse effect is going to get exacerbated. Hence, there is a need to undertake comprehensive research on abiotic stresses and develop effective measures to cope with them. Cutting edge science has to be fully used to develop genetically stable crop, livestock and fishery on the strategic platform of resource management. With advances in

genomics, biological research is now shifting from the functions of individual genes to behaviors of complicated systems that emerge from the interactions of a multitude of factors. These recent developments necessitate the promotion of a combination of approaches collectively called 'Systems Biology.' Recognizing the fact that climatic change would only accentuate the adverse effects of abiotic stresses on various sectors of agriculture, the Government of India established a National Institute of Abiotic Stress Management (NIAM), where multi-disciplinary teams will work together to make significant advances in this emerging field of research. The institute will conduct research through four schools – 'Drought Stress Management', 'Atmospheric Stress Management', 'Edaphic Stress Management' and 'Policy Support Research' – employing cutting-edge research tools and techniques and through networking with other centers of excellence. These efforts will also amalgamate technological advancements taking place universally. The intermediate products of tolerance to multiple stresses generated will be made use of by other institutes to develop end products. Conjointly, the NIAM will build up human resources through education and capacity building to address the challenges in a new mode. The Institute will strongly complement the ongoing R&D in the national agricultural research system (NARS) without proliferating into other new institutes.

Concurrent Session Presentations

Theme 1: Assessment of climatic-change in arid lands

1. Rapid measurement of dust emission from semi-arid to hyperarid landforms across the Southwest U.S. and Israel: Implications for the assessing impacts of global climate change on wind erosion and dust emission

Eric V. McDonald* and S.N. Bacon

*Division of Earth and Ecosystem Sciences, Desert Research Institute, Reno, NV 89512, USA. *E-mail: emcdonald@dri.edu*

Forecasted changes in global climatic patterns will impact the formation and sustainability of soil crust (physical, chemical, and biologic) resulting in possible profound changes in dust emission from dryland soils. Assessment of potential changes in dust emission potential at the local level is difficult because traditional in situ measurements involve large (~5-10 m in length) and expensive wind tunnels that have limited application to the extensive areas of dryland soils common to non-agricultural settings. We began a campaign to directly measure dust emissions under disturbed and undisturbed surface conditions within the Mojave and Sonoran Deserts of southwest U.S. and within Negev Desert of Israel using the Portable in situ Wind Erosion Lab (PI-SWERL). The PI-SWERL is a novel device for measuring dust emissions from soil surfaces that requires limited setup time and allows for rapid measurements. Originally PI-SWERL was limited to measuring particles with diameters of 10 microns (PM_{10}) or less; however, we recently modified PI-SWERL so that it is now capable of measuring total suspended particle (TSP) emission flux from extremely dust-rich and highly erodible surfaces under high friction velocities. Results indicate that the PI-SWERL provides a reasonable measure of dust emission over a range of soil types having a variety of textures, crust characteristics, and roughness elements. The magnitude of TSP emission flux from arid landforms is largely controlled by geomorphic setting, soil properties, and type of

surface conditions. The types of geomorphic-based emissions data measured from landforms in semi-arid to hyperarid environments will help to quantify variables used to make dust-emission terrain-based hazard maps, provide information to refine dust emission models related to global-scale atmospheric dust loading, as well as help to provide information for the mitigation of wind erosion by incorporating potential emissions larger than the PM_{10} particle size.

2. Rangeland vegetation assessment in the Eastern and Western regions of Libya

Fahim Ghassali¹, Hassan Steita², Souleiman Bel Kheir², Khalfallah Mustafa ben Hcine² and Mounir Louhaichi¹

¹International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria; e-mail: f.ghassali@cgiar.org; m.louhaichi@cgiar.org; ²Agricultural Research Center (ARC), Libya

Rangelands in the dry areas of the Southern Mediterranean basin extend over large areas, constituting one of the dominant forms of land use in the area. These are often hot spots of biodiversity and are threatened by encroachment of farming practices, overgrazing and climate change. Thus, there is an urgent need to rehabilitate and better manage these degraded lands. However, the first step before engaging in any rangeland rehabilitation and management project should be centered toward mapping and assessing rangeland condition. The purpose of this study is to investigate the current status of rangeland vegetation in Libya. To meet this objective during the spring of 2010, a team from ICARDA and ARC-Libya conducted a vegetation assessment across several sites in the eastern and western parts of Libya. Conventional sampling techniques for rangeland monitoring and assessment including quadrates and line intercept as well as near-earth remote sensing technology were adopted. Vegetation parameters recorded were standing biomass, cover, frequency and density. Preliminary results indicated that total biomass and plant density were significantly different by

region: 172 kgDM/ha and 42 plant/m² for the east compared to 673 kgDM/ha and 100 plant/m² for the west. Percent green cover as estimated by the digital charting technique showed differences between and within the two regions. Sixty-one species from 22 families were observed in the eastern region compared to 92 species from 29 families in the western region. The differences were not reflected in the plant diversity and richness as the two regions showed similar results in vegetation cover (25%), species richness (9 species) and Shannon diversity index (1.8). Annual species were dominant in the east and had low biomass while perennial shrubs species dominated the west. Human induced activities, in particular cultivation and overgrazing, could have contributed to the existing spatial variability. The information gathered in this study can provide baseline data needed for a proper future monitoring of these natural resources.

3. Relationship between AVHRR NDVI and precipitation in northern China

Guo Jian* , Wang Tao and Xue Xian

*Key Laboratory of Desert and Desertification, Institute of Cold and Arid Regions Environmental and Engineering Research, Chinese Academy of Sciences, No. 320 Donggang West Road, Lanzhou 730000, Gansu Province, China; *e-mail: keen@lzb.ac.cn*

Water is a primary resource limiting terrestrial biological activity, particularly in arid and semi-arid regions. This study focuses on the temporal and spatial variation between vegetation green biomass and precipitation parameters (annual precipitation AP, annual efficient precipitation AE), annual precipitation uniformity APU and growing season precipitation GSP) in northern China. The relationship between vegetation and precipitation was investigated with Normalized Difference Vegetation Index (NDVI) images (1982–2006) derived from the Advanced Very High Resolution Radiometer (AVHRR), and precipitation data from 297 weather stations throughout northern China. Results indicate vegetation green biomass

increased linearly ($P < 0.001$) through both AP and AEP gradient, but increased nonlinearly through APU gradient. There are 82, 78 and 33 stations of 297 with positive linear relationship ($P < 0.05$) between NDVI and AEP, AP and GSP respectively and 50 stations with negative linear relationship ($P < 0.05$) between NDVI and APU. Moreover, most stations with NDVI significantly linearly related to precipitation parameters are distributed within the 200–400mm annual precipitation isoline. Our results confirm the lag effect of precipitation on vegetation and also help understand the tendency and spatial pattern of vegetation response to climate change.

4. Long-term trend analysis in heavy and extreme events in semi-arid rainfall station, as an indicator of climate change

Khaldoon A. Al-Qudah¹ and Abdullah A. Smadi²

¹UNESCO Chair for Desert Studies; e-mail: kalqudah@yu.edu.jo; kalqudah@gmail.com; ²Statistics Department; Faculty of Science, Yarmouk University, Irbid 21163, Jordan

Trends in extreme events have been worldwide analyzed as an indicator of change in climate driven by increase in atmospheric greenhouse gases. Statistical analysis of heavy (i.e. maximum, 75th and 90th percentiles) daily rainfall for 86 years for a semi arid rainfall station in Jordan has been presented. The regression approach as well as the Mann-Kendall test were used to investigate significant trends in those data. Both methods assure a significant downward trend. It is however observed that other related variables including yearly total rainfalls and the number of rainy days per year do not show any significant trend. It is also observed that the fitted linear trend model of maximum daily rainfall shows an estimated rate of decrease of nearly 2mm per decade. A plausible change in the trend is detected in the year 1982/1983. The fitted trend models for both periods show that the rate of decrease after the change point is doubled. Finally, “extreme events” of maximum daily rainfalls are investigated through the readings

falling above the 75th and 90th percentiles. It is observed for both cases that the frequency of those events is decreasing.

5. Developing an index based on surface temperature for assessment of moisture availability over vegetated land

Abdelmoneim A. Mohamed¹, R. Kimura² and M. Shinoda³

Arid land Research Center, Tottori University, Hamasaka 1390, Tottori 680-0001, Japan, ¹E-mail: ehamir@alrc.tottori-u.ac.jp; ehamir97@hotmail.com; ²E-mail: rkimura@alrc.tottori-u.ac.jp; ³E-mail: shinoda@alrc.tottori-u.ac.jp

Droughts have become widespread in the Northern Hemisphere, including in China, where they have affected farmland resources on the Loess Plateau; the potential use of these resources is substantially limited by the availability of water. Given this background, we proposed a new index, the Normalized Day-Night Surface Temperature Index (NTDI), to estimate moisture availability (m_a , defined as the ratio of actual to reference evapotranspiration). The NTDI is defined as the ratio of the difference between the maximum daytime surface temperature and the minimum nighttime surface temperature, to the difference between the maximum and minimum surface temperatures estimated from meteorological data by applying energy balance equations. To calculate the index, we used data of 20 clear-sky meteorological observations made during the 2005-growing season at a natural grassland station in the Liudaogou River basin on the Loess Plateau. The NTDI showed a significant inverse exponential correlation with m_a ($R^2 = 0.97$, $p < 0.001$). This result encourages us to examine the capability of the index to monitor the moisture availability on the regional scale; we combined the one-point but detailed meteorological data (including radiation components) and spatial remote sensing (MODIS) data of land surface temperature (LST). The results showed that the NTDI reveals a pattern similar to those for the NDVI and land use classification. However, it was found that the NTDI has an

advantage over the NDVI in distinguishing bare ground and rainfed farmland (with almost the same NDVI values) due to its higher sensitivity to surface wetness. These results strongly suggest that the NTDI based on the MODIS data will provide a promising tool for a regional-scale drought monitoring.

6. The role of modelling tools in researching pest/plant interactions in relation to climate change

Mohamed A. Fahim¹, M.K. Hassanein¹, M.S. Kadah² and A. F. Abou Hadid³

Central Laboratory for Agricultural Climate (CLAC), 12411 Giza, Egypt; ¹e-mail: ali.mohamed73@gmail.com, dr_mosaadkotb2003@yahoo.com; ²e-mail: moheyclac@yahoo.com; ³e-mail: aabouhadid@yahoo.com

This study explores some of the impacts that climate change, with warmer and more variable weather, may have on the crops pests in Egypt. It aims to elucidate how warmer temperatures and an increase in extreme weather events may affect the incidence of the main crops pests in recent years. Earlier onset of warmer temperatures could result in an earlier threat from disease with the potential for more severe epidemics and an increase in the number of fungicide applications needed for control. The potential impact of climate change on the development and growth of crops and the pests has been investigated in the past by means of modelling. However, little was done on plant diseases. Models of plant disease have been developed to incorporate more sophisticated climate predictions. At the population level, the adaptive potential of plant and pathogen populations may also prove to be one of the most important predictors of the magnitude of climate change effects. The combination of long-term change (warmer average temperatures) and greater extremes (heat spells, and droughts) suggest that climate change could increase incidence of crop pests in Egypt. In practice, an epidemic onset that is 2-4 weeks earlier would necessitate 2-4 additional sprays to achieve sufficient control of disease. According to the impact of projected climate

change trends, 1-5 more sprays may have to be applied in the period 2025-2100 for the most pest epidemics in Egypt. There is a need for a better impact assessment of climate change on plant pests and diseases as the Fourth Assessment Report of the IPCC has treated this subject insufficiently.

Theme 2: Local impact of climate change on the natural resources of water, land and biodiversity & agricultural productivity

1. Ecological and physical response and feedbacks to fires in western North American deserts

David S. Shafer¹, Vic Etyemezian¹, Karletta Chief¹, Dave DuBois², Ilias Kavouras³, James King¹, Julianne J. Miller¹, George Nikolich¹, and Stephen Zitzer¹

¹Desert Research Institute, Nevada System of Higher Education, 755 E. Flamingo Road, Las Vegas, NV USA 89119; e-mail: david.shafer@dri.edu. ²Department of Plant and Environmental Sciences, New Mexico State University, Box 30003 MSC 3Q, Las Cruces, NM, USA 88003; ³Institute National des Etudes Demographiques, 133, Boulevard Davout, Paris Cedex 20 France

Large fires (>2000 hectares) have increased in western North America deserts since the mid-1980s. This trend is expected to continue under climate change projections of higher temperatures, decreased precipitation (particularly spring and summer), and continued spread of introduced annual grasses (e.g., *Bromus tectorum*, *B. rubens*, *Taeniatherum asperum*). Paradoxically, when precipitation occurs, it is projected to be more often as short, intense storms. In the Great Basin and Mojave Deserts, these conditions are likely to favor these grasses over native shrubs. Their proliferation during wet periods creates dry biomass that would fuel larger fires when dry conditions return, a contributing factor in the 2005 Southern Nevada Complex fires. Another feedback is that these grasses quickly colonize burned areas. For

example, more than 40 percent of *Coleogyne ramosissima* shrublands have burned in eastern Nevada since 2000. Following these fires, invasive grasses have usually become established, but little recruitment of shrubs has occurred. If these sites become dominantly grasslands, precipitation will probably cause greater runoff and soil erosion.

Mojave and Great Basin fires are likely to be of lower intensity than those in forests and affect post-fire aeolian response. During the Upper Gleason burn, fire temperatures (maximum 315 °C) were insufficient to develop hydrophobicity or increase soil bulk density. However, it is hypothesized that vaporization of soil moisture and combustion of interstitial soil organics would reduce particle adhesion, increasing potential aeolian soil erosion. Post-fire measurements of potential emissions were one or more orders of magnitude higher. During the burn, emissions were also monitored for biomass and soil constituents. There are exceptions to these post-fire feedbacks and responses. At the Jacob Fire, *C. ramosissima* recruitment occurred the following spring. Invasive grasses have not colonized the Upper Gleason or other nearby burns. Understanding these exceptions could help in developing restoration techniques and strategies for limiting destructive post-fire responses.

2. Climate change impact on highland dry farming agriculture of Iran

Abbas Keshavarz¹ and H. Dehghanisani²

¹Senior Irrigation and Water Management Scientist, Tehran, Iran, e-mail: keshavarz1234@yahoo.com

²Irrigation and Drainage Department, Agricultural Engineering Research Institute (AERI), P.O.Box 31585-845, Karaj, Iran, e-mail: dehghanisani@yahoo.com

Agricultural highlands in Iran are generally classified as semi-arid based on moisture index. Annual precipitation there varies between 300 to 400 mm in the areas such as East Azarbaijan, Zanjan, Hamadan, Qazvin, Markazi provinces. It may reach to 900 mm in Yasouj region. Soils in highlands, particularly in cultivated rain-fed highlands, are still not well developed. Highland

areas play a significant role in agricultural and livestock production in Iran, where its sustainability is mostly related to climate change and drought. About 75% of agricultural production of the country comes from the highland areas. In this paper current climate characteristics, soil and water, land use, farming systems and productions in different highlands is studied and new technology, strategies, research achievements and impact on production technology, and technology transfer in the face of climate changes are evaluated and discussed. Crop production in highland areas has been increasing over last 20 years (1992-2008) because of the increase in the cultivated area, application of results of research and the implantation of technical/financial supportive schemes. However, the yield in rainfed areas has followed sinusoidal variation, and has been influenced significantly by variation in climatic conditions over this period. Average grain yield of rainfed wheat over the period of 1985-2005 was 715 kg/ha, with five seasons having grain yields less than 600 kg/ha, and eight seasons with grain yield of 600 -700 kg/ha. Total rainfed area in highland decreased in drought years, especially in 1999-2001. Eight wheat cultivars have been released over last 20 years including six bread wheat and two durum wheat cultivars to overcome impact of climate change or poor rainfall distribution in location and time. Other research achievements to decrease the impact of climate change on food security of the country are also discussed.

3. Changes of water resources and their impact on ecological environment in Minqin Basin

Cui H. Huang^{1,2}, X. Xue¹, T. Wang^{1*}, F. Peng^{1,2}, Q.G. You Quangang¹

¹Key Laboratory of Desert and Desertification, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou 730000, China. E-mail: hch@lzb.ac.cn; xianxue@lzb.ac.cn; wt@lzb.ac.cn; pengguy02@yahoo.com; iori19840903@yahoo.com.cn; ²Graduate School of Chinese Academy of Sciences, Beijing 100039, China; * Corresponding author: wt@lzb.ac.cn

Based on a hydrogeological survey and analysis, a case study of Minqin Basin is presented to illustrate change in water resources and its effects on the ecological environment in the arid area of northwest China. The results show that with the over use of surface water and groundwater in the upper and middle reaches of the Shiyang River there is a rapid reduction of water flowing into the lower reaches; at the same time with the development of human activities and increase of population, the needs for surface water and groundwater resources are ever-growing from year to year, which has led to over exploitation of ground water. Over exploitation of groundwater has led to many ecological and environment problems, such as worsening water quality, a serious degeneration of the natural and artificial vegetation in the marginal zones of the deserts, soil salinization or alkalization and land desertification. Human activity, in particular large-scale water resources development associated with dramatic population growth in the last 50 years, has led to tremendous changes in the groundwater regime. Therefore, measures such as modern irrigation technology and new regulation to cover water resources management and allocation within the river basin, to regenerate ecological environment, are urgently needed for the regional sustainable development in Minqin Basin.

4. Climate change impact on water resources management and agricultural water productivity in irrigated area of Karkheh River Basin

Hossein Dehghanisani¹, A. Keshavarz², M. Akbari¹ and T. Oweis³

¹Irrigation and Drainage Department, Agricultural Engineering Research Institute (AERI), P.O.Box 31585-845. Karaj, Iran, e-mail: dehghanisani@yahoo.com

²Senior Irrigation and Water Management Scientist, Tehran, Iran, e-mail: keshavarz1234@yahoo.com; ³ICARDA, Aleppo, Syria

The Karkheh River Basin (KRB) is one of the most productive agricultural areas of Iran, accounting for 10% of the total irrigated lands and more than 9% of the total crop production. The climate

is mainly semi-arid with large variations in the average annual precipitation between southern and northern regions. It has now become a water shortage area and increasing incidences of drought has further compounded the problem. As a result, livelihoods of rural communities are at stake. To address these problems the Iran government has begun construction of the Karkheh Dam and related irrigation network. The establishment of the reservoir, control of flood and operation of irrigation and drainage projects has influenced agricultural activity, water productivity, as well as environmental conditions in KRB. In this study the farming system, production variation, and water allocation system in irrigated areas of KRB during the last decade, and measures for improvement in water resources management and agricultural water use efficiency, have been examined. Results showed that total production and land productivity increased significantly, especially for wheat and maize; yield of wheat and maize are about 4000 and 8500 kg/ha respectively. A fair amount of irrigation water is however wasted in conveyance and field application, reducing the irrigation efficiency--overall irrigation efficiency of the traditional networks ranges between 14 to 23 % -- and water resources are at the risk of quality degradation. Water productivity for the annual crops such as wheat and barley are less than 0.5 kg/m³. The major reasons for low efficiencies were inadequate water delivery systems and inefficient on-farm water management practices. The groundwater level in non-arable land varies between 4-7 m while its level is about 1.2-3.0 m in cultivated land. The main problem of agriculture in this region is water logging and salinity. The salinity level (EC) of the ground water and irrigation water is 6-9 dS/m and 3 dS/m, respectively, while soil salinity is highly variable in the region ranging from about 2 dS/m to well over 100 dS/m.

5. Responses of some rangeland and crop plants of Uzbekistan to climate changes

Muhtor Nasyrov¹ and James Bunce²

¹*Samarkand State University, Samarkand, Uzbekistan; e-mail: muhtorn@yahoo.com;*

²*CSGCL, PSI, BARC, ARS-USDA, USA*

Countries such as those in Central Asia that have arid and semi-arid climates with already high temperatures and limited water may be particularly vulnerable to future climate changes. Annual temperatures have risen by about 1.4 °C during the last 100 years and are predicted to continue to rise in the future. This could intensify droughts, but rising carbon dioxide concentrations might alleviate effects of drought on plant growth. To evaluate the influence of these global changes on crop and rangeland production in Uzbekistan, there is a critical need to develop more precise, realistic techniques to evaluate the effects of water stress and elevated carbon dioxide on plant growth. We are using a new method of applying a uniform soil water deficit to plants to test whether elevated carbon dioxide protects cotton plants from the effects of soil water deficits. We are also comparing responses of some rangeland species to short-term and long-term changes in carbon dioxide and temperature. Results indicate that the equivalent soil water stress decreases cotton leaf gas exchange less at elevated than at ambient carbon dioxide, and that plant adjustments to the stress result in no inhibition of growth at elevated carbon dioxide while growth is reduced by the same stress at ambient carbon dioxide. While long-term exposure to elevated carbon dioxide increased growth in all of the rangeland species examined, in some of the species studied long-term exposure to elevated carbon dioxide increased the inhibition of photosynthesis by high temperature stress.

Theme 3: Enhancing resilience of local agricultural communities in drylands through adaptation strategies

3a: Agronomy and water management

1. Climate change and water resources: Strategies and practices for improved water management in arid countries

B. S. Choudri¹ and Mushtaque Ahmed²

Center for Environmental Studies and Research (CESAR), Sultan Qaboos University, PC 123, Al-Khod, Muscat, Oman; ¹e-mail: bchoudri@squ.edu.om; ²e-mail: ahmedm@seq.edu.om

In its Fourth Assessment Report (AR4), the Intergovernmental Panel on Climate Change (IPCC) highlights the complex linkages between climate change and water. The likely warmer climate induced by the climate change is set to alter hydrological cycle and the shifting pattern of the rainfall would affect the spatial and temporal distribution of runoff, soil moisture, and surface and groundwater reserves. Melting of glaciers, snow and ice sheets would increase the sea level. All this in turn would have worldwide impacts on ground and surface water supply. Based on projections of the IPCC it is clear that in the near future, some parts of the world, especially in the arid region, would have a large number of people living under water stress and water crisis. Therefore, there is an urgent need to assess the impacts of climate change on water and devise adaptation measures including management structures and processes by which one can deal with this challenge. The paper highlights the climate change impacts on water in the arid region, provides an overview of water resource management challenges including transboundary geopolitical concerns, and emphasizes the importance of an integrated framework for adaptive policy making. Further, it examines the viable water resource management options for various sectors and regions and showcases some of the international best practices in adaptation

and mitigation. The paper also highlights the complementary role of traditional knowledge in coping with climate change risks and uncertainties and the need for a balanced view in designing adaptation and mitigation strategies.

2. Performance and adaptation of the Vallerani mechanized water harvesting system in degraded *Badia* rangelands

Issa A. Gammoh¹ and Theib Y. Oweis²

¹Department of Horticulture and Crop Sciences, Faculty of Agriculture, University of Jordan, Amman, 11942, Jordan. E-mail: issagammoh@yahoo.com; ²Integrated Water and Land Management Program, ICARDA, P.O. Box 5466, Aleppo, Syria. Email: t.owais@cgiar.org

Rainwater harvesting in micro-catchment contour ridges and semicircular bunds is an option for utilizing the limited rainfall, improving productivity, and combating land degradation in dry rangeland areas (*badia*). However, implementation of this practice using manual labor or traditional machinery is slow, tedious and costly, and often impractical on a large scale. These limitations can be overcome using the 'Vallerani' plow for constructing continuous and intermittent ridges with high 'field capacity'. The plow (model Delfino 50 MI/CM, manufactured by Nardi, Italy) was tested and adapted to *badia* conditions in Jordan. The performance of the machine, its weaknesses and potential improvements were assessed in the 2006/07 season at three sites on 165 hectares of various terrains, slopes and soil conditions. The performance parameters included effective field capacity (EFC), machine efficiency (ME), and fuel consumption. Field tests were carried out at different traveling speeds of the tractor (130 HP), for different pit sizes and contour spacings. Overall mean performance indicators were: EFC of 1.2 ha/hr, 51% ME and average fuel consumption of 5.15 liter/ha. Increasing furrow spacing had a small effect on ME; increasing traveling speed had a greater effect. A guidance table was developed, relating performance parameters with furrow spacing, speed, and pit size setting. This could

be a useful reference for the implementation and management of mechanized micro-catchment construction in the *badia*. The system was able to construct continuous ridges with high performance as designed. However, it was unable to construct intermittent ridges at speeds exceeding 4 km/hr; problems were encountered in properly staggering the pits at successive contours.

3. Laser guiding system for the contouring of the Vallerani mechanized micro-catchment water harvesting

Issa A. Gammoh¹ and Theib Y. Oweis²

¹Department of Horticulture and Crop Sciences, Faculty of Agriculture, University of Jordan, Amman, 11942, Jordan. E-mail: issagammoh@yahoo.com; ²Integrated Water and Land Management Program, ICARDA, P.O. Box 5466, Aleppo, Syria. E-mail: t.oweis@cgiar.org

Mechanized construction of micro-catchments for water harvesting using the Vallerani plow was successfully tested in Syria and Jordan for rehabilitation of *badia* (rangeland) areas. However, one major issue for large-scale implementation was the high cost and time required to manually identify contours for the plow to follow. An auto-guiding system was needed to enable the tractor to follow contours without demarcation through conventional surveying. Most existing auto-guiding systems, which are usually used in road construction and agricultural land leveling, were found to be expensive or not practical. A low-cost laser guiding system (LGS), with specifications that suit the contour ridging under *badia* topographic conditions, was chosen, mounted, tested and adapted to water harvesting applications. The system consisted mainly of a portable laser transmitter and a tractor-mounted receiver, connected to a guidance control box. The system was field-tested over 95 ha, and system capacity determined under different terrains, grades (1-8%), and furrow spacings (4-12 m). Weaknesses were identified, and improvements in the system were suggested. The easy adaptation and implementation of the LGS to the Vallerani unit tripled system capacity, improved efficiency and precision, and substantially reduced the cost of

constructing micro-catchments for water harvesting. The system, after full evaluation, is recommended for the large-scale rangeland rehabilitation projects in dry areas of WANA.

4. Impact of micro-catchment water harvesting on plant diversity in Jordan Badia rangelands

Nisreen Alshawahneh¹, Hani Saoub, Theib Oweis², and Nasri Haddad³

¹Faculty of Agriculture, University of Jordan, Amman, Jordan; e-mail: hanis@ju.edu.jo; ICARDA, Aleppo, Syria, e-mail: t.oweis@cgiar.org; ICARDA West Asia Regional Program, Amman, Jordan, e-mail: n.haddad@cgiar.org

Water scarcity is the limiting factor in plant establishment and growth. Micro-catchment water harvesting systems provide an opportunity for plants regeneration and improved vegetation. A field experiment was conducted at Mharib village, about 65 km south-east of Amman in the Jordan badia (latitude 31.672358°, longitude 36.21763°), to evaluate the effect of micro-catchment water harvesting technique on the native vegetation. There were two main treatments of land slope, Slope 1 (S₁: <5%), and Slope 2 (S₂: 8-12%), and the nine sub-treatments in each slope: T₁: water harvesting with Vallerani intermittent contour ridges (CRVI) within catchment area (CRVIC); T₂: water harvesting with CRVI within the ridges (CRVIW); T₃: water harvesting with Vallerani continuous contour ridges (CRVC) within catchment area (CRVCC); T₄: water harvesting with CRVC within the ridges (CRVCW); T₅: water harvesting with traditional contour ridges (CRTP) within catchment area (CRTPC); T₆: water harvesting with traditional contour ridges (CRTP) within ridges (CRVCW); T₇: barley plantation (BP); T₈: control, with no intervention and no grazing (CIG); and T₉: control, outside the intervention area, but protected from grazing (to study the effect of protection against the intervention plus protection). The average vegetation cover for within contour ridges treatment increased from 20% in December 2006 survey to 52% in April 2007. The highest total number of plants was recorded for *Poa*

bulbosa L., followed by *Torularia torulosa* (Desf.) O.E.Scultz. Species richness value in April 2007 was 58% higher than that in December 2006; it ranged from 33 species to 5 species, from which 74% were annuals. The mechanized contour ridges intervention recorded the highest plant number whereas the traditional ridges recorded the lowest. On the other hand, mechanized intermittent contour ridges recorded slightly higher number of plants per square meter compared with mechanized continuous contour ridges within contours. Barley plantation resulted in the lowest plants per square meter compared with the other interventions with no significant difference with the control treatment.

5. Assessing the suitability and location of water harvesting and supplemental irrigation using SWAT model

Ahmed Al-wadaey¹, Feras Ziadat¹, Theib Oweis¹, Mohi ElDeen ElAoujli² and Ahmed Alboueichi³

¹Integrated Water and Land Management Program, International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria, e-mail: A.AL-Wadaey@cgiar.org, F.Ziadat@cgiar.org, t.owais@cgiar.org; ²Agriculture Research Center, Libya, e-mail: ahmedalbuaishe@yahoo.com; ³College of Agriculture, Omar Al-Mukhtar University, Libya, e-mail: mhieldin@yahoo.com

Rainfall in arid and semi arid areas is limited with high spatial and temporal variability, resulting in low water productivity. Rainwater harvesting (WH) and supplemental irrigation (SI) can improve water productivity, control erosion, and contribute to adaptation to climate change and variability. The possibility of implementing WH and SI depends on climate, hydrology, vegetation, agriculture practices, and soils. One common reason for low adoption of improved land and water management practices is the lack of systematic knowledge on potential areas and suitable locations for these interventions. This study aimed to identify areas within watersheds that are most suitable for WH and SI, to maximize the benefits from interventions. SWAT (Soil Water Assessment Tool) was used to identify suitable areas in four watersheds in eastern and western Libya. The watershed sizes

ranged from 87 to 900 km². The average annual precipitation was 100–400 mm. GIS layers, including digital elevation model (DEM), soil data and land use, were used to set up the model. Data from eleven weather stations for years 2000–2010 were used for simulation. Model output was used to assess hydrological process by estimating runoff coefficient (rainfall: runoff) in each sub-watershed and hydrologic response unit (HRU). Runoff coefficients at HRUs varied from zero to 0.23, with significant variation among the four watersheds. Areas where WH interventions can be implemented can be identified based on runoff coefficient at field scale, while other techniques such as large dams can be placed on the stream network where high runoff is generated. These results were integrated with GIS layers of land use, soil, and community distribution to identify potential sites for SI. Hydrological models are a useful tool to assess the impact of land use, analyze soil, rainfall and runoff and other parameters; and identify suitable areas for implementing WH and SI.

6. Effects of simulated rainfall amount and frequency on seed germination and seedling emergence of two desert shrubs

Peng Fei¹, Wang Tao¹, Wataru Tsuji² and Atsushi Tsunekawa²

¹Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences, China; e-mail: pengguy02@yahoo.com; wangtao@lzb.ac.cn ; ²Arid Land Research Center, Tottori University, Japan, e-mail: tsun@alrc.tottori-u.ac.jp; tsunekawa@alrc.tottori-u.ac.jp

In seriously degraded Minqin desert-oasis ecotone, coppice dunes that protect the oasis are being degraded. To restore the degraded coppice dunes, favorable seed germination conditions and a successful development of plants to a mature, seed-producing individual are necessary. *Reaumuria songarica* (Pall.) Maxim and *Nitraria tangutorum* Bobr. are the two major species growing on the coppice dunes. We conducted experiments to investigate the effect of simulated rainfall amount

and frequency on seed germination, seedling emergence and seedling dry weight of the two species. Three simulated rainfall patterns: 5 mm per day, 10 mm every two days, and 20 mm every four days were employed. Seeds of the two species were placed at the optimal depth in the dune sand. Germination of the two species was not influenced by rainfall pattern and germination percentage of the *N. tangutorum* was higher than that of *R. songarica* at all the three water treatments. Seeding emergence was significantly affected by simulated rainfall pattern and seeding emergence was higher at 5 mm per day and 20 mm every four days water treatments. Seedling emergence percentage of *N. tangutorum* was higher than that of *R. songarica* at 5 mm per day treatment but no difference was observed at 10 mm every two days and 20 mm every four days. Rainfall pattern significantly influence seedling dry weight. Both the species had the maximum seedling dry weight at 10 mm rainfall every two days. The increasing extremely heavy rainfall events in Minqin are conducive to the seedling emergence but not favorable for seedling establishment, which might decrease the restoration of coppice dunes.

7. Deficit irrigation as an alternate option under water shortage conditions in the Nile Delta of Egypt

Atef Swelam^{1,2}, Fawzi Karajeh², Yousri Atta³, and Abdallah Swelam⁴

¹Agricultural Agricultural Engineering Department, Faculty of Agriculture, Zagazig University, Egypt, e-mail: icarda-cairo@cgiar.org; ²Nile Valley, Red Sea and Sub-Sahara Regional Program, Cairo, Egypt, e-mail: f.karajeh@cgiar.org; ³Water Management Research Institute, National Water Research Center, Cairo, Egypt; ⁴National Wheat Research Program, Field Crop Research Institute, Agriculture Research Center, Giza, Cairo, Egypt

Deficit irrigation (DI) is a useful option for on-farm water management under scarcity of irrigation water. This study was conducted at Zankalon Water Research Station, Water Management Research Institute, Egypt, during 2007/08 to 2009/10, to study the effect of DI on water consumptive use and yield of two wheat cultivars ‘Gemmieza 9’

and ‘Sakha 93’ to develop a decision tool for managing irrigation applications under water-deficient conditions in the Nile Delta. Three irrigation treatments were used (three, four and five irrigations, I_1 , I_2 and I_3 , respectively; I_3 represents the common farmer practice). Each irrigation event delivered the same quantity of water, resulting in the total water delivery of 5793, 4693 and 564 $m^3 ha^{-1}$ in treatments I_3 , I_2 and I_1 , respectively.

Averaged across the three seasons, cultivar Gemmieza 9 significantly surpassed Sakha 93. I_3 gave the best yield and I_1 the poorest. There was no difference in grain and straw yields of treatments I_3 and I_2 . Using I_2 could reduce the water applied by farmers traditionally (I_3) by 1100 $m^3 ha^{-1}$ per season, or 19%. To get maximum yield of Gemmieza 9 and Sakha 93 cultivars in those parts of the Nile Delta where irrigation is not a limiting factor, treatment I_3 is appropriate, but I_2 might be adequate as an adaptation to the longstanding problem of water shortages at the end of the canal in the Nile Delta.

The average consumptive use of water was 26.7, 32.4 and 39.1 cm for I_1 , I_2 and I_3 , respectively, and Gemmieza 9 used more than Sakha 93 (33.6 cm versus 31.9 cm). Wheat plants met about 73.7% and 26.3% of their water needs from the 0-30 cm and 30-60 cm layers, respectively under I_3 . Treatment I_1 increased the water uptake from the 30-60 cm layer to 29%.

The highest water productivity was with I_1 (1.88 $kg m^{-3}$) followed by I_2 (1.83 $kg m^{-3}$) and I_3 (1.64 $kg m^{-3}$). Gemmieza 9 used water more efficiently than Sakha 93.

8. Magnetic water technology, a novel tool for improving crop production

Mahmoud Hozayn^{1*}, Amany A. Abdel-Monem² and Amira M.S. Abdul Qados³

¹Agronomy Department, ² Botany Department, Agricultural and Biology Division, National Research Centre, El-Bohoth St., 12311 Dokki, Cairo, Egypt; ³Botany Department, Princess Nora Bint Abdul Rahman University, Riyadh 13242 – 07229, Kingdom of Saudi Arabia; * e-amil: m_hozien4@yahoo.com

The technology of magnetized water has been widely studied and adopted in agriculture in many countries (Russia, Poland, Australia, USA, China and Japan), but in Egypt studies on the use of magnetized water in agriculture is very limited. Therefore, the present work was carried out to study the response of growth, yield components and yield and some chemical constituents of wheat and flax (monocotyledonous) and chick pea and lentil (dicotyledonous plants) for irrigation with magnetized and tap water under green house condition. Magnetized water exhibited marked increases in the vegetative growth and the content of photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids), total phenols and total indole acetic acid and the yield and yield components of all crops. The increases in seeds yield/plant were 10.0, 33.3, 26.9, and 46.6%, for flax, wheat, lentil and chick pea, respectively. This preliminary study shows that magnetized water can be promising for improving the crop productivity and quality under Egyptian conditions.

9. Mediterranean olive growing system adaptation to climate changes: Optimization of the water use management using biosensors as a water state monitoring device

Dalenda Boujnah^{1*}, M. Guerfel³, M. Gouia⁴, B. Badra², I. Kmicha², and S. Lamari¹

¹Institut de l'Olivier, BP: 14- 4061 Sousse Tunisie. * e-mail: dalenda_boujnah@yahoo.fr; ²Faculté des sciences Sfax-Tunisie; ³Institut Supérieur de biologie appliqué de Médenine; ⁴Institut Supérieur d'Agronomie de Chott Mariem

Water stress is considered to be one of the most important factors limiting plant growth and production. Thus, monitoring plant water status in the field is of great interest, as it would allow the diagnosis of the onset and severity of water stress and help in scheduling irrigation according to the actual plant needs. Changes in plant water status could be assessed by using a sensitive physiological indicator, which integrates both soil and climatic conditions. One of the more recent easy assessment

techniques that establish a quantitative relationship between plant water status and other physiological parameters is the measurement of the sap flow. The technique provides a continuous record of plant water losses and requirements in response to environmental variables. The aim of our study was to evaluate a quantitative direct relationship of the olive (*Olea europaea* L) tree transpiration to plant water status that might be used to schedule irrigation to maintain plant water status above a certain threshold in field grown olive trees. The relationships between water status, gas exchange parameters and sap flow were examined in field grown olive tree of cultivar 'Chemlali' in three different densities under rainfed conditions. Using this relationship, a critical value of daily sap flow decrease could be estimated and used as an accurate and simple signal for real-time efficient cultural intervention in olive tree orchard. This approach has the advantages that it needs only a small number of sensors and little data processing.

10. Impact of water stress and nitrogen fertilizer levels on cotton under high temperature in Upper Egypt

Said Abd El-Tawab Farag Hamada

Cotton Research Institute, Agricultural Research Center, Giza, Egypt; e-mail: said.hamoda@yahoo.com

This work was carried out at El-Mattana Agricultural Station, Luxor Governorate, Egypt, during 2007, 2008 and 2009 seasons to study the impact of water stress and nitrogen fertilizer levels on growth, yield and fiber quality of 'Giza 90' cv. under high temperatures in Upper Egypt. Two irrigation intervals (15 and 21 day) and three levels of nitrogen (30, 45 and 60 kg N/fed.) were used. Obtained results revealed that the years affected significantly all characters under study due to the variation in total amount of heat units, which were higher in 2008 growing season and which led to a significant increase in growth (plant height and number of fruiting branches per plant) and caused decrease in seed-cotton yield and fiber quality. Prolonging the irrigation interval to 21 day resulted

in significant reduction in vegetative growth, no. of open bolls per plant, boll weight, seed cotton yield and gave low fiber quality. The increase of N level to 60 kg N /fed significantly increased the vegetative growth, number of open bolls per plant, boll weight, seed cotton yield and gave good fiber quality. Well-watered plants responded more favorably to N supply than water-stressed plants. The interactions between years, irrigation intervals and N levels were significantly in affecting growth, yield and fiber traits. Prolonging the irrigation interval and increasing stress of water under high temperature on cotton plant gave the lower values of traits under studied. Positive and significant correlation was found between cotton growth and heat units but seed cotton yield and its components were negatively and significantly correlated with heat units. Under El-Mattana conditions, therefore, proper N level was 60 kg N /fed and the irrigation interval was 15 day to assure high yield and quality and to avoid adverse effects of high temperature in some seasons.

11. Improving growth, yield and quality of pea (*Pisum sativum*) on sandy soil by phosphorus fertilizer and biological seed treatments to control root rot and damping off

Samir Osman El-Abd^{1*}, M.F. Zaki¹, R.S.R. El-Mohamedy² and H.A. Hamouda³

¹Vegetable Research Department, * e-mail: samir_elabd@yahoo.com; ²Plant Pathology Department and ³Fertilizer Technology Department, National Research Centre, Dokki, Cairo, Egypt

One of the important methods to combat the current climate changes in the dry areas is to use agronomic practices to produce healthy plants under such conditions. Plants with a healthy root system would also have more efficient water use. Field experiments were conducted for two seasons (2007/08 and 2008/09) on newly reclaimed sandy soil in El-Nobaria region, Beheira Governorate, Egypt, to study the effect of phosphorus fertilizers (0, 25, 50 and 75 kg P₂O₅ per fed) and/or biological

seed treatments (untreated seeds, seeds priming with 1% CMC, seeds bio-priming with 3x10⁶ cfu/ml *T. harzianum* with and without 1% CMC) on the control of damping off and root rot diseases and growth, yield and quality of pea. Phosphorus fertilizer levels at 50 and 75 kg P₂O₅ per fed were superior than 25 kg P₂O₅ per fed in decreasing the root rot infection and reduction in the incidence of pea root rot. Bio-priming seed treatment improved growth, green pods yield and macro-nutrients (N, P, and K) uptake in leaves and seeds compared with other seed treatments. Bio-priming along with the application of 50 kg P₂O₅/fed gave highest increase in vegetative growth, green pods yield and quality as well as chemical contents in leaves and seeds. This combination was also highly effective in reducing root rot at both pre- and post-emergence stages.

12. Developing an adaptation strategy to reduce climate change risks on wheat grown in sandy soil in Egypt

Samiha A.H. Ouda^{1*}, Mahmoud Sayed¹, Gamal El Afandi², and Fouad Khalil¹

¹Water Requirements and Field Irrigation Research Department, Soil Water and Environment Research Institute, Agricultural Research Center, Egypt; *e-mail: samihaouda@yahoo.com; saied-ma@hotmail.com; ²Al Azhar University; Faculty of science; Department of Astronomy and Meteorology; Egypt

Adaptation to climate change could be implemented at the farm level by using management practices that could improve the productivity of crops under current climate conditions and consequently reduce climate change risks. A two-year field experiment was conducted at Ali Mobark village at El-Bastan in Egypt to study the effect of an improved management practice, i.e. chemigation (injecting agro-chemical via irrigation water) and traditional practice (i.e. farmer practice of irrigation, broadcasting fertilizers on field and spraying herbicides) on wheat yield and consumptive use on sandy soil under sprinkler irrigation. The data were used to calibrate CropSyst model. Two climate change scenarios (A2 and B2) obtained from

Hadley model were incorporated in the model to assess the effect of climate change on wheat yield. Moreover, the effect of the interaction between the above treatments and two early sowing dates was simulated to develop effective adaptation strategy to reduce climate change impact on the yield of wheat grown on sandy soil. The yield increased by an average of 33% with chemigation over the traditional practice in both growing seasons. Under the two climate change scenarios, grain yield was reduced by up to 30% under farmer's method and by about 25% when chemigation was used. The reduction in the water use efficiency was also lower under chemigation treatment. This highlights the importance of improved management practices to reduce the risk of climate change. The results also revealed that sowing wheat one week earlier under chemigation treatment improved wheat yield by about 6 and 5% under A2 and B2 scenarios, respectively. Water use efficiency was also improved. This implied that more improvement in wheat yield could occur if other management practices were used under future climate change conditions.

13. The annual organic carbon requirement for sustainable crop production in the Sahel, West Africa

Satoshi Nakamura^{1,2}, K. Hayashi¹, H. Omae^{1,2}, R. Tabo², D. Fatondji², H. Shinjo³, A. K. Saidou⁴, and S. Tobita¹

¹Crop Production & Environment Division, Japan International Research Center for Agricultural Sciences (JIRCAS), Tsukuba, Ibaraki, 305-8686, Japan, e-mail: nsatoshi@affrc.go.jp;

²International Crops Research Center for the Semi-Arid Tropics, West & Central Africa (ICRISAT-WCA), BP 12404, Niamey, Niger; ³Graduate School of Agriculture, Kyoto University, Kyoto, 606-8502, Japan; ⁴Institut National de Recherches Agronomiques du Niger (INRAN), BP 429, Niamey, Niger

Many studies report improvement of crop yields through organic matter application in the Sahel. However, proper evaluation of the effect on the sustainability in crop production has not been done because the studies were generally short-term.

Although a model simulation approach would be effective for the evaluation of sustainability in a long-term perspective, unfortunately most of existing soil organic matter (SOM) models are configured for the temperate zone. In this study, we aimed at evaluating the Rothamsted Carbon Model (Roth-C), a convenient and widely acknowledged SOM model, for its applicability in the semi-arid tropical zones, through the comparison of SOC (soil organic carbon) changes predicted by Roth-C with those observed in the long-term trials conducted since 1983 by ICRISAT-WCA in the Sahel environment. The conformity between the predicted and actual SOC values was generally good in a total of 32 treatments at the two sites where long-term trials were conducted. The LOFIT (Lack of Fit) and RMSE (Root Mean Square Error) values, the statistical indicators of unconformity in model calculations, did not show any significant error between the predicted and observed SOC values, indicating that Roth-C can successfully estimate long-term SOC changes in the Sahel, regardless of difference in land and soil fertility management practices. The SOC values after 10 years were predicted by Roth-C for 59 treatments (32 from the trials and 27 from the suggested technology options in the Sahel). Annual carbon requirement was computed to be about 0.8 tons of carbon per ha in this region, where the coefficient of determination in the regression was statistically highly significant (0.948). This amount of carbon is equivalent to 1.6 to 2.0 t ha⁻¹ as crop residues and 2.0 to 4.0 t ha⁻¹ as manures.

14. Role of conservation agriculture in the control of carbon emission and enhancement of crop yield and water productivity under dry farming systems

Ayman Al-Ouda¹

¹Leader of Conservation Agriculture Program, Plant Resources Department, The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria. P.O. Box: 2440; e-mail: aymanalouda@yahoo.com

Conservation agriculture (CA) system is considered as one of the most adaptive approaches to mitigate the vulnerability of the agro-ecosystems to climate change, where it can reduce the harmful impacts resulting from drought, and minimize the rate of soil erosion, the overheating of the soil surface, and the steep fluctuations between day and night soil temperatures. Experiments on farmers' fields for three consecutive growing seasons in five governorates in Syria showed that the productivity increased by 14.1 – 51.0% in wheat, by 16.7 – 35.0% in barley, by 12.1% in lentil, and 15.0 – 39.5% in chickpea with CA as compared to the conventional tillage system. CA also increased water use efficiency by 20 – 55% depending on the crop and the environment at the test site. These results indicate the relevance of conservation agriculture in mitigating the severity of drought and enhancing the adaptive capacity of crops to climate change especially under rainfed conditions.

15. Olive- mill wastewater spray to improve structural stability and reduce wind erosion in the southern Tunisian arid zones

Mounir Abichou^{1*}, M. Labiadh², W. Cornelis³, D. Gabriels³, B. Ben Rouina¹, H. Taamallah² and H. Khatteli²

¹Institut de l'Olivier, Tunisia, *e-mail: abichoumounir@yahoo.fr; ²Institut des Régions Arides, Tunisia; ³Faculté de Gent, Belgium

The quantity of the olive-mill wastewater (OMW) that accumulates over time poses a real threat to environment in Tunisia. It is, however, rich in organic matter. At the same time, the soils of the sandy plains of southern Tunisia are low in organic matter content and are thus very prone to wind erosion. They are being eroded and contributing to the formation of sand dunes. An experiment was, therefore, started at the Chammakh–Zarzis site in 1995 to test the effect of olive-mill wastewater sprays at different rates (50, 100 and 200 m³ per ha), in comparison to no spray of OMW, on the cohesion of this sandy soil. The OMW spray

improved soil organic matter content (from 0.06 to 1.27% after 10 years of spray), the structural stability of the soil (soil aggregates of > 2 mm size increased by 34 % with 200 m³ per ha dose), and raised the threshold of friction-velocity for wind erosion from 8.5 m/s for 50 m³ per ha OMW spray to 12 m/s for 200 m³ per ha OMW spray, reducing the wind erosion.

16. Potential of protected agriculture to enhance water and food security in the Arabian Peninsula

Ahmed T. Moustafa¹, Abdullah Al-Shankiti², Arash Nejatian³

¹Protected Agriculture Specialist, ICARDA-APRP, a.moustafa@cgiar.org; ²On-Farm Water Management Specialist, ICARDA-APRP, a.Shankiti@icarda-aprp.ae; ³Activities Coordination Officer, ICARDA-APRP, a.nejatian@icarda-aprp.ae

Food security is a major issue in the Arabian Peninsula countries, especially the six Arab States of the Gulf Cooperation Council (GCC). Harsh environment, high temperature and water scarcity are the major constraints for enhancing food production in the region. The present conventional farming practices have low water and land productivity which make these practices technically and economically incapable to meet the challenges of food deficit and water scarcity. Groundwater is being rapidly depleted and agriculture has increasing to depend on unconventional water resources using expensive desalination techniques. Economic utilization of such expensive water requires an efficient system for producing high value crops. Such a situation makes the techniques of protected agriculture (PA) as a valuable alternative for the region.

Collaborative research of ICARDA and the national research systems of the region confirmed the high potential of PA for improve food and water security. For example, tomato yields in open field in Qatar in 2007 were only 4 to 6 kg/m² compared to 17 kg/m² in the protected agriculture in the cooled greenhouses (GH). The study also showed that using soilless production techniques (hydroponics) would improve water productivity even further. Water pro-

ductivity of tomato was 7 and 48 kg/m³ in soil and hydroponics system under PA, respectively in the period from November to April. Cost benefit analysis confirmed that PA and its associated techniques were more profitable as compared to the traditional production systems in the open field. Although the initial capital investment is higher, better yield and water saving would cover the costs within 3-4 seasons. However, there is a need for more support to growers to stimulate adoption of new techniques. Training programs and technical back stopping should be made available as well as improved marketing to encourage growers to produce quality crops.

17. Productivity and water use efficiency of five grasses in United Arab Emirates

Ahmed E. Osman¹, M. Makawi² and R. Ahmed²

¹Pasture and Range Ecologist, Arabian Peninsula Regional Program, ICARDA, Dubai. Current address, P.O. Box 3369, Khartoum, Sudan. E-mail: goldentulipsudan@yahoo.com; ²Dhaid Research Station, Central Region, Ministry of Environment and Water, UAE

Freshwater in the Arabian Peninsula (AP), is scarce and the consumption is high, which has put negative pressure on land resources, agricultural production and public health. A joint research effort between the national agriculture research systems of the AP countries and the International Center for Agricultural Research in the Dry Areas (ICARDA) is focusing on identifying new forages that use less water. Collection missions for indigenous plant species were carried out in 6 AP countries, where seeds of potential forages were collected. Most of these species are being evaluated for their forage and seed production, feed quality and water use efficiency in the respective countries.

In this study the forage productivity, seed production and water use efficiency (WUE) was determined for two seasons in the United Arab Emirates of buffel grass (*Cenchrus ciliaris* L.), dakhna (*Coelachyrum piercei* (Benth.) Bor), da'ay

(*Lasiurus scindicus* Henr.) and tuman (*Panicum turgidum* Forssk.) and one exotic species, Rhodes grass (*Chloris gayana* Kunth). Three irrigation levels were used, W₁ (1858-6758 m³ ha⁻¹), W₂ (929-3379 m³ ha⁻¹) and W₃ (464-1689 m³ ha⁻¹).

Buffel grass was the highest producer of dry matter (DM) under all irrigation treatments. Its average yield was 14.6 and 15.1 t ha⁻¹ in the two seasons, which was significantly higher than other grasses, while dakhna was the lowest yielder. Buffel grass had the highest WUE value in the two seasons (0.7 and 0.8 kg DM m⁻³) which was significantly higher over the other grasses. Buffel grass showed the highest increase in WUE in both seasons when irrigation was reduced from W₁ to W₃. The results suggest that native desert grasses such as buffel grass could replace exotic Rhodes grass in the cropping system of the Arabian Peninsula in order to save irrigation water. More research is needed in the area of seed production

18. Approaches and efforts on mitigating aeolian desertification in Northern China

Wang Tao and Xue Xian*

Key Laboratory of Desert and Desertification, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese of Academy Sciences, 320 West Donggang Road, Lanzhou, 730000 China, *e-mail: xianxue@lzb.ac.cn

Desertification is damaging the drylands that cover approximately 41% of the land surface of the world and are home to more than 38% of the total global population of 6.5 billion. The pace of desertification is likely to get accentuated by the impact of the ongoing global climate change. Some efforts have been made in several parts of the dryland world to combat desertification. Aeolian desertification (desertification/land degradation resulting from wind erosion) in the agro-pastoral ecotone of northern China has been a serious problem. This paper presents some typical field experiments on combating aeolian desertification in the agro-pastoral ecotone of northern China, in

order to provide a regional case study in support of the theoretical and practical approaches to the prevention and reversal of desertification on global scale. Based on these studies it is concluded that (1) the rehabilitation of arid human-environmental (H-E) ecosystems is a slow and long-term process; (2) the input from outside of the arid H-E ecosystem is necessary for combating desertification; and (3) the regional differences and complexity within the arid H-E ecosystem has to be taking into account while developing the rehabilitation and reversal measures.

Theme 3b: Animal production and pasture management

19. Genetic variation for tolerance to abiotic stresses in Egyptian desert sheep and goats raised under the hot dry conditions

Adel M. Aboul-Naga¹, TM.M. Abdel Khalek¹, A.R. Elbeltagy¹, M. H. Elshafie¹, M. K. Yousef³, G. Maharem¹, M. Tibbo³ and B. Rischkowsky³.

¹Animal Production Research Institute, Ministry of Agriculture, Dokki, Cairo, Egypt. adelmaboulnaga@hotmail.com; ²Nevada State University, LV, USA; ³International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria

A study was designed to analyze the genetic variation in the tolerance to abiotic stresses (heat, exercise and dehydration) in the indigenous desert sheep and goats raised in the hot dry Northern Coastal Zone of Egypt. Fifty-nine ewes and twenty four does, exposed to natural heat stress under solar radiation, were kept outdoors between 12:00 and 3:00 pm for 3 successive days in July and August. The same animals, used in the physical exercise stress treatment, walked about 7 km (with average speed of 115 m/min) under direct solar radiation over the period from 12:00 to 3:00 pm. The ten ewes and ten does exposed to dehydration stress were not allowed to drink for three successive days. Main climatic parameters were assessed of the

animal pre-, during and post-treatment. Biological parameters (thermal, respiratory and metabolic) were measured before and after the treatments. Blood samples were collected for genomic analysis. Both heat and exercise stresses affected all biological parameters significantly ($p < 0.001$) except the metabolic heat production in sheep. Both intra-breed and inter-species variation in response to stresses were detectable. A tolerance index was developed to assess individual animal tolerance, based on the changes in rectal temperature, gas volume, respiration rate, and biological heat production. Individual rank for tolerance level ranged between '0' (considered most tolerant animal) to '4' (considered the least tolerant). Forty-four percent of the does and 23.7% of the ewes showed high tolerance to heat stress (index 0 and 1), while 16% of does and 59.3% of ewes showed low tolerance (index 3 and 4). None of the ewes can be classified as highly tolerant to exercise stress, while 20% of the does were ranked as highly tolerant. Two does showed high tolerance to both stressors. Dehydration stress raised significantly all thermal parameters ($p < 0.01$) and decreased respiration by higher values in sheep than in goats while body weight losses were more drastic in the does than in the ewes.

20. Effect of local feed alternatives on milk fatty acid composition of fat-tailed Awassi ewes

Souheila Abbeddou^{1,2}, Hans Dieter Hess³, Barbara Rischkowsky² and Michael Kreuzer¹

¹ETH Zurich, Institute of Plant, Animal and Agroecosystem Sciences, Universitaetstrasse 2/LFW B56 CH-8092, Zurich, Switzerland, e-mail: souhila30@hotmail.com; ²ICARDA, Aleppo, Syria; ³Agroscope Liebefeld-Posieux Research Station ALP, Posieux, Switzerland

Feed scarcity is the main constraint to livestock production in dry areas. This scarcity is exacerbated by rangeland degradation and the recurrent droughts linked to desertification and climate change. Alternative feeds were proposed to alleviate grazing pressure and to mitigate desertification.

Their successful integration depends on their ability for improving milk production without negatively affecting milk quality.

Recently, the human health benefits of fatty acids (FA) have got increasing attention. These include n-3 FA (e.g. α -linolenic acid; ALA), *cis*-9, *trans*-11-C18:2 (rumenic acid, a CLA isomer) and *trans*-11 vaccenic acid. While ALA in milk depends on dietary intake and on the rate of escape from ruminal biohydrogenation, milk CLA and *t*11-C18:1 depend solely on the action of ruminal biohydrogenation.

The influence of various feed alternatives on milk FA composition was investigated at ICARDA, Syria, in an experiment with, per diet, ten Awassi ewes (51.0±6.5 kg) allocated in a randomized block design. Diets were isonitrogenous and isoenergetic and had forage:concentrate ratios of 0.3:0.7. Test feeds constituted 0.3 of the diets replacing control diet ingredients (barley straw by lentil straw, olive or *Atriplex* leaves; and wheat bran/cottonseed meal by olive cake or tomato pomace). Animals were group-fed with 2.5 kg dry matter/day and water *ad libitum*. The experiment lasted for 50 days, where milk was sampled every second week.

In the unchanged milk and milk fat yield, the ALA biohydrogenation increased with intake. ALA proportion was high with olive leaves (0.41%) and low with olive cake (0.13%) ($p < 0.001$). Tomato pomace and olive leaves increased the CLA proportion to 0.66%, compared to 0.42% in control. Olive leaves furthermore affected biohydrogenation in a way that *t*11-C18:1 proportion was highest (1.22% vs. 0.67% with olive cake). The results suggest that it is possible to enhance the potential health benefit of milk by strategically including alternative feeds.

21. Effects of seed density and treatment on the germination and establishment of different halophyte shrub species under semi arid conditions of Syria

Mounir Louhaichi and Fahim Ghassali

International center for Agricultural Research in the Dry Areas, P.O. Box 5466, Aleppo Syria; e-mail: m.louhaichi@cgiar.org

Beyond the large and widespread non-tropical arid and semi-arid rangeland areas, their continuous degradation highlights the alarming state leading to desertification. This situation is exacerbated by the changes in temperature and rainfall as projected under climate change scenarios. Moreover, the restoration attempts using direct seeding of indigenous species have been hardly implemented because of the low germination rate and consequently the low economic return. An investigation was made into the effects of direct seeding and seeding rates on seed germination and establishment of several halophyte shrub species. Seven halophyte species (*Atriplex halimus*, *A. canescense*, *A. leucoclada*, *A. nummularia*, *A. lentiformis*, *Salsola vermiculata* and *Haloxylon aphyllum*) were tested under three seeding densities (10, 30 or 60 seeds per pot) and two seed treatments (complete fruits or naked seed) with five replications in completely randomized design under semi-arid field condition at ICARDA's headquarters in Syria. The results showed significant differences ($p < 0.001$) among the species and seed treatments and their interaction. However, there was no significant ($p > 0.05$) effect for the seed density. These results confirm our hypothesis that traditional methods for planting seeds in high seed density are not affecting the overall germination rate. Seed density of *A. halimus* and *S. vermiculata* showed the highest percent germination for both seed treatments. Strikingly, seed fruits of *A. leucoclada* gave better germination response than naked caryopses. In a second step and after germination all pots were thinned to one seedling which was monitored frequently for one year. Digital image processing

technique was used to estimate percent vegetation cover as an indication of plant vegetative growth. Seed treatments had no significant effect on plant establishment. There was a significant difference among the species ($p < 0.001$) with *A. leucoclada* having the highest vegetation cover in contrast to *H. apyllum* which had the lowest canopy cover.

22. Cactus: a crop to meet the challenges of climate change in dry areas

Ali Nefzaoui¹ and Mohamed El Mourid

International Center for Agricultural Research in the Dry Areas (ICARDA), North Africa Regional Program, Tunisia; ¹General Coordinator of FAO-ICARDA CACTUSNET. a.nefzaoui@cgiar.org

The future of the arid and semi-arid zones of the World largely depends on the development of sustainable agricultural systems based on the choice of appropriate crops. The suitable ones are those that successfully cope with water shortage, high temperature and poor soils, and easy management to provide food and forage for the subsistence agriculture, in addition to valuable product and by-products. Opuntias, particularly *Opuntia ficus indica* (cactus pear) fit most of the requirements described above. They play an important ecological role in combating desertification as well as producing fruits and vegetables for human consumption, feed for livestock, biomass for energy purposes, cochineal for carmine production, and numerous by-products (beverages, vegetarian cheese, drugs, and cosmetics). They also provide shelter and food for various wildlife species living in arid environments.

Cacti can grow in severely degraded soils, which are inadequate for other crops. *Opuntia* spp. have a great capacity to withstand severe dry conditions and are ideal for responding to global environmental changes. Their root characteristics avoid wind and rain erosion, encouraging their growth in degraded areas. The importance of cacti is reinforced with regard to the wide range of possible use. Indeed, they can be used: (i) as forage, (ii) as vegetable where young cladodes are consumed fresh or

cooked, (iii) as fruit where a sustainable horticultural system is achieved in several countries (Italy, Tunisia, Morocco, South Africa, Mexico, Chile, etc.), (iv) as cochineal where carminic acid, a natural red dye accepted by health authorities worldwide is obtained, (v) as processed foods where a potential market for fruit, and “nopalitos” to produce concentrated foods, juices, liquors, semi-processed and processed vegetables, food supplements and the cosmetics industry might be a significant source of income, and (vi) for medicinal applications: promising results for the treatment of gastritis, diabetes, hypercholesterolemia, and for obesity.

Theme 3c: Stress physiology

23. The ability of Sedum plant to tolerate different environmental stresses

Ahmed Al-Busaidi¹, T. Yamamoto² and M. Inoue²

¹College of Agricultural & Marine Sciences, Department of Soils, Water and Agricultural Engineering, Sultan Qaboos University, P.O. Box 34, Al-Khoud123, Muscat, Oman, Tel: (968) 24143736, Fax: (968) 24413418, e-mail: ahmed99@squ.edu.om ; ²Arid Land Research Center, Tottori University 1390 Hamasaka, Tottori 680-0001, Japan

Globally arid and semiarid areas are facing salinization of soils along with the acute shortage of water resources. The utilization of marginal waters for agriculture is getting considerable importance in such regions. In our experiment, sedum (*Sedum aizoon* var. *flobundum*) plants, which are tolerant to the water stress, were tested for growth parameters in response to irrigation with diluted sea water to the salinity levels of 0.7, 15, 30 and 46 dS m⁻¹. The results demonstrated that evapo-transpiration was affected negatively by the salinity treatments. The electrical conductivity of the soil and drainage water increased significantly with higher saline water. Fresh water gave the highest plant biomass whereas diluted sea water apparently decreased plant biomass with increasing salinity. However, the conjunctive use of sea water with higher dilution gave more sedum biomass yield than less diluted sea water. Water deficit increased with increasing

salinity level. The ratio of dry and fresh plant weights significantly increased with increasing salinity levels. The ability of the plant to survive under sea water irrigation was due to its mechanism of keeping water in its leaves and tolerating water stress conditions caused by salts accumulation in the root zone. Sedum survival under heat, water and salinity stress conditions is considered as a unique feature that is needed in the changing environment of increasing water deficit and temperatures.

24. Alleviation of the potential impact of climate change on wheat productivity using arginine under irrigated agriculture in Egypt

Amany A. Abd El-Monem¹ and Mahmoud Hozayn²

¹National Research Centre, Botany Department, Agricultural and Biology Division, El-Bohoth St., 12622 Dokki, Cairo, Egypt; e-mail: m_hozien4@yahoo.com; ²National Research Centre, Agronomy Department, Agricultural and Biology Division, El-Bohoth St., 12622 Dokki, Cairo, Egypt; e-mail: amany.gouda5@yahoo.com

Agriculture is inherently sensitive to weather and climate. Adaptation of an appropriate management strategy is one of the measures to cope with the impacts of changing climate. This study was designed to explore the role of foliar application of arginine (0.0, 2.5 and 5.0 mM) in increasing the tolerance of wheat cultivar 'Sids-93' to late sowing (23 December and 23 January, simulating expected changes in climate) as compared to the normal sowing date (23 November) in Egypt. The field experiment was conducted at the Agricultural Research Station of National Research Centre in Shalkan Province, Kaluobia Governorate. Delayed sowing caused marked reduction in biological and economic yield, through reduction in the spike length and weight, spike grain weight, spike number/ m², and 1000-grains weight. The reduction in economic yield reached to 10.4 and 41.2 % when sowing was delayed to 23 December and 23 January, respectively. Foliar application of arginine at 2.5 and 5.0 mM on normal and delayed sown wheat exhibited significant increase in yield and its components in comparison to untreated plants. The

magnitude of increase was more pronounced with 2.5 mM of arginine, being 19.23, 20.53 and 25.51% in the normal, and 30 and 60 days delayed sowing, respectively. It is thus concluded that arginine could alleviate the adverse impact of climate change, simulated by late sowing, on the yield of wheat in semi-arid region under irrigated agriculture.

25. Seed priming, a promising tool to improve crop production under different environmental stress conditions

Hamdino M.I.Ahmed and Amal Z.A. Hegazi

Horticulture Research Institute, 9 Gamaa Stree, Giza, Egypt, e-mail: hamdino@yahoo.com, hamdini.ahmed@gmail.com

Environmental stresses are a major constraint to meeting the world food demand, as they are considered to be the main cause of yield reduction in the food crops. The potential yield losses by individual abiotic stresses are estimated at 17% by drought, 20% by salinity, 40% by high temperature, 15% by low temperature, and 8% by other factors. Seed germination and early seedling establishment are generally the most sensitive stages to stresses as plant tolerance usually improves with plant development. Rapid and uniform seed germination and early seedling growth are of vital importance for crop production under stress conditions. Thus, if the adverse effects can be alleviated at the initial growth stages, the chances of establishing a crop will be much improved. Investigation of techniques to improve tolerance of plants to different environmental stresses during germination and emergence are numerous. One presowing seed treatment method that has proven successful in increasing seed vigor in most cases is the seed priming. Primed seeds usually germinate more rapidly than unprimed seeds once placed in an appropriate germination environment. Over the last two decades, the seed priming approach has been used extensively to enhance the rate and uniformity of field germination and emergence in many important crop plants grown under both stress and non stress conditions. A brief review of the work is presented.

26. Effect of artificial Zeolite on growth under saline irrigation in Qatar

Mina Yamada

Department of Agriculture, Tottori University, 101, Koyama-cho Minami 4chome, Tottori 680-8553, e-mail: myamada@xf7.so-net.ne.jp

For targeting zero emissions, coal fry ash is converted to the Ca-type artificial zeolite (Chubu Electric Power Co. Ltd., Japan). It has a porous and crystalline structure, a high CEC of about 300 cmol (+)/kg, and a large specific surface area. Therefore, its application in the soil can be expected to improve the water and nutrient holding capacity of soil and prevent salinity.

The leaching, loss of moisture by percolation and salinity are serious problems on sandy soils in the dry lands. To assess these effects on dry land, experiments were conducted using saline irrigation (EC=6.4dS/m, Na+568ppm, and Ca²⁺ 417ppm) in Qatar.

A 2% zeolite application increased the soil water content 2-folds over the control at 20cm depth, although, there was no change at the ground level. The growth of vegetables was decreased by the half reduction of the supplied fertilizer; however, application of zeolite recovered the growth under this condition. Zeolite improved the early growth of vegetables and turf.

The surface soil in a zeolite-free plot became hard and showed salt accumulation and salt crust, which probably inhibited the sprouting of turf. However, the addition of only 1% zeolite reduced these problems and 2% zeolite increased growth by about 3-folds compared to the zeolite-free plot at 113 days after planting. This indicates that zeolite can potentially reduce salt damage. Thus, it can be expected that using artificial zeolite would be effective for plant production and soil conservation in dry lands due to its water and fertilizer holding and salt masking abilities.

27. Appropriate crop selection to match quality of irrigation water under expected climate change in the Gulf countries

Nazir Hussain¹, Ghanim Abdul Rehman Alghanim¹, Khalid Mahmood², Nasser Salim AlWahaibi³ and Salim AlRasbi³

¹Soil Research Section, Department of Agricultural Affairs, Ministry of Environment, Government of Qatar, Doha, Qatar, E-mail: drnazirhussain@gmail.com; ²Soil and Water Testing Laboratory, T. T. Singh, Punjab, Pakistan; ³Agriculture Research Center, Rumais, Ministry of Agriculture and Forestry, Muscat, Sultanate of Oman

Climatic change is a global phenomenon which has been gradually occurring over the past years and its impact is expected to enhance in the future. Rise in temperature, cyclones, floods, variability and unpredictability of rainfall, droughts and melting of ice would eventually alter the hydrological cycle and the drier regions of the globe will become more dry in the future. This will make it highly difficult for water scarce regions, such as the Gulf countries, to face these future challenges. Surface water scarcity will increase usage of groundwater, the major part of which is saline. More pumping coupled with high evaporation will increase salt concentrations in the soil and ground water. As crops differ in their sensitivity to salts, a wise decision in the selection of crops and cropping sequences well suited to prevailing quality of irrigation water will be required. The Gulf countries are already facing problem of scanty rainfall and very high temperatures, being part of the desert climate region. The water resources are highly limited that mostly comprise of saline groundwater with seawater intrusions in some areas. Only a few areas have water of EC less than 2 dS m⁻¹. However, this limited water resource is not being utilized in an efficient manner at present. Comparatively good quality waters (EC < 3 dS m⁻¹) are mainly being used to grow salt tolerant fruit tree (Date palm) and fodders (alfalfa and Rhodes grass), which consume a lot of water with low returns. Growing of these crops would have been more appropriate with water of EC 5-10 dS m⁻¹. The good quality water can be utilized for growing seasonal vegetables

that would give two crops a year with less total water consumption but 3-5 times more income. It is recommended that any two of such vegetable crops as onion, pepper, beans, carrot, radish, eggplant, cucumber and okra be grown with water of EC less than 2 dS m⁻¹ where it is available. Similarly, two crops a year of vegetables like potato, sweet potato, cabbage, spinach, turnip, sweet melon and watermelon should be grown with water of EC 2-3 dS m⁻¹. Tomato and squash can be cultivated even with water of EC 3-5 dS m⁻¹. The field crops like barley and wheat or fodders (sorghum, pearl millet, Rhodes grass, alfalfa) should be restricted to areas with water of EC 5-7 dS m⁻¹. Future plantations of date palm should only be made in areas with water of EC 7-10 dS m⁻¹. Highly salt tolerant forest plants like *Acacia ampliceps* can be grown when the EC of water is more than 10 dS m⁻¹. In this way, the water resource use will become the most appropriate and economical and it will help in mitigating the adverse effects of future climate changes.

Theme 3d: Crop improvement (breeding and biotechnology)

28. Development of crop varieties resistant to drought and heat stresses in Egypt

Ahmed Hamdi*, M.S.E. Sharshar, A. Shehada, F.H. Shalaby, and A.M.O. El-Bawab

*Field Crops Research Institute, Agricultural Research Center, Post Code: 12619, Giza, Egypt. Corresponding author *e-mail: ahihamdi@yahoo.com*

The increasing population, shortage in food supply and limited land and water resources in Egypt have directed the activities of Field Crops Research Institute towards increasing productivity per unit area and water and intensifying crop production in both old and new lands and particularly in the rainfed areas. The rainfed coast in north Egypt has about 168 thousands hectares of land. Rainfall here is extremely low, 105 to 300 mm. Several drought-tolerant varieties have been developed and

disseminated for rainfed conditions in the northern coast. These include the bread wheat (*Triticum aestivum* L.) cultivar 'Sahel 1', which gave grain yield of 1.19 t/ha under rainfed conditions. In barley (*Hordeum vulgare* L.) the drought-tolerant cvs. are 'Giza 125, 126 and 2000', as hulled barley, and 'Giza 130 and 131' as hull-less barley. Their average grain yield was 1.1 t/ha under < 200 mm rainfall, with a superiority of 12.3 to 25.3% in yield over the local checks. In lentil, the drought-tolerant cultivar 'Sinai 1' is highly adapted to dry condition in North Sinai, yielding 116% higher than 'Giza 9'. In addition, under irrigation conditions, efforts have been made to reduce the frequency of irrigation and hence reduce amount of irrigated-water for the most of field crops. Several cultivars of faba bean, lentil and soybean have been identified as adapted to low-water requirements under irrigated conditions. Attention has also been given to develop heat-tolerant cultivars. Most of that work has been done in South Egypt (Quena, Toshkey and East-Owinat) where the high temperatures are common. A total of 25 heat-tolerant crop cultivars have been identified and released. These included 3 bread wheat, 3 durum wheat, 1 barley, 6 single and triple-crosses of maize, 6 lentil and 7 soybean cultivars.

29. Enhanced adaptation of lentil to rain-fed farming systems in South Asia

Ashutosh Sarker¹, Shiv Kumar¹, R. Shrestha², J. Kumar³ and M.J. Uddin⁴

¹International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria, e-mail: a.sarker@cgiar.org ; ²Nepal Agricultural Research Council (NARC), Rampore, Nepal; ³Indian Institute of Pulses Research (IIPR), Kanpur, India; ⁴Bangladesh Agricultural Research Institute (BARI), Ishurdi, Bangladesh

Lentil (*Len culinaris* Medikus subsp. *culinaris*) is an important pulse crop for human food, animal feed and in sustainable cropping systems of South Asia. Countries in South Asia, Bangladesh, India, Nepal and Pakistan together contribute nearly half, and consume about 70% of total global lentil production. However, the crop encounters

numerous biotic and abiotic stresses among which drought is most widespread. Lentil is generally grown under residual soil moisture after monsoon season in South Asia, and the crop frequently suffers from terminal drought. In the context of changing climate, lentil like many other winter crops faces combined effects of heat and drought, which can cause substantial yield loss annually. Lentils in South Asia have narrow genetic base with respect to morphological, agronomic and stress tolerant traits. The national programs of South Asia region have strong collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA) in lentil improvement. ICARDA with its global mandate on lentil improvement is engaged in research to address these stresses through agronomic and genetic means, and the products are being shared with the national programs. Through laboratory and field screening techniques, the Center has identified appropriate germplasm from its large collection of > 11000 cultivated lentil and wild accessions from 72 countries. Targeted utilization of these materials in genetic enhancement research has resulted in the construction of new genotypes with enhanced resistance to drought through various of mechanisms, including escape, dehydration avoidance and dehydration tolerance.

ICARDA uses its dry research site, Breda, which experiences <200 mm average annual rainfall, to screen genotypes in large-plots. In 2008, some of the breeding lines produced 700-800 kg/ha seeds under <165 mm rainfall with terminal water and heat stress. The promising lines have been delivered to national programs through international nursery network. Several productive varieties under water stress conditions have been released in Bangladesh, Nepal and Pakistan, a number of advanced lines are in the All India Coordinated Trials in India. These have early seedling vigor, fast ground coverage, early maturity, robust tap and lateral root systems, high biomass development, and an ability to adapt under mixed cropping, inter-cropping and no-till production systems. Yield stability with acceptable production potential under drought stress of these cultivars and high market price of lentil has

encouraged farmers to expand lentil production in the region.

ICARDA continues this effort in collaboration with national partners to further develop heat and drought tolerant cultivars and matching production technologies to fit lentil in new cropping systems niches arising in the context of climate change and farmer's and consumers' demands.

30. Differences in response to water deficit stress among some lines of chickpea

Henda Mahmoudi¹, N. Ben Hmida Labidi², and C. Abdelly²

¹Visiting Scientist, International Center for Biosaline Agriculture, P. O. Box 14660 Dubai United Arab Emirates, e-mail: hmj@biosaline.org.ae; ²Laboratoire des Plantes Extrêmophiles, CBBC, BP 901, Hammam-Lif, 2050, Tunisia.

Five lines of Tunisian cultivars of chickpea (*Cicer arietinum* L.), inoculated with *Mesorhizobium ciceri* UPMCa7, were cultivated during the vegetative stage on sterilized sandy soil. Two levels of soil moisture were compared (100 or 33% of field capacity). The work aimed at assessing the relative tolerance of these lines to drought and then, to study the relationships between the degree of sensitivity of plant growth and the N content to drought and traits characterizing the nodules. Water stress limited plant growth, leaf number and chlorophylls content in the leaves, and nitrogen fixation. The reduction in N₂ fixation was because of the increase in nodule mortality and restriction of nodule growth resulting in decrease of nodule biomass per plant. All these effects were statistically significant. However, inter-varietal differences for water stress effects were limited to change in plant biomass relative to control (but not in absolute biomass); change in root to shoot ratio; loss of chlorophylls; and nodule mortality. The physiological importance of these results and their putative agricultural implications are discussed.

31. Engineering antioxidants in transgenic potato (*Solanum tuberosum* L.) confers greater tolerance to various environmental stresses

Amin Elsadig Eltayeb¹, Mohamed Elsadig Eltayeb Habora², Hisashi Tsujimoto³ and Kiyoshi Tanaka⁴

¹Arid Land Research Center, Tottori University, Hamasaka 1390, Tottori, 680-0001, Japan; e-mail: eltayeb@muses.tottori-u.ac.jp; ²Laboratory of Plant Biotechnology, Faculty of Agriculture, Tottori University, Koyama Minami 4-101, Tottori 680-8553, Japan, e-mail: mohamed_elsadig@yahoo.com; ³Laboratory of Plant Genetics and Breeding, Faculty of Agriculture, Tottori University, e-mail: tsujim@muses.tottori-u.ac.jp; ⁴Laboratory of Plant Biotechnology, e-mail: jotanaka@muses.tottori-u.ac.jp

Environmental stresses such as drought, salt and heavy metals are known to accelerate the accumulation of reactive oxygen species (ROS) in plant cells. ROS are capable of unrestricted oxidation of many cellular components and can lead to oxidative destruction of the cells. Low molecular weight antioxidants such as glutathione (GSH) and ascorbate (AsA) are considered of paramount importance in preventing and controlling the dangerous affects of ROS. In order to maintain greater protection against environmental stresses, we developed transgenic potato (*Solanum tuberosum* L.) overexpressing either *Arabidopsis thaliana* glutathione reductase gene (*AtGRI*) or dehydroascorbate reductase (*AtDHAR1*). The GR transgenic potato maintained up to 6.5 folds higher GR activity, 5.8 folds glutathione (GSH) contents and up to 2.2 folds higher glutathione *S*-transferase activity compared to non-transformed plants (NT). Interestingly, while the GR transgenic plants exhibited decreased dehydroascorbate reductase (DHAR) activity, the relative reduced ascorbate (AsA) contents were higher while the relative dehydroascorbate (DHA) were lower compared to NT which provide a support to the hypothesis that an active glutathione-independent pathway for DHA reduction might exists *in vivo*. These GR transgenic plants maintained an enhanced tolerance to methylviologen, and cadmium. When subjected to drought stress, the transgenic plants exhibited faster recovery with less visual injury compared to

NT. On the other hand, DHAR transgenic potato maintained up 5 folds higher DHAR activity and exhibited greater tolerance to methylviologen, drought and salt stresses. These results suggest that manipulation of either glutathione or ascorbate levels provides reliable strategy for the development of industrial transgenic potato plants with enhanced tolerance to multiple environmental stresses.

32. Identification and expression analysis of salt and drought stress responsive genes from *Leymus mollis*, a coastal wild relative of wheat (*Triticum aestivum*)

Mohamed Elsadig Eltayeb Habora¹, Amin Elsadig Eltayeb², Hisashi Tsujimoto³ and Kiyoshi Tanaka⁴

¹Laboratory of Plant Biotechnology, Faculty of Agriculture, Tottori University, Koyama Minami 4-101, Tottori 680-8553, Japan, e-mail: mohamed_elsadig@yahoo.com; ²Arid Land Research Center, Tottori University, Hamasaka 1390, Tottori, 680-0001, Japan, e-mail: eltayeb@muses.tottori-u.ac.jp; ³Laboratory of Plant Genetics and Breeding, Faculty of Agriculture, Tottori University, e-mail: tsujim@muses.tottori-u.ac.jp; ⁴Laboratory of Plant Biotechnology, e-mail: jotanaka@muses.tottori-u.ac.jp

The dune grass *Leymus mollis* (Triticeae; Poaceae) is a wild relative of wheat (*Triticum aestivum*) and grows mainly along sea coasts and in inland dry areas. *L. mollis* is characterized as significantly tolerant to salt and drought stresses, resistant to diseases and adaptive to harsh environmental conditions. Despite its high tolerance to multiple environmental stresses, the genetic bases that control the biochemical and physiological response to salt and drought stresses in *L. mollis* remain largely unexplored. We used subtractive subtraction hybridization (SSH) to identify salt and drought stress responsive genes from *L. mollis*. Fifty nine genes were identified and confirmed to be differentially regulated. Allene oxide cyclase (AOC) and methyljasmonate induced lipoxygenase (LOX) genes were among the highly responsive genes under salt stress, while chloroplast inositol phosphatase (CIP), phosphoethanolamine

methyltransferase (PEAMT), ETTIN-like auxin response factor (ARF) and an unknown gene were among the highly regulated genes under drought stress. These genes were also shown to be differentially expressed in response to jasmonic or abscisic acid. Southern blot analysis indicated that *L. mollis* genome has higher number of the isogenes for PEAMT, CIP and ARF compared to that found in the Chinese spring wheat. Since the PEAMT is involved in the biosynthesis of the glycine betaine (GB), we analyzed the contents of GB in *L. mollis* under salt stress. An increased accumulation of GB was observed which indicates the important role of PEAMT in salt stress tolerance in *L. mollis*. Identification of these genes provides insights into the mechanism of salinity and drought tolerance in *L. mollis*. Furthermore, these genes represent important genetic resources for wheat improvement.

33. Collection, characterization and identification of drought, salinity and heat tolerant *Sinorhizobium* nodulating alfalfa for adaptation to climate change

Imane Thami-Alami^{1*} and Sripada M. Udupa²

¹Institut National de la Recherche Agronomique (INRA), Centre Régional de la Recherche Agronomique de Rabat, B.P. 415, Rabat, Morocco, e-mail: thamialami_ma@yahoo.fr; ²ICARDA-INRA Cooperative Research Project, International Center for Agricultural Research in the Dry Areas (ICARDA), B.P. 6299, Rabat, Morocco, e-mail: s.udupa@cgiar.org

The gram-negative bacteria *Sinorhizobium meliloti* and *S. medicae* are able to interact with roots of alfalfa to form nitrogen-fixing nodules and survive

as a free living saprophytic bacterium in the soil. The host, alfalfa is the most important forage legume crop in the arid and semi-arid areas of Morocco and North Africa. In these areas, alfalfa is grown in marginal soils and frequently subjected to drought, extremes of temperature and high or low soil pH, soil salinity and heavy metals, which affect biological nitrogen fixing ability of rhizobia and productivity of the host. In this study, we examined physiological diversity of the sampled isolates from marginal soils of arid and semi-arid regions of Morocco for tolerance to the above stresses, molecular genotypic diversity at Repetitive Extragenic Palindromic DNA regions of *Sinorhizobium* nodulating alfalfa, and biological nitrogen fixing efficiency of some of the tolerant isolates. The study revealed that out of the 157 sampled isolates, 136 isolates were identified as *S. meliloti* and the rest as *S. medicae*. Further phenotyping of these alfalfa rhizobia for tolerance to the environmental stresses revealed a large degree of variation: 55.41%, 82.16%, 57.96% and 3.18% of the total isolates were tolerant to NaCl (>513mM), water stress (-1.5 MPa), high temperature (40°C) and low pH (3.5), respectively. Sixty-seven isolates of *S. meliloti* and thirteen isolates of *S. medicae* that were tolerant to salinity were also tolerant to water stress. Most of the isolates of the two species showed tolerance to heavy metals (Cd, Mn and Zn). The phenotypic clusters observed by the cluster analysis clearly showed adaptations of the *S. meliloti* and *S. medicae* strains to the multiple stresses. Genotyping with rep-PCR revealed higher genetic diversity within these phenotypic clusters and classified all the 157 isolates into 148 genotypes. Some of the tolerant strains were also efficient in biological nitrogen fixation. Therefore, these tolerant strains have a great potential for exploitation in salt and drought affected areas for BNF in alfalfa and also for adaptation to climate change.

Theme 5: Blending indigenous/traditional knowledge and heritage with modern science

1. Climate change and local adaptation strategies in the Middle Inner Mongolia, northern China

Shulin Liu* and Tao Wang

*Key Laboratory of Desert & Desertification, Chinese Academy of Sciences; Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences, Lanzhou 730000, China; *e-mail: liusl@lzb.ac.cn*

According to records of 17 meteorological stations located in the study area, climate change of middle Inner Mongolia in northern China was analyzed in this paper. Based on SPOT VGT data, and combined with field investigation, local vegetation change was detected in the last 10 years. The results show that local climate trend has been towards warm-dry conditions during the last 50 years. Air temperature increased by $0.318\text{ }^{\circ}\text{C}10\text{y}^{-1}$ during 1960-2009 and by $+0.423\text{ }^{\circ}\text{C}10\text{y}^{-1}$ during 1980-2009, while precipitation decreased by $-2.91\text{ mm}10\text{y}^{-1}$ and $-8.85\text{ mm}10\text{y}^{-1}$ during the respective periods. Yearly cumulative NDVI value and yearly NDVI maximum showed huge fluctuation during the last 10 years, especially continuous lower vegetation cover in the western Sonid Steppe Region. With annual mean wind speed decreasing since 1970s, sand-dust storm events decreased till 1990s, but the frequency and intensity of these has increased in the recent decade. Frequent droughts and dust-storms have also seriously affected local pasture and grazing activities, and often resulted in heavy economic loss, especially during the drought period of 1999-2001. To face the drought disasters and strong dust-storms, the local authorities put forward the 'enclosing-transferring' strategy and made great efforts to adapt to the climate change and avoid further environmental deterioration. The efforts included selective emigration, decreasing livestock numbers, fencing grasslands and building forage production bases with efficient irrigation system, and actively adjusting the industrial

structure. However, the effects and some potential problems of this adaptation strategy need to be explored further in the longer term for different sub-regions.

2. Adaptation of mountain villages to glacier loss – pilot research in western Tajikistan

Stefanie Christmann¹ and Aden Aw-Hassan²

¹International Center for Agricultural Research (ICARDA), CAC Regional Program, Tashkent, Uzbekistan, e-mail: s.christmann@cgiar.org; ²ICARDA, Aleppo, Syria, e-mail: a.aw-hassan@cgiar.org

All glaciers in western Tajikistan are forecasted to melt off within a few decades due to climate change. The World Bank regards Tajikistan as the most vulnerable country of all the East European and former Soviet Union countries mostly due to lack of adaptive capacity. In 2010 a case study in two mountain villages in Zerafshan region showed high potential to increase adaptive capacity. Though both villages did not refer to climate change in their efforts to improve livelihoods before, each village developed comprehensive, ambitious and realistic short term and long term action plans within a participatory research project. The local strategies include (1) means to increase skills on all relevant levels for both women and men, (2) environmental adaptation, (3) economic alternatives and (4) management instruments. In one village for the first time men and women joined in meetings and worked together. Realization of the risk for the livelihoods and the need for skills resulted in readiness to improve women education and their participation in decision making. Interviews later confirmed the commitment to collective action and equity.

At present, mountain villages lose time to build capacity and to adapt, because the *research* focuses on mapping and modeling, and specific aspects like disaster prevention instead of directly addressing the local communities as key players of an imminent climate-induced shock: from plenty

of water to scarcity within one generation. What is needed are: (1) best practices for capacity building, collective action and collective management, (2) glacier specialists and experts to identify sites and plan construction of water catchments in adequate number, (3) technology packages for mountain slopes, diversification of agricultural production, (4) strengthening market value chains, (5) measures to prevent loss of biodiversity on high altitude.

As the migration from mountainous areas would increase due to low income in the agricultural sector, there will be more impediment for the implementation of adaptation measures because of the lack of male labor force. Adaptation to climate change therefore must go in line with making mountain agriculture more profitable. Otherwise abandoned mountainous areas will cause reduction of agricultural area and production, loss of biodiversity and social and possibly political tension in the areas of resettlement. Research for development therefore might focus on local communities, expand socio-economic research and develop a future oriented agriculture-based strategy for dry mountainous areas.

3. Performance assessment of farmers' management for tertiary level irrigation in arid region – a case study of irrigation improvement in Egypt

Ahmed Mohsen Aly¹, Y. Kitamura² and K. Shimizu³

¹The United Graduate of Global Arid Land Sciences, Tottori University, 680-8553, Tottori, Japan, e-mail: ahmed_mohsen_mando@yahoo.com; Researcher Assistant (Civil Engineer), National Water Research Center, 13621/5, Delta Barrage, Egypt; ²Laboratory of Water Use and Management, Agriculture Faculty, Tottori University, e-mail: ykita@muses.tottori-u.ac.jp; ³Laboratory of Water Use and Management, Agriculture Faculty, Tottori University, e-mail: shimizu@muses.tottori-u.ac.jp;

Arid and semi-arid regions are characterized by little rainfall and severe water scarcity that is being exacerbated by climate change. A trend for decrease in rainfall is affecting the overall hydrology and water resources in the arera.

A typical example is the Nile River Basin where runoff variability in upstream countries is of great importance to the sustainable development of downstream countries such as Egypt. The increase in water demand of upstream countries in the Nile Basin, coupled with the impacts of climate change, can affect the availability of water resources for the downstream countries. Egypt, therefore, faces the challenge of dealing with reduced availability of water resources by applying policies to improve the performance of the water supply system and its development.

The Irrigation Improvement Project (IIP) is one of the most important attempts in Egypt to implement more effective on-farm irrigation technologies for modifying traditional irrigation system and saving water by improving the existing delivery system in the Nile Delta over a total area of about 1.05 million ha by 2017.

This study aims to evaluate the irrigation system after the improvements brought about by IIP and to determine its impact on water delivery performance on tertiary canal and farmer's practices in the field by comparing with other unimproved system using a set of performance indicators.

Results show that the IIP project generally has a positive effect on farmer's practices. The duration of irrigation has been reduced by about 30% - 50% for major crops at different locations in the irrigation system as compared to the unimproved system. In addition, there has been an increase in the production of main crops by about 6% - 20% with the improved system. This can partly be contributed to the formation of water user associations and their successful management and operation of water supply and distribution network.

4. Economic benefits of integrating forage shrubs in dryland agricultural systems: an Australian case-study

Marta Monjardino, D. Revell, and D. Pannell

CSIRO Sustainable Ecosystems, Private Bag 2, Glen Osmond SA 5064, Australia, e-mail: Marta.Monjardino@csiro.au

In face of climate change and other environmental challenges, one strategy for incremental improvement within existing farming systems is the inclusion of perennial forage shrubs. In Australian agricultural systems, this has the potential to deliver multiple benefits: increased whole-farm profitability and improved natural resource management.

The profitability of shrubs was investigated using Model of an Integrated Dryland Agricultural System (MIDAS), a bio-economic model of a mixed crop/livestock farming system. The modelling indicated that including forage shrubs had the potential to increase farm profitability by an average of 24% for an optimal 10% of farm area used for shrubs under standard assumptions.

The impact of shrubs on whole-farm profit accrues primarily through the provision of a predictable supply of ‘out-of-season’ feed, thereby reducing supplementary feed costs, and through deferment of use of other feed sources on the farm, allowing a higher stocking rate and improved animal production.

The benefits for natural resource management and the environment include improved water use through summer-active, deep-rooted plants, and carbon storage. Forage shrubs also allow for the productive use of marginal soils. Finally, we discuss other, less obvious, benefits of shrubs such as potential benefits on livestock health. The principles revealed by the MIDAS modelling have wide application beyond the region, although these need to be adapted on farm and widely disseminated before potential contribution to Australian agriculture can be realized.

Theme 6: Socioeconomic, institutional and policy considerations

1. Alternative futures: Community involvement in planning and policy in the Southwestern United States with reference to climate change and water

David Mouat¹, S. Bassett², P. Marin¹, J. Lancaster¹, and S. Thomas¹

¹*Desert Research Institute, Reno, NV 89512, USA; e-mail: dave.mouat@dri.edu; pablo.marin@dri.edu; judith@dri.edu; scott.thomas@dri.edu;* ²*University of Nevada, Reno, NV 89557, USA, e-mail: sbassett@unr.edu*

The Southwestern United States is a patchwork of desert and agricultural ecosystems; of expanding cities and rural economies – and has one of the fastest growing populations in the nation. Land use patterns, human lifestyles and social institutions are changing, and the pressure on natural resources, particularly water, is extreme as different interest groups negotiate the “lions share” for their benefit. Tightly controlled in terms of planning and with a proliferation of policies covering many aspects of life, the effects of climate change in this semi-arid to arid region are sufficiently uncertain as to be factored out of many management and policy decisions.

Community involvement in identifying driving forces for change and critical uncertainties – such as climate change - which are outside human control, leads to the development of descriptive scenarios of possible alternatives for future urban growth. The spatial and temporal manifestations of the scenarios are alternative futures – and modeling their respective impacts on a suite of variables encompassing natural and human systems form the core of a recent study in the Southwestern US. The impacts of selected scenarios on the availability of water and other natural resources show the potential power of alternative futures analysis. The consideration of alternative futures and their

potential impacts assists communities at local and regional level plan for change, and develop policies which enhance resilience of both social and natural systems in the face of climate change and its potential socioeconomic and environmental effects. While the case study concerns a portion of the United States, the techniques should be of value to other regions.

2. Managing drought in Indian arid zone: Future strategies

Murari M. Roy

*Central Arid Zone Research Institute, Jodhpur (Rajasthan) – 342003 India;
e-mail: mmroyster@gmail.com*

Droughts in India are mainly due to various kinds of failures of rains from south west monsoon. The arid zone of the country is the most vulnerable to drought, now the probable frequency being once in two years. The drought for the three consecutive years during 1998, 1999 and 2000 is a fresh reminder of the likely impacts of climate change on agriculture and society. The earlier approaches to combat drought mainly focused on measures of employment generation through relief works. The budgetary allocations under various centrally sponsored schemes have also some role in reducing the impacts and severity of droughts. In view of above, it is now extremely relevant to work out appropriate adaptation strategies on short and medium to long term. The important measures include use of modern tools of information technology to arrive at precise warning systems to forecast drought. Altered agronomy of crops through small changes and cultivation of altered crops or cultivars more adapted to changed environment will lead to ease the pressures. Practicing resource conserving technologies that enhance efficiency of water and fertilizers on one hand and restrict release of soil carbon in the atmosphere is very important.

For drought proofing the region, the medium to long term strategies should aim at creating

resilience or robustness by measures like securing good quality water, collection and conservation of rain water, joint management of forest and arable lands in forest fringes, promotion of perennial vegetation, improved livestock management and exploitation of under-exploited and under-utilized plant species. As the problems of tackling drought are complex, multi-institutional and multidisciplinary resource building approaches with farmer at the centre are the basic requirements. Similarly, drought prone communities, villages, and the areas have to learn to adopt and sustain drought proofing methodologies.

3. Policy and institutional impact on sustainability of highland agricultural system in Iran and recommended strategies

Abbas Keshavarz¹ and H. Dehghanisanij²

¹Senior Irrigation and Water Management Scientist, Tehran, Iran, e-mail: keshavarz1234@yahoo.com ; ²Irrigation and Drainage Department, Agricultural Engineering Research Institute (AERI), P.O. Box 31585-845. Karaj, Iran, e-mail: dehghanisanij@yahoo.com

Agricultural development has been among key policies and strategies during four cultural, social and economic programs conducted in Iran over the period of 1989-2009. Agricultural production considerably increased over this period, except in very dry and unfavorable seasons. The highland dryland agriculture areas are facing multiple challenges that are both interrelated and interactive. High food demand, food insecurity, and population growth rate are important challenges. In this paper, the impact of climate change on irrigated and rainfed crop-livestock farming systems, gender issue, rural population (socio-demographic), and features of households of highlands in terms of livelihood sources and poverty are examined and the strategies for better use of highland areas under drought are discussed. There are specific policies that directly affect the livelihoods of rural households in the highland rural areas. Study showed that wheat production increase during

the period from 1993 to 2007 was partly due to the government policy to promote agricultural development through financing facilities, development of research, and implementation of technical and supportive programs that emphasized productivity per unit water rather than land. Research priorities for the future are presented, considering severe climatic limitation in highland rainfed areas, and the prevailing biotic and abiotic stresses that constrain productivity of and crop production and horticulture.

4. Intensification of small ruminant production is essential to save rangelands – a case study of Syria's drylands

Farouk Shomo and Aden Aw-Hassan

International Center for Agricultural Research in the Dry Areas (ICARDA), PO Box 5466, Aleppo, Syria; e-mail: f.shomo@cgiar.org; a.aw-hassan@cgiar.org

There has been significant growth in the small ruminant population and production in WANA during the last three decades. The production growth is attributable to improvement in veterinary services, provision of feed subsidies and credit to producers, increased use of alternative feed sources, and progressive intensification of production. Consumption growth has occurred because of the increase in per capita real income, urbanization and population growth. The environmental impacts associated with the expansion of small ruminant production, in terms of rangeland degradation, are an important public concern. Technological improvement and policy changes are necessary for further improvement in the performance of the small ruminant sector to ensure that poor small producers get better productivity and better income. A case study was conducted in Syria's dry areas to determine sources of technical inefficiencies in order to improve sheep performance. A random sample of sheep producers was surveyed. Based on sheep movement, four production systems were identified; migratory, transhumance, semi-sedentary, and sedentary. The survey data was

analyzed using a single-stage model for estimating the technical inefficiencies of each production system and its determinants. Technical efficiency ranged from 0.67 to 0.97, with considerable variation within each of the four production systems. The sedentary production system was the most efficient, and the migratory system the least efficient. The major factors causing inefficiencies included high abortion rate, low fertility, high lamb mortality, and long distances to water sources and markets. Improving the physiological conditions of the sheep and selecting an appropriate system of sheep production, according to the location of the farm, would improve efficiency of the sheep production substantially. Producers should be encouraged to shift to more intensive systems.

5. Grassland conservation in China reviewed from the standpoint of environmental and ecological economics

Kunio Hamamura¹ and Wenjun Han²

¹Formerly Scientist at the Arid Land Research Center (ALRC), Tottori University, Tottori, Japan; e-mail: hamakuni05@aol.com; ²Grassland Research Institute, Chinese Academy of Agricultural Sciences, Huhhot, China

In Inner Mongolia, China, grasslands have been degraded because of overgrazing, mining activities, vehicles running, and the impact of tourism and other human activities. In total, 59% (46.7Mha) of grasslands were degraded (11% - severely, 37% - at medium level and 52% - slightly). The increase in goat rearing to get cashmere fiber has been said to intensify degradation because goats tend to eat up even the grass roots. To conserve the grasslands, Chinese government established grassland law first time in 1985 and revised it in 2002. Revised law intends, among other things, to fix the carrying capacity of the livestock on the grassland. The targets of carrying capacities are to be fixed dependent on the local situations. Although, it is a big progress to establish the targets of livestock number basing on any scientific data, the strict control may be difficult to implement because the herders may not be willing to follow the regulation

without any compensation. The carrying capacity figures vary by region, year, season, animal species, productivity of grassland, the degree of outsourcing of feed and other factors. The situation after the implementation of the law are reviewed with special emphasis on the environmental economics and ecological economics.

6. Rangelands deterioration and sheep production

Oula Kanawaty and Farouk Shomo

International Center for Agricultural Research in the Dry Areas (ICARDA), PO Box 5466, Aleppo, Syria; f.shomo@cgiar.org

Livestock production sector contributes about 36% of total agricultural production in Syria. It is a main source of income for rural population, especially in remote areas. The extensive sheep production system is dominant in dry areas. To meet the increasingly demand and to increase their income usually sheep producers increase their production

by increasing flock size. Increasing national flock has increased the pressure on rangeland and over grazing is one reason of rangeland deterioration and it has a negative impact on the environment. The climate change is exacerbating the degradation. In the 1950s rangeland provided about 50% of total sheep diet, while in recent years it provides only about 10%. In recent years demand on livestock product is increasing and prices of dairy products and live animals are increasing but the income of the producers is not increasing, which indicates a problem in marketing system. A market study was conducted to the study marketing chains, constraints, opportunities and pathways for small producers to market their products in better way. A trend analysis of sheep population, meat production and consumption indicated that sheep population grew rapidly and it reached unexpected number even over the planned number estimated by the Syrian Ministry of Agriculture. Increasing producers' income through better marketing system and by intensification of sheep production will have better impact on rangelands, natural resources and the environment.

Poster Presentations

1. Indigenous knowledge of water harvesting for sustainable rainfed farming systems in North Yemen

Ahmed Al-wadaey¹ and Abdulrahman Bamatraf²

¹*Integrated Water and Land Management Program, International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria, e-mail: A.AL-Wadaey@cgiar.org;* ²*Sana'a University, Soil and Water Department, College of Agriculture, Sana'a, Yemen; e-mail: ambamatraf@yahoo.com*

Over centuries, Yemeni farmers have used traditional water harvesting methods to manage scarce water resources, ensuring long-term sustainability through demand management and adequate resource replenishment. However, these methods – despite being effective and cost-efficient – are either in decline or have been completely abandoned. In Sadah Basin, North Yemen, farmers use a unique traditional rainwater harvesting system. Grapes are planted in deep trenches (1-2 m deep, 5-20 m long). Runoff from different catchment areas (mountains, streams, arable flat land) is diverted, through centuries-old runoff-management structures, to the grape trenches. These techniques ensure land sustainability, especially in severe dry seasons when runoff is insufficient for crop needs. The objectives of our study were to better understand the functioning of this traditional system, document the indigenous knowledge that is being abandoned and identify the most important socioeconomic factors that have an impact on the system: ownership rights of catchment and cultivated land, and priority rights to runoff water, firewood, and grazing land. Hydrological and socioeconomic assessments were done and criteria for ownership/priority categorized. Three areas in Sadah basin (Majz, Wadeah and Dammaj) were covered. Information was collected through a survey of 62 farmers in the area to get farm assessment. Measurements of hydraulic structures that divert runoff; and hydrological estimation of runoff depth, volume and rainfall depth during rainstorms were done. The system delivers sufficient runoff to grape farms, and the trenches maintain soil moisture, reduce surface evaporation, and increase yield. Hydraulic

structures are fairly well designed, in relation to land ownership in the catchment and cultivated areas. Proper maintenance of this water harvesting system will improve its efficiency; farmers' livelihoods, and the productivity and sustainability of rainfed farming systems in Yemen.

2. Improving water productivity for high value crops under protected agriculture in Emirates

Ahmed T. Moustafa¹, Arash Nejatian², Hamalan Abu Al Kabash³

¹*Regional Coordinator, International Center for Agricultural Research in the Dry Areas (ICARDA), e-mail: a.moustafa@cgiar.org;* ²*Activities Coordinator officer, ICARDA, e-mail: a.nejatian@icards-aprp.ae;* ³*Agricultural Engineer, Al Hamranieh Research Station, Ministry of Environment and Water, UAE*

ICARDA organized a comparative study during the 2009/2010 season, in collaboration with NARS in UAE, to compare and demonstrate the productivity of tomato crops in hydroponics and conventional soil base production system under greenhouse condition at Al Hamranieh Research Station where tomato crops were planted in three 240m² non-cooled greenhouses (GHs). Two GHs were equipped with soilless production system while the third one had the conventional soil system and served as a control. Two mixtures of coco peat and perlite (1:1 and 2:1) were used as growing media for hydroponics systems. Water meters were installed for all GHs. The planting was done on 18 Nov 2009 and crop lasted until 15 April 2010. The average yield of tomatoes in 1:1 and 2:1 media, reached to a peak of 12.5 and 12.1 kg/m² while in soil this figure was only 6.5 kg/m². On the other hand, water productivity peaked at 48 and 46 kg/m³ for soilless system with 1:1 and 2:1 media, respectively, compared to 7 kg/m³ in soil. The fertilizer consumption in soilless systems was considerably less than in the soil system. Each soilless GH used a total of 83.5 kg of fertilizer (including NPK, Ca(NO₃)₂, MgSO₄, Fe and trace elements) against 102 kg of NPK and

Trace elements used in GH with soil system, where one metric ton of organic manure was also applied before planting. The results clearly established the superiority of the soilless system over the conventional soil culture.

3. Root development and carbohydrate reserves as related to persistence of some desert grasses

Ahmed E. Osman*¹ and W. Tsuji²

*¹Pasture and Range Ecologist, Arabian Peninsula Regional Program, ICARDA, Dubai. Current address P.O. Box 3369, Khartoum, Sudan. E-mail: goldentulipsudan@yahoo.com;
²Assistant Professor, Arid Land Research Center, Tottori University, Japan. E-mail: tsun@alrc.tottori-u.ac.jp

Buffel grass (*Cenchrus ciliaris* L.), also called Labeid, Dakhna (*Coelachyrum piercei* Benth. Bor) and Da'ay (*Lasiurus scindicus* Henr.) from the United Arab Emirates together with one commercial species, Rhodes grass (*Chloris gayana* Kunth.), were grown under controlled environment of a green house at the Arid Land Research Center, Tottori University, Japan, during 2007-2008. The grasses were sown in PVC pots (22 cm-diameter and 110 cm height) filled with sandy soil to 100 cm depth. The pots received 2.4 g fertilizer containing NPK (13:13:16) plus 1.6 g micronutrients mixture and 4.0 g Calcium Hydroxide before grasses were transplanted on July 31, 2007. The pots were irrigated daily with 150, 100, 50 and 50 ml tap water during four growth cycles of 35, 37, 51 and 35 days, respectively. The grasses were harvested at the end of each growth cycle, oven dried, and weighed. After the fourth harvest, 12 pots (three for each species) were cut each horizontally into four strata (25 cm), the soil washed and roots collected. Additionally 4 pots, representing the four species were cut vertically and whole roots were collected. The roots were oven dried (80 °C), weighed, ground and used for carbohydrates (NSC) analysis.

Rhodes grass and buffel grass maintained the highest dry matter yield throughout the study with no significant difference between them. This was

matched by Dakhna in the first growth cycle only. Recovery after harvest became weak for Dakhna and Da'a starting the second growth cycle and stopped completely in the third and fourth cycles. Rhodes and buffel grass showed the most extensive root development in the soil profile, explaining their persistence and high productivity. The highest root accumulation for all the grasses was found on the top and bottom strata. Rhodes grass and buffel grass were also the highest in total NSC in their roots over the other two grasses.

4. Accumulation of quaternary ammonium compounds in plant species growing in around Taklamakan desert of XinJiang region, China

Ailijiang Maimaiti*, N. Yamanaka², F. Yamamoto¹, N. Mori¹, and Q. YuNuSi³

¹The United Graduate School of Agricultural Sciences, Tottori University, 4-101 Koyama-Minami, Tottori, 680-8550, Japan; *e-mail: ailijan@alrc.tottori-u.ac.jp;
²Arid Land Research Center, Tottori University, 1390 Hamasaka, Tottori, 680-0001, Japan;
³XinJiang Agricultural University, No 42 Nanchang road, Urumuqi, 830052, China

As a consequence of global warming, climate change-induced shifts in precipitation and evaporation patterns, environmental conditions such as drought and salinity are likely to increase in arid and sub-arid areas. However, from the standpoint of biological adaptation to environment, some plants are tolerant to such stresses. Hence, there is interest in understanding adaptation to stress that have naturally evolved in plants. Synthesis and accumulation of organic solutes such as quaternary ammonium and amino acids in response to stress is a common adaptation found in plants. Betaines are quaternary ammonium compounds and they are known to be one of the major osmoregulating substances in the tissue. Among them, glycine betaine (GB) is the most widespread in plants and bacteria. Other betaines, β -alanine betaine (AB), and γ -butyrol betaine (γ -BB) have also been known to be present in some

plant species. The present research aimed to assess the osmoprotectant accumulation of plants growing in unfavorable conditions as it could be associated with the resistance to abiotic stress in those plants. Plant leaves of 27 species were collected in XinJiang, China, dried at 80°C and pulverized prior to extraction of betaines. Betaines were determined using capillary electrophoresis. The results showed that GB was detected in many species. Plant species of Chenopodiaceae family, such as *Halostachys caspica*, *Kalidium foliatum* in saline soil, and *Haloxylon persicum* in sandy desert, accumulated high concentration GB. Significantly high concentration of AB was determined in *Capparis spinosa* (Capparaceae) growing in drought condition. In addition, some species also synthesised γ -BB, but only at low concentrations. The results clearly indicated that betaines serve as a compatible solute and osmoprotectant in some xero-halophyte species under various abiotic stresses.

5. Challenge of concurrent biofuel and food production - a case study of *Jatropha* cultivation by small scale farmers in Mexico

Ando Takayuki

Arid Land Research Center (ALRC), Tottori University, 680-0001 Hamasaka, Tottori, Japan; e-mail: andota@alrc.tottori-u.ac.jp

The production of biofuels has been increasing rapidly to combat global warming and addressing depletion of fossil fuels by setting up the biofuel introduction targets in European countries and others. In 2008, food prices were 64% above the levels of 2002, partly attributed to diversion of food crop area to producing feedstocks for biofuels because of the growing demand of biofuels. Potential negative impacts on society and environment, such as buy up farm land, depletion of water resources, biodiversity loss, etc., have revealed and criticisms of large-scale biofuel plantations have mounted.

To cope with this situation, a statement on Global Food Security was issued in Hokkaido Toyako Summit in 2008 to develop biofuels from non-food plant materials and inedible biomass to ensure the compatibility of policies for the sustainable production and use of biofuels with food security. Further, efforts have been accelerating to produce biofuels without damaging environment and society by studying sustainable biofuel standards or criteria. As a result of the Deepwater Horizon explosion in the Gulf of Mexico this April, demand for biofuels will rise than before as a part of the transition to clean energy by the new USA administration. So, it is urgent issue to establish cultivation system of biofuel plants without adverse social and environmental impacts. In Mexico, *Jatropha* (*Jatropha curcas* L.), biofuel feedstock plantation started by small scale farmers in 2008 with government support. There are diverse cultivation methods; however, the basic idea is to produce not only biofuel feedstock but also food by mixed cropping system of *Jatropha* with crops such as corn and beans. Outline of the concurrent *Jatropha* and crop production system will be presented.

6. An estimation of the probability distribution of Wadi Bana flow in the delta Abyan of Yemen

Khader B. Atroosh¹ and Ahmed T. Moustafa²

¹ *Irrigation and Water Management Specialist, AREA, Elkod Agricultural Research Station, Abyan, Yemen ; e-mail kbatroosh@hotmail.com;* ² *Protected Agriculture Specialist, ICARDA, APRP, Dubai, EAU, e-mail: a.moustafa@cgiar.org*

Wadi Bana is one of the main wadies in Yemen, where different quantities of water reach the Delta, depending on the amounts of rainfall in the wadi watershed. In order to estimate the spate water flow distribution probability, data on water flow were collected during the period from 1948 to 2008. Chi-square test was significant for autumn and summer seasons. The annual maximum runoff was 286.6 million m³ in the 1957 and the minimum runoff was 30.4 million m³ in 1974. The estimated flow

during wet, medium and dry years were 103 to 134, 76 to 103 and 55 to 76 million m³, respectively, for autumn season and 52 to 81, 29 to 52 and 15 to 29 million m³ respectively, for summer season. The flow in autumn season accounts for about 70% of total annual flows.

7. Importance of improved wheat varieties for enhancing the adaptive capacity of agro-ecosystems to climate change

Ayman Al-Ouda

Conservation Agriculture Program, Plant Resources Department, The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria. P.O. Box: 2440; e-mail: aymanalouda@yahoo.com

A field experiment was conducted under rainfed condition at Izra'a Research Station, during the two growing seasons, 2007-2008 and 2008-2009, to evaluate the response of 19 ACSAD lines and varieties of bread wheat (*Triticum aestivum* L.) to identify the most drought tolerant-high yielding genotypes, which could be used in crop improvement to develop cultivars better adapted to climate change under dry farming systems. Growth and physiological attributes such as leaf area index, flag-leaf area, leaf relative water content, and yield components and yield were studied.

Large variations were found. Genotypes ACSAD1163, ACSAD1135 ACSAD1123 ACSAD1149, and two cultivars 'ACSAD901' (improved Domma4) and 'Cham6' achieved significantly higher grain yield under drought and terminal heat stress conditions of the rainfed growing conditions at Izra.

These cultivars can be grown under such marginal conditions, and can be used as parents in the genetic improvement program for tolerance to drought and heat stresses which are going to be exacerbated because of the climatic changes.

8. Osmolyte accumulation in *Tamarix* species growing under various soil conditions in the Southwestern USA

Fumiko Iwanaga¹, S. Imada¹, T. Taniguchi¹, K. Acharya², N. Mori³, F. Yamamoto³, and N. Yamanaka¹

¹Arid Land Research Center, Tottori University, Hamasaka1390, Tottori, Tottori 680-0001, Japan; e-mail: fumiko.iwanaga@alrc.tottori-u.ac.jp; ²Desert Research Institute, 755 E., Flamingo Road, Las Vegas, NV89119, USA; ³Faculty of Agriculture, Tottori University, Minami 4-101, Koyama, Tottori, Tottori 680-8553, Japan

In the context of growing concerns about environmental changes, ecological sustainability and biodiversity are essential factors to acquire the function and productivity of ecological system. Though there are various environmental and anthropogenic factors affecting ecological changes, introduction of alien species would have significant influence on the local biodiversity, especially in arid and semi-arid areas, where the local species have been used as economical and environmental friendly species in agriculture or horticulture, landscape and living areas, and for conservation of environmental systems. In the Mojave Desert in the Southwestern USA, *Tamarix* spp. have shown progressive expansion in their distribution in riparian and lowland area, and have become dominant species inhibiting establishment of other native species. In recent years, these are a serious concern for managers of lentic or slow waters.

In the natural environment, plants often accumulate in their cells various metabolites that are of low molecular weight, highly soluble and non-toxic to tissues at high concentrations. These osmolytes or compatible solutes include betaines and related compounds, polyols, sugars, and amino acids. Their accumulation is regarded as one of survival strategies to dehydration stress. However, there is great variation among plant species in the respect of type and quantity of accumulated osmolytes. In the present study, we investigated osmolyte accumulation in *Tamarix* spp. under various soil conditions to clarify the mechanism of stress tolerance of this species.

9. Long-term effects of dust storms for nomads in Mongolia

Haosheng Mu^{1,*}, S. Otani², K. Onishi¹, T. Hosoda¹, M. Okamoto¹, and Y. Kurozawa¹

¹ Division of Health Administration and Promotion, Faculty of Medicine, Tottori University, 86 Nishi-cho, Yonago 6838503, Japan; * e-mail: muhs@med.tottori-u.ac.jp;

² Arid Land Research Center, Tottori University, Tottori 6800001, Japan

Rapid climate change in Mongolia has escalated the severity of dust storms and makes them a more serious hazard than ever before. Fifty-two people lost their lives and 320,000 animals were killed in the two-day dust storm of 26-27 May in 2008. This study aimed to assess long-term effects of dust storms for nomads in Mongolia. We performed a cross-sectional survey for QOL (quality of life) and subjective symptoms one year later (May 2009) from the above mentioned dust storm event. The study subjects were 45 inhabitants of the stricken area, comprising 22 men and 23 women with a mean age of 42.1 (SD \pm 12.9) years. They were the nomads living in Hentiy Prefecture, Mongolia. The data collection was done by a face-to-face interview with a questionnaire. The subjective symptoms included eye (itching, hyperemia, and lacrimation), nasopharyngeal (sneezing, nasal discharge, and congestion), respiratory (cough, sputum, breathlessness, and chest discomfort) conditions. QOL was assessed based on four subscales of a 36-item short-form health survey (SF-36). Four subscales are general health (GH), vitality (VT), mental health (MH), and role-physical (RP).

The subjects affected by the dust storm (victims group) were compared with those who were not (non-victims group). A multiple logistic regression and multiple regression analysis were used in the statistical analyses. There were 11 victims and 34 non-victims from total subjects in this study. The results of the comparison of the subjective symptoms showed that proportion of victims group was higher than non-victims group (non-significant). For QOL, the scores of all SF-36 subscales for victims group were lower than non-victims group. Moreover, multiple regression

analysis results showed statistically significant correlation between victims group and RP ($\beta = -0.260$, $P < 0.1$). In summary, as the long-term effects of dust storm for nomads, the possibility of the QOL decline was indicated.

10. Biodiversity conservation of multi-purposes species across the Libyan Mediterranean rangelands

Hassan Estita¹, Amin Khatib Salkini², Suleiman Belkhir¹ and Mounir Louhaichi^{2*}

¹Agricultural Research Center (ARC), Libya; ²International center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria; * e-mail: m.louaichi@cgiar.org

Rangelands make up an important part of the earth's surface area and are important feed source for livestock, habitat for wildlife, means for environmental protection and for the *in situ* conservation of plant genetic resources. Nevertheless, biodiversity in rangelands is in the brink of extinction due to a combination of many factors including global climate change and rapid increases in human and livestock populations. We surveyed and documented current status of indigenous multi-purpose species across the Libyan Mediterranean coast in a joint collection missions between ICARDA and ARC Libya. The field visits took place during the spring/summer of 2009 and 2010 when 26 sites were surveyed. During the collection missions, over 150 species belonging to at least 30 families were recorded. The most dominant family was *Chenopodiaceae* (25%), followed by *Fabaceae* (15%). Though this is a first step in the right direction, the study concluded that in order to effectively conserve rangeland biodiversity of the Mediterranean rangelands of Libya and to restore their productivity, it is important to take actions that lead to the establishment of a national program for biodiversity conservation where all concerned parties are involved. Also it would be necessary to establish permanent monitoring sites for comparison of present and future observations.

11. Soil fertility improvement in the Sahel with the use of indigenous organic resources

S. Tobita¹, H. Omae¹ and O. Ito¹

¹*Crop Production & Environment Division, Japan International Research Center for Agricultural Sciences (JIRCAS), Tsukuba, Ibaraki, 305-8686, Japan; e-mail: mima@affrc.go.jp*

Soil fertility degradation is a major agricultural problem in Sub-Saharan Africa and the generation of technologies to combat it has gained international recognition as one of the most prioritized issues after the turn of the millennium. We at JIRCAS, the focal point institution of the Consultative Group on International Agricultural Research (CGIAR) in Japan, started a research project in 2003 titled, “Improvement of Fertility of Sandy Soils in the Sahelian Zone through Organic Matter Management,” in collaboration with the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) Sahelian Center (presently, West and Central Africa), based in Niamey, Republic of Niger. This project aims to develop and propose affordable technologies with efficient use of indigenous resources because villages and farmers in the region have very little access to agricultural inputs from the outside, e.g. chemical fertilizers. Therefore, we have studied the role of indigenous organic matters in the sandy soils and the contribution of plant resources to the nutrient budget of agro-ecosystems in the Sahel. The project has made several achievements and developed technological options, ranging from intensive to extensive, which are: (a) synergistic effects of combination of organic materials and inorganic fertilizers, (b) identification of dual-purpose cowpea varieties and their incorporation into millet-based cropping systems in the Sahel with optimized configurations, (c) understanding the nutrient flow in the agro-ecosystems and adjustment of uneven distribution of organic matters to farms, and (d) prevention of wind erosion and fertility improvement with the use of fallow vegetation bands, etc.

The verified and fine-tuned technological options are currently being integrated into different

appropriate technological packages through farmer-participatory approaches under the collaboration with INRAN (Niger National Institute for Agricultural Research) in villages of the Fakara region, southeast of Niger. Also, the technological options are evaluated for their sustainability in terms of carbon budget in the soil with the use of simulation models.

12. Effects of Na⁺ and Ca²⁺ on root cell wall composition in two soybean cultivars differing in salt tolerance

Lina Yin¹, Shiwen Wang², Amin Elsadig Eltayeb³, Hisashi Tsujimoto⁴, and Kiyoshi Tanaka⁵

¹*Laboratory of Plant Physiology, Faculty of Agriculture, Tottori University, Tottori 680-8550, Japan; Arid Land Research Center, Tottori University, Tottori 680-0001, Japan. Email: linayincau@yahoo.co.jp;* ²*Laboratory of Plant Genetics and Breeding Science, Faculty of Agriculture, Tottori University, Tottori 680-8550, Japan. Email: wshiw@sohu.com;* ³*Laboratory of Plant Physiology, Faculty of Agriculture, Tottori University, Tottori 680-8550, Japan. Email: aminhabora@hotmail.com;* ⁴*Laboratory of Plant Genetics and Breeding Science, Faculty of Agriculture, Tottori University, Tottori 680-8550, Japan. Email: tsujim@muses.tottori-u.ac.jp;* ⁵*Laboratory of Plant Physiology, Faculty of Agriculture, Tottori University, Tottori 680-8550, Japan. Email: jotanaka@muses.tottori-u.ac.jp*

Salinity is one of the most serious problems in agriculture in the world that severely inhibits crop growth and yield, especially in the arid and semi-arid regions. In plants, cell wall is the framework that fulfils structural, protective and growth-regulating functions during its life cycle. However, little is known about the change of cell wall composition (including pectin, hemicelluloses and cellulose) under salinity. Calcium was widely reported to affect cell wall structure and alleviate salinity stress. Thus, this study investigated the effects of both sodium and calcium on root cell wall composition in two soybean (*Glycine max* (L.) Merr.) cultivars, ‘Tousan69’ (salt-sensitive cultivar) and ‘Dare’ (salt-tolerant cultivar), to clarify the relationship between cell wall composition and the salinity tolerance. Results showed that salt inhibited root growth while calcium application recovered

it, and this recovery effect was more prominent in Dare (88% recovery) than in Tousan69 (65% recovery). The cell wall polysaccharide, especially pectin, decreased significantly by salinity, but this decrease was more severe in Tousan69 (53%) than in Dare (30%). Calcium application restored it; in Dare, pectin content was restored to 109%, while in Tousan69, it was 84%, and the restoration was parallel to the recovery of root growth in two cultivars. The maintained cell wall polysaccharide was essential for cell division and elongation under salinity. These results suggested that changes in cell wall composition have a close relationship with the regulation of root growth under salinity. The difference in salt tolerance between the two tested cultivars can partly be explained on the basis of the changes in the cell wall composition in response to salinity. The alleviation effect of calcium on salinity stress is related to the maintenance of cell wall composition, especially the pectin content.

13. *Boswellia sacra* a high value traditional plant in dry land Southern part of Oman

Mohsin Alaamri

Environment Society of Oman, P.O. box 3955, Ruwi 112, Sultanate of Oman, e-mail: mohsinjedan@yahoo.com

Boswellia sacra (Burseraceae) grows wild in dry hot lands in the southern part of Oman (Dhofar), where the water is limited and the land unsuitable for traditional agriculture purpose. *B. sacra* is a multipurpose tree, but is particularly known for its high value *olibanum* (*lubban*) material. Olibanum was the main source of income and the only exported product in the past. It is used for rituals and in church ceremonies worldwide, traditional medicines, pharmaceuticals, perfumery, cosmetics, chewing, painting, and food flavouring. In addition to these uses, the species has other numerous environmental and traditional socio-economical benefits. This study is based on literature review, and on the interview of local people, as well as, on the personal field experiences. The objective is to introduce the

importance of the species and to study the native habitats, distribution, and the harvesting techniques. *B. sacra* is distributed between western border of Oman and 55° E longitude and 16° to 17° N latitude, at less than 100 to 1200 m altitude, in an area receiving a mean annual rainfall of 40 – 100 mm. The soil is carbonitic, isohyperthermic, lithic torriothent, with poor mineral nutrient content. The olibanum is produced when the tree is tapped by making a thin vertical slit into the tree trunk. The initial cut size develops into a wider and deeper wound as tapping cycles proceed. Hence, the initial size should be about 18 cm² (3×6 cm) and 1-2 mm in depth and the diameter of tree trunk should not be less 10 cm. Tree tapping should be stopped 2-3 week before the rain season. The method of tree tapping and olibanum collection should be revised for long-term tree protection.

14. Groundwater resource sustainability in Wadi Watir, Gulf of Aqaba, Sinai, Egypt

Mustafa A. Eissa^{1,2}, James M. Thomas², Maher I. Dawoud³, Greg Pohl², Mohamed A. Gomaa¹, Kamal A. Dahab³ and Ron Hershby²

¹Desert Research Center, Hydrogeochemistry Department, Matariya, Cairo, Egypt, e-mail: Mustafa.Eissa@dri.edu;

²Desert Research Institute, Division of Hydrologic Sciences, Reno, Nevada, USA; ³Faculty of Science, Geology Department, Menoufiya University, Egypt

In order to manage groundwater in a sustainable way in the Wadi Watir Delta the amount of average annual groundwater recharge to the area needs to be known. The delta is a tourist area in the arid southeastern part of the Sinai Peninsula, Egypt, where development is constrained by the amount of groundwater that can be developed in a sustainable manner. The study area is underlain by alluvial and sandstone aquifers, which are underlain by impermeable Precambrian basement. The scarcity of rainfall during the last decade, combined with high pumping rates, has resulted in the degradation of water quality in the main supply wells along the mountain front and seawater intrusion along the coast resulting in reduced groundwater pumping.

A three-dimensional groundwater flow model (MODFLOW) was developed and calibrated using groundwater level changes and pumping rates from 1987 to 2008. This model estimates that the average groundwater recharge rate to the study area is 5026 m³/day. A variable-density flow and seawater intrusion model (SEAWAT) was also developed for the area to simulate seawater intrusion for different pumping scenarios. Model results show some seawater intrusion along the coast. Water chemistry and stable isotope data were used to calculate the proportion of seawater mixing in groundwater along the coast. Water chemistry and stable isotope data were also used in geochemical modeling (NETPATH) to determine the sources and mixing of different groundwaters from the mountainous recharge areas and within the delta aquifers. Geochemical modeling also shows that the salinity of the groundwater is controlled by dissolution of minerals and salts in the aquifers along the flowpaths and mixing of chemically different waters. Future groundwater pumping should be closely monitored to limit upwelling of saline groundwater into the well field near the mountain front and along the coast to limit seawater intrusion.

15. Influence of trehalose treatment on the stress tolerance of *Elaeagnus oxycarpa* seedlings

Naoki Murata¹, Fumiko Iwanaga², Kiyoshi Tanaka¹, Ailijiang Maimaiti¹, Norikazu Yamanaka²

¹The United Graduate School of Agricultural Sciences, Tottori University, Tottori 680-8553, Japan; e-mail: murata@alrc.tottori-u.ac.jp; ²Arid Land Research Center, Tottori University, Tottori 680-0001, Japan

Recently, severe land degradation became a serious problem in the western part of China. A lot of revegetation projects have been undertaken to protect the indigenous ecosystem, however, the survival rate of planted tree seedlings was low. Some techniques to improve salt and drought tolerance of seedlings are required to enhance the survival rate for an effective revegetation. In this research, we studied changes of tree seedlings'

salt and drought tolerance with application of trehalose, a disaccharide formed by two molecules of glucose, which has a function to protect cell membranes and proteins from dehydration. As plant materials, seedlings of *Elaeagnus oxycarpa*, indigenous tree in Northwest China, were grown in hydroponic culture with 50% Hoagland's solution, and trehalose treatment was applied by replacing the culture solution by trehalose solutions (0, 0.2, 0.3 M) for 2 days. Then, we replaced the trehalose solutions with NaCl solutions (0, 0.3 M) or PEG (polyethylene glycol) solutions (0, 300 g/L), and observed the changes in the seedlings for 1 week. After these stress treatments, the seedlings were allowed to grow for another three weeks on 50% Hoagland's solution, and then their dry weight was determined. Under the salt stress condition, the dry weight of the leaves at the end of the experiment was larger in the groups treated with trehalose compared to the control group, and the survival rate was the highest in the group treated with 0.2 M trehalose. Thus, exogenous trehalose application seemed to improve the salt tolerance of seedlings. In contrast, under the osmotic stress condition (PEG treatment), the number of leaves markedly decreased in the groups treated with trehalose while that of the control group remained almost unchanged.

16. Assessment of GHG emission and relevant agricultural policies in Egypt

Mohey S. Kadah¹, M.A. Fahim², M.K. Hassanein² and A. F. Abou Hadid³

¹Climate Change Information Center (CCIC), 9 El-Gamaa st., 12619 Giza, Egypt. Email: moheyclac@yahoo.com;

²Central Laboratory for Agricultural Climate (CLAC), 12411 Giza, Egypt. Email: ali.mohamed73@gmail.com, dr_mosaadkotb2003@yahoo.com; ³Agricultural Research Center (ARC), 9 El-Gamaa st., 12619 Giza, Egypt. Email: aabouhadid@yahoo.com

The growth of the GHG emissions in Egypt is primarily linked to the strong economic growth and the attendant increases in energy use, especially through higher demand for electricity and transport services. The aggregate GHG emissions without

the impacts of land use changes was estimated to be over 116 million tons of CO₂ equivalent in the baseline year 1990/91; it increased to 230-270 million tons in 2009. Energy related emissions were the main sources of GHG emissions, in large part due to combustion of fossil fuels, about 180-190 million tons. The agriculture sector was the second largest GHG emission source with 35 million tons, mainly from enteric fermentation and rice cultivation, followed by the non combustion related industrial emissions of CO₂, mainly from the steel and cement industries.

Sustainable and organic agriculture in Egypt offer multiple opportunities to reduce GHGs and counteract global warming. Reducing GHGs through carbon sequestration in soil has even greater potential to mitigate climate change. Improving soil sequestration of carbon is desirable in both low- and high-intensity crop and animal systems. However, soil improvement is particularly important for agriculture in developing countries where crop inputs such as chemical fertilizers and pesticides are not readily available, their costs are prohibitive, they require special equipment, and the knowledge needed for their proper application is not widespread. In this presentation, policy recommendations for controlling GHGs emissions and mitigation options are presented. Areas for improvement include increased use of no-till cropping, agro-forestry, and integrated crop and animal farming, and decreased use of external inputs in agriculture. The techniques offered by organic agriculture are valuable for consideration in these efforts.

17. Effects of the Asian dust events on healthy subjects in Japan

S. Otani¹, K. Onishi², H. Mu², and Y. Kurozawa²

¹Arid Land Research Center, Tottori University, Tottori, 680-0001, Japan. Email: otanis@oregano.ocn.ne.jp; ²Division of Health Administration and Promotion, Faculty of Medicine, Tottori University, Yonago, 683-8503, Japan

The occurrence of Asian dust events is a frequent

problem, with associated health issues throughout Northeast Asia. It is thought that these events are an environmental problem due to human's impact caused by forest reduction, soil degradation, and desertification, rather than being simply a natural seasonal phenomenon. However, the effects of Asian dust on human health are not well-known in Japan.

We evaluated the association between daily symptoms and Asian dust events in Yonago, Japan. The subjects were 50 healthy individuals who were distributed survey sheets on nasopharyngeal, ocular, respiratory, and skin symptoms, which were quantified in spring, 2009 and 2010.

We investigated the symptoms of the subjects on Asian dust days and non-dust days, and compared the symptom scores with meteorological data and measures of suspended particulate matter (SPM), which is the indicator of Asian dust. At the same time we analyzed the metallic constituent that adhered to particulate of Asian dust. The scores for symptoms were significantly higher on dust days than on non-dust days. Skin symptom scores were positively correlated with the SPM and nickel levels. Our results provide preliminary evidence that Asian dust influences the symptoms of healthy subjects, although the symptoms are not severe. Moreover, skin symptoms during this study may be an allergic reaction to metals bound to Asian dust particles.

18. Expression of drought-related traits of *Aegilops tauschii* accessions and their corresponding synthetic hexaploid wheat

Quahir Sohail^{1*}, T. Inoue², H. Tanaka¹, and H. Tsujimoto¹

¹United Graduate School of Agricultural Sciences, Tottori University, Japan; *e-mail: quahirsohail@hotmail.com; ² Arid Land Research Center, Tottori University, Japan

Aegilops tauschii is considered to be the D genome

donor to *Triticum aestivum*. Synthetic hexaploid wheat lines (SW) were developed by crossing *Ae. tauschii* with *T. durum* wheat cultivar 'Langdon'. These SW lines have the same A and B genomes, but the D genome is different. A pot experiment was conducted in Tottori University in controlled conditions having a day length of 14 hours, light intensity of 80,000 lux, and day/night temperatures, respectively, of 25/20 °C and relative humidity of 50/60 %. The objective of the study was to correlate the expression of drought-related traits of *Ae. tauschii* accessions and their corresponding synthetic hexaploid wheat. *Ae. tauschii* accessions and SW lines were grown under well-water conditions (WWC) and drought conditions (DC). Data were recorded on photosynthesis, stomatal conductance, intercellular CO₂, transpiration rate, SPAD reading, water potential, and dry weights of roots and shoot. Results of correlation studies between a subset of 20 SW lines and their parental *Ae. tauschii* accessions are reported in this paper. Correlations for the different characters were calculated for WWC and DC. Correlations between *Ae. tauschii* lines and their corresponding SW lines were not significant for all characters when it was calculated based on data from WWC and DC, because the points were much scattered with some outliers. These outliers could be important for further work and breeding purposes. Dry weight is considered as criteria for growth under DC and WWC. Based on the mean of all the *Ae. tauschii* and SW lines under WWC, *Ae. tauschii* produced significantly more total dry weight than SW lines. However, under DC, SW lines on the average produced more total dry weight than *Ae. tauschii*. Percent reductions in total dry weight under DC of *Ae. tauschii* was individually compared to that of the corresponding SW lines. The reduction in SW was much less than *Ae. tauschii* accessions; the percent reduction under DC ranged from 39 to 77 in *Ae. tauschii* lines, whereas in SW lines it ranged from 11 to 57.

19. Olive mill waste water valorisation in agriculture: Effects on the soil proprieties and barley yield

Raja Dakhli¹, Houcine Taamallah¹, Ridha Lamouri² and Kamel Nagaz²

¹Laboratory of Eremology and Combating Desertification. Institute of Arid Areas, 4119- Medenine, Tunisia, e-mail: rajaedakhli@yahoo.fr; taamallah@irisit.rnrt.tn.; ²Laboratory of Arid and Saharan Agrosystems. Institute of Arid Areas, 4119- Medenine, Tunisia

Olive oil extraction produces large amounts of waste water, known as olive mill waste water (OMWW) 'Margines'. This sludge has a high chemical oxygen demand and contains high level of phenolic compounds and is therefore a cause of environmental pollution. The exploitation of this waste without preliminary treatment is very limited considering its toxicity for soils and plants. In Tunisia, 700,000 tons of Margines, produced annually, are generating pollution. They are dried in special basins and then put in heap to be used as compost while an important fraction of the product is poured directly in the beds of natural channels (*wadi*). It is within the above framework that this work has been carried out aiming at finding new technologies or processes for the treatment and use of this effluent. The use of Margines on sandy soil in Southern Tunisia represents an interesting alternative. The major aim of this study was to investigate the use of Margines as a fertilizer for barley cultivation. Application of 50 m³/ha (T1), 100 m³/ha (T2) and 200 m³/ha (T3) of this wastewater resulted in a significant improvement in the soil fertility. The carbon/nitrogen ratio increased from 9 for the control to more than 22 for the T3 treatment. The potassium content showed also a considerable improvement (300 mg/kg for the control; > 1988 mg/kg for T3). Because of its binding and hydrophobic effects, the application of Margines resulted in a more stable soil and created mulch reducing the moisture loss.

The barley seed yield remained nearly the same at T1 (1362, 2Kg/ha) as under control (1262.2 Kg/ha),

but it decreased under T2 and T3 (respective values being 762.9 and 362.2 kg/ha). Thus, Margines applied at high doses (100 m³/ha and 200 m³/ha) reduced the production whereas the low dose (50 m³/ha) improved the soil characteristics and slightly increased the yield of barley. It is, therefore, recommended that the Margines can be applied @ less than 50 m³/ha for barley cultivation.

20. Prediction of tomato yield under climate change conditions by using simulation model

S.M.K. Abou-Shleel¹, M.H. Edriss², A.A. Abdou², M.A. Medany³ and S. M. Saleh⁴

¹Department of Environment and Bio-Agriculture., Faculty of Agriculture, Al-Azhar University, Cairo, Egypt; ²Department of Horticulture, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt; ³Horticultural Research Institute, A RC, Giza, Egypt ; ⁴Central Laboratory of Agricultural Climate, A R C, Giza, Egypt, e-mail: samirmm2000@yahoo.com

This study was carried out during the summer season of 2007, at two locations in Egypt (Tall El-kabeer in Ismailia Governorate and Al-Khanka in Qaluobiya Governorate), to assess the impact of three transplanting dates (10 March, 1 April and 20 April) and three levels of nitrogen fertilizer (150, 180 and 210 kg N/fed.) on tomato yield ('Super Strain B' cultivar) under current climatic conditions. The DSSAT (Decision Support System for Agro-technology Transfer) software tool was run with data on weather, soil and experimental results in order to predict tomato yield under climate change conditions. Predicted and measured yields were comparable. The DSSAT was able to simulate tomato crop performance under current conditions with a difference of only 0.3 to 0.6 % from the actual yield.

The potential impact of climate change on tomato production was evaluated by simulating different locations, planting dates and N levels with the climate change scenario A₁ by the years 2025s, 2050s, 2075s and 2100s compared to that under the

current conditions of 2007 season. Using the future climate data, a yield reduction from -8 to -24% was predicted without adaptation for the years of 2025 to 2100. The negative impact was decreased (-3 to -15%) when planting date was advanced by 30 days from the normal planting date.

21. Optimum water application for buffel and Rhodes grass in Oman

Safaa Al Farsi¹, Ahmed Al Bakri², Abdullah Alshankiti³ and Ahmed Osman⁴

¹Directorate of Agriculture and Livestock Research, Sultanate of Oman, e-mail: alfarsi99@hotmail.com; ²Director, Agriculture and Livestock Research, Sultanate of Oman, e-mail: research@omantel.net; ³Water Management Specialist, International Center for Agricultural Research in the Dry Areas (ICARDA), Arabian Peninsula Regional Program (APRP), P.O. Box 13979, Dubai, UAE, e-mail: a.alshankiti@icarda-aprp.ae; ⁴Former Pasture and Range Ecologist, APRP e-mail: goldentulipsudan@yahoo.com

Oman has a large area of rangelands, particularly in Dhofar region. The forage grass species of the rangelands have been severely affected by salinity in combination with drought and heat. In northern Oman, a gradual loss of palatable species has been noticed to the level of near extinction, thus affecting the originally rich plant diversity. Such degradation has been primarily attributed to overgrazing by the increasing number of animals. Under such conditions of drought, heat and salinity, appropriate indigenous rangeland grass species such as Buffel grass (*Cenchrus ciliaris*) are highly valuable for developing integrated forage production systems by replacing the exotic Rhodes grass being currently grown with high water inputs. It would also help to alleviate grazing pressure on rangelands in Oman. The objective of this study was to compare and assess the water productivity of Buffel and Rhodes grasses under different water application rates and determine optimum irrigation regimens for each grass. Preliminary results of this study are presented in this poster.

22. Effect of A-shaped NFT system orientation on strawberry production and quality

S.M. Singer¹, S.H. Ahmed², U.A. El-Behairy³ and A. F. Abou-Hadid⁴

¹Vegetable Research Department, National Research Center, Dokki, Giza; e-mail: sayedsinger@gmail.com; ² Central Laboratory for Agricultural Climate (CLAC), Agriculture Research Center, Giza, Egypt; ³Horticulture Department, Faculty of Agriculture, Ain-Shams University, Shobra El-Khaima, Cairo, Egypt; Agriculture Research Center, Giza, Egypt; ⁴Agriculture Research Center, Giza, Egypt.

With the current challenging situation regarding water availability in Egypt, there is an increased need for water conservation methods. Nutrient Film Technique (NFT) is a hydroponics technique whereby a very shallow stream of water containing all the dissolved nutrients required for plant growth is re-circulated passing the bare roots of plants in a watertight gully. NFT can therefore be a valuable tool in water conservation. This study was conducted on a private farm at Alexandria desert road to investigate the effect of different orientation and side of planting on yield and quality of strawberry produced by two A-shape systems under NFT and substrate, during 2005/2006 and 2006/2007.

The experiment included three orientations of A-Shape system: North South (serving as control), East West, and North East; two cultivation sides: side one (S₁) and side two (S₂) of A Shape system; and three levels: higher level (L₁), medium level (L₂), and bottom level (L₃) in each side. Results indicated that when the A-Shape system oriented towards North East it provided the highest light intensity to the plants, and resulted highest total leaf area, fruit yield, and vitamin C, TSS, N% and K% in the fruit. Cultivating the plants on side 1 significantly increased total yield, and vitamin C and TSS in the fruits. There was also a significant effect of cultivation level on total leaf area, total yield, vitamin C and TSS of strawberry fruits. From the overall results it can be concluded that orienting the A shape NFT system towards North East, instead of North South, gave the higher yield and quality of strawberry.

23. Changes in precipitation patterns in Syrian semi arid, arid, and extreme arid regions over last five decades

Michael Skaf¹ and Shifa Mathbout²

¹Faculty of Agriculture, Tishreen University, Ecology and Forestry Department, Lattakia, Syria; ²General Commission for Scientific Agricultural Research, Lattakia Center, Syria; e-mail: shifamathbout@yahoo.com

Climate change may cause profound effects on terrestrial ecosystems. Global warming is likely to alter hydrological cycle that will change global and regional precipitation regimes. Interactions between changing precipitation regimes and other aspects of global change are likely to affect natural and managed terrestrial ecosystems as well as human society. Precipitation is a key component of the global water cycle and terrestrial hydrology. Shifts in precipitation regimes may have an even greater impact on ecosystem dynamics than the singular or combined effects of rising CO₂ concentration and temperature, especially in arid and semiarid environments. Changes in rainfall patterns may have large effects on a wide range of biological processes such as carbon cycling, soil CO₂ flux, CO₂ uptake and aboveground net primary productivity (ANPP), community composition, and population and community dynamics. Global circulation models for the Mediterranean region forecast reduced annual precipitation and more extreme rain events along with seasonal changes. Annual and seasonal rainfall data for ten stations located in semi arid, arid, and extreme arid regions in Syria were analyzed to detect changes in precipitation over the period 1958-2008 using monotonic and step-change trends. Despite of positive trends for autumn rainfall in most regions, the results showed a negative tendency in annual rainfall in all regions which is related to reduction in spring and winter rainfall. The results of Mann-Kendall test on monotonic trend indicated statistically significant trends for some regions, whereas step-change trends were significant for all stations.

24. Effect of drought stress on post-anthesis assimilation and grain yield of synthetic wheat derivatives

Tomoe Inoue¹ and P. An²

Arid Land Research Center, Tottori University, 1390
Hamasaka, Tottori 680-0001, Japan, ¹e-mail: sapan@alrc.
tottori-u.ac.jp;

²e-mail: an.ping@alrc.tottori-u.ac.jp

A field experiment was conducted to investigate contribution of pre- and post-anthesis assimilation to grain yield of two synthetic hexaploid wheat derivatives and their recurrent parent cultivar 'Cham 6' under irrigated and non-irrigated conditions. Aboveground dry matter at anthesis and maturity was measured, and remobilization of pre-anthesis assimilates to the grain and its contribution to the grain yield were evaluated. Photosynthetic rate and leaf water potential were measured during grain filling. There were no significant differences in grain yield among the genotypes under irrigated condition, while under non-irrigated condition, one synthetic-derived line, SYN-10, showed significantly higher grain yield than other genotypes. Contribution of pre-anthesis assimilate to the grain yield of all genotypes was similarly increased under non-irrigated condition. Dry matter accumulation from anthesis to maturity in SYN-10 was significantly higher than in other genotypes under non-irrigated condition. Photosynthetic rate of ear of all genotypes decreased similarly under non-irrigated condition, while that of flag leaf was significantly higher and less affected by drought in SYN-10 than in other genotypes. The stress-induced reduction in stomatal conductance in the flag leaf of SYN-10 was lower than that of other genotypes. Water potential of the flag leaf of all genotypes was similarly decreased under non-irrigated condition. These results suggested that main physiological factor associated with drought resistance in SYN-10 was the high stomatal conductance in the flag leaf during grain filling under low leaf water potential.

25. Sodium dynamics of invasive *Tamarix ramosissima* in the lower Virgin River, Nevada

S. Imada¹, K. Acharya², Y. Li^{2,3}, F. Yamamoto⁴, F. Iwanaga¹, T. Taniguchi¹, and N. Yamanaka¹

¹Arid Land Research Center (ALRC), Tottori University, Tottori
680-0001, Japan; e-mail: yamanaka@alrc.tottori-u.ac.jp;

²Desert Research Institute (DRI), Las Vegas, NV 89119, USA;

³School of Environmental Science and Engineering, Hohai
University, Nanjing 210098, China; ⁴Faculty of Agriculture,
Tottori University, Tottori 680-8553, Japan

Biodiversity of riparian vegetation along Virgin River has been strongly changed due to river management, invasive plants and climate change. Tamarisk (*Tamarix* spp.), a halophyte shrub native to Eurasia and Africa, has been spreading rapidly in the US for many years. Tamarisk is considered to cause an increase in surface soil salinity through salt secretion from the salt glands in the leaves, and the increase in surface salts may result in the elimination of native riparian plants. To increase our understanding of the effects of invasive tamarisks on riparian vegetations and ecosystems, we conducted a 1-year field experiment to investigate sodium dynamics of a *Tamarix ramosissima* forest in the lower Virgin River, Nevada. Three quadrant plots (5 × 5 m) were set up in the forest in August 2009 and the size all living and dead sprouts were measured. Litter traps, throughfall and stem-flow collectors were set in the plots and their samples were collected during the experiment. Soil samples were collected near the three plots. Seven individuals outside of the plots were harvested; all living and dead sprouts were measured for their size, separated by each biomass part and weighed. Roots were dug up and weighed. We estimated biomass in the forest using regression equations developed and vegetation survey data in each plot and. The Na concentrations in the plant, litter, rainfall and soil samples were determined. The percentage of Na in the soil (0 to 50 cm depth) that got accumulated in the aboveground parts was 12%. The major sink for Na among the aboveground parts was the leaves, which accounted for 31% of the total Na in the trees. The amount of Na returned to the soil through rainfall and fallen

leaves was as much as that in the aboveground parts. Thus, *T. ramosissima* would return high amount of Na to the soil as a result of leaching by rainfall and litter production.

26. Natural regeneration of native biodiversity following climate change related wildfire in a desert blackbrush community in Nevada USA

Stephen F. Zitzer and David Shafer

Desert Research Institute, Las Vegas, Nevada, USA. E-mail: Stephen.Zitzer@dri.edu

Thousands of hectares of shrub communities dominated by blackbrush (*Coleogyne ramosissima*) have been destroyed by wildfire over the past 20 years due to climate change related droughts and increased carbon sequestration. Most of these burned communities subsequently become dominated by annual non-native grasses, with little or no regeneration of blackbrush. Blackbrush communities occur on 5,000-125,000 year-old aridisols between elevations of 1,000-2,000 m, with annual precipitation ranging from 50-200 mm, and cover more than 1,000,000 hectares in the Mojave Desert. We studied the impact of a 2008 wildfire on the regeneration of native biodiversity in a grazed blackbrush community

heavily invaded by non-native cheatgrass (*Bromus tectorum*). Total shrub cover that in unburned communities ranged from 47-58 percent was destroyed by the fire, while climate change related drought over the past 20 years had resulted in shrub mortality rates of 64-74 percent.

Plant regeneration in 2009 following average winter precipitation of 85 mm included a surprisingly large number of blackbrush seedlings (29 seedlings/m²), while blackbrush seedling density in unburned locations ranged from 0-3 seedlings/m². Conversely, cheatgrass density in burned locations ranged from 0.2-1.6 seedlings/m², while cheatgrass density in unburned sites ranged from 223-255 seedlings/m². Though winter precipitation in 2010 was 104 mm, the patterns of blackbrush and cheatgrass densities were similar, but 25 percent lower than 2009. Native winter annual species densities in burned areas were comparable to cheatgrass densities in unburned areas in 2009, but were almost four-fold greater in 2010 and included an increase in species diversity from 12 to 29 species. Regeneration of native biodiversity at our study site indicates that a critical climate change and/or elevated CO₂ threshold beyond which native biodiversity irreversible declines has not been exceeded in this desert shrub community.

International Dryland Development Commission (IDDC)

Chairman

Adel El-Beltagy

Chair, Agriculture Research and Development Council (Egypt), Emeritus Professor, Ain Shams University, Cairo, Egypt

Vice-Chairman

Idris Trylor

International Center for Arid and Semiarid Land Studies, Texas Tech University, Texas, USA

Secretary General

Gareth Wyn Jones

Former Director, Centre for Arid Zones Studies, University of Wales Bangor, UK

Executive Secretary

Mohan C. Saxena

Member National Academy of Agriculture Sciences (India) and Senior Advisor to ICARDA
Director General

Board Members

Ali Ahoonmanesh, Former Vice Minister and Head of AREO, University of Shiraz, Iran

Dzhamin Akemaliev, Former President Kyrgyz Agrarian Academy, General Director of Kyrgyz Agricultural Research Institute, Bishkek, Kyrgyzstan

Manual Anaya, Coordinator, Center for Training in Water Harvesting, Post-Graduate College, Mexico

Kamal Batanouny, Professor, Faculty of Science, Cairo University, Egypt

Adli Bishay, Board Chair and Executive Director, FEDA, Emeritus Professor, AUC, Egypt

Iwao Kobori, Senior Program Advisor, United Nations University, Tokyo, Japan

KPR Vittal, Director, Central Arid Zone Research Institute, Jodhpur, India

David Nygaard, Director, Rural Development Programmes, Aga Khan Foundation, Geneva, Switzerland

Shinobu Inanaga, Former President of JIRCAS & Director of ALRC, Tottori University, President Tottori Institute of Industrial Technology, Tottori Japan

Hans van Ginkel, Former Rector, United Nations University, Tokyo, Japan

Tao Wang, Director, Cold and Arid Regions Environmental and Engineering Research Institute, CAS, Lanzhou, China

Tenth International Conference on Development of Drylands

International Scientific Committee

Chairman

Prof. Dr Adel El-Beltagy, Chair of IDDC, Chair of Agricultural Research and Development Council of the Ministry of Agriculture and Land Reclamation, Government of Egypt

Members

H.E. Dr Hilal Al-Hinai, Secretary General, The Research Council, Sultanate of Oman

Prof. Iwao Kobori, Senior Program Advisor, United Nations University, Tokyo, Japan

Prof. Charles F. Kennel, Distinguished Professor of Atmospheric Science, Emeritus Senior Advisor, Sustainability Solutions Institute, University of California, San Diego, USA

Prof. Dr R.G. Wyn Jones, Associate Director, Center for Arid Zone Studies, University College of North Wales, UK, Secretary-General, IDDC

Prof. Dr Atsushi Tsunekawa, Director of Arid Land Research Center, Tottori University, Japan

Dr. Zafar Adeel, Director, United Nations University - Institute for Water, Environment and Health (UNU-INWEH), Hamilton, Canada

Dr. M.V.K. Sivakumar, Director, Climate Prediction and Adaptation (CLPA) Branch, World Meteorological Organization (WMO), Geneva, Switzerland

Dr. Ayman Abu-Hadid, President, Agriculture Research Council (ARC), Ministry of Agriculture and Land Reclamation, Giza, Cairo, Egypt

Dr. Maarten van Ginkel, Deputy Director General, International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria

Prof. Dr. Wang Tao, Director General, Cold and Arid Regions Environmental & Engineering Research Institute, Chinese Academy of Sciences, Lanzhou 730000, China

Prof. Dr Mohan Saxena, Senior Advisor to the Director General, ICARDA, Gurgaon, Haryana, India, Executive Secretary, ICDD