Third Country Training Program (TCTP) for Iraq

Technical Report

on

Improving Water Productivity in Agricultural Systems

April 24 – May 12, 2016
Amman, Jordan

Organized by
International Center for Agricultural Research in the Dry Areas (ICARDA)

In collaboration with
National Center for Agricultural Research and Extension (NCARE)

Under the support of
Japan International Cooperation Agency (JICA)
Arab Fund for Economic and Social Development (AFESD)
Islamic Development Bank (IDB)
Chinese Academy of Agricultural Sciences (CAAS)

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Executive Summary

Name of the project

Capacity Development for Agriculture and Water Management for Iraq and Regional countries

Partners

Japan International Cooperation Agency (JICA)
Arab Fund for Economic and Social Development (AFESD)
Chinese Academy of Agricultural Sciences (CAAS)
Islamic Development Bank (IDB)
National Center for Agricultural Research and Extension (NCARE)
International Center for Agricultural Research in the Dry Areas (ICARDA)

Purpose

To enhance Capacity Development of government officials and researchers who are engaged in agricultural development in Iraq and other countries.

Specific objectives of the training course on Seed Health Testing

Up-to-date knowledge and enhanced capacity on best practice for water management for water used efficiency.

Specific outputs

Nine professionally-trained NARS partners from Iraq, two~~2~~ from Jordan and eight~~8~~ from other countries participated in the training: two~~2~~ from China, one~~1~~ from Lebanon, one~~1~~ from Palestine, one~~1~~ from Iran, one~~1~~ from Sudan, one~~1~~ from Turkey~~ish~~, and one~~1~~ from Morocco on improving skills for water management for water used efficiency with emphasis on dry land agriculture. While nine~~9~~ Iraqis, one~~1~~ Lebanese, one~~1~~ Sudanese and two~~2~~ Jordanians were funded by JICA, Iranian and Turkish were supported by the Islamic Development Bank (IDB), Palestine and Moroccan participants were sponsored by the Arab Fund for Economic and Social Development (AFESD), and two~~2~~ Chinese~~s~~ participants were supported by Chinese Academy of Agricultural Sciences (CAAS) (Please refer to Annex VI).

Specific outcomes

Design, implement, manage, analyze and report on research and development in improving water management in agricultural systems and acquire up-to-date information on research and practical activities in water management for water used efficiency in each participating country.

General Overview

Water is the major limiting factor for agricultural production in the dry areas of Central and West Asia and North Africa (CWANA). Agriculture accounts for around 80% of water consumption in the region, however, the rapidly growing population, industrialization, and urbanization will lead to reallocation of water increasingly away from agriculture to other sectors. On the other hand, high population growth rates require a continuous increase in agricultural production.

There are few opportunities for capturinge ~~of~~ new water resources, and there is a tendency towards non-sustainable, ~~–~~over-exploitation of existing sources. Therefore, sustainability of agricultural production depends on conservation and appropriate allocation and management of the scarce water resources in the region. Improving the efficiency of water use through proper crop selection, cropping pattern, cultural practices, and improved management techniques is essential to boost on-farm productivity either under rainfed or irrigated conditions. Another important approach towards improving water use efficiency is to link on-farm issues at the watershed level, applying integrated natural resource management methods.

ICARDA's mission is to improve the welfare of people through agricultural research and training to increase the production, productivity, and quality of food, while preserving or improving the resource base. ICARDA's training courses are designed to improve the capabilities of scientists and technicians in national agricultural research systems (NARS) in developing countries to conduct research independently, and to foster transfer of technology and address issues related to farmers' decisions in adopting or rejecting new technologies. To this end, ICARDA has organized this course.

Course objectives

The focus of this year's course is on improving water productivity and management of water resources in rainfed environments. The purpose of the course is to provide participants with the necessary practical and theoretical information to improve water productivity in rainfed agriculture, and to increase their capability to support sustainable agricultural production. At the end of the course, the participants should be able to:

- Design, implement, manage, analyze and report on research and development in the area of water productivity in rainfed agriculture and acquire up-to-date information on research and practical activities in the management of water resources in each participating country

- Apply an integrated natural resource management approach to optimize the use of scarce water resources in rainfed agriculture

Organization of the Course

With financial support ~~from the Japan International Cooperation Agency (~~JICA~~)~~, through its overseas office in Jordan, ~~Islamic Development Bank (~~IDB~~)~~, ~~Arab Fund for Economic and Social Development (~~AFESD~~)~~, and ~~Chinese Academy of Agricultural Sciences (~~CAAS~~)~~ in collaboration with ~~the~~ Jordan's ~~National Center for Agricultural Research and Extension (~~NCARE~~)~~, ~~the International Center for Agricultural Research in the Dry Areas (~~ICARDA~~)~~ conducted the course at ICARDA's offices in Amman, Jordan. The course included classroom lectures and discussions, as well as practical field and laboratory exercises. The lectures were given in English, and all course materials were~~as~~ provided as hardcopies as well as softcopies in the form of individual flash drives to the trainees. A certificate of attendance was awarded at the end of the course to each trainee.

Organizing Committee

Mr. Charles Kleinermann, Head, ICARDA Capacity Development Unit (CDU)

Dr. Vinay Nangia, ICARDA Agricultural Hydrologist, Course Coordinator

Mr. Masafumi Tamura, Technical Training Officer, ICARDA Capacity Development Unit (CDU)

Course Structure

The course comprised of four modules (See detail in Annex I):

- Module 1: In- country preparation

During the course, participants were requested to prepare and give a presentation on water management technologies, opportunities and research in his/her country on green water management and water productivity and on one of the two agro-ecosystems covered by the course. Therefore, all participants were requested to collect information (data, pictures, maps) on water management issues in their country before joining the course, to be developed and presented in a formal seminar at the end of the course.

- Module 2: Lectures and practical applications

All participants participated in three weeks lectures on rainwater management and water productivity improvement in agricultural systems, and field visits and laboratory exercises. The following major subjects were covered:

- Agricultural water productivity concept, importance and ways of improvement
- Improved water management options in rainfed farming
- Planning, design and implementation of supplemental irrigation systems
- Planning, design and implementation of water harvesting systems
- Soil-water relations (measurements, monitoring and modeling)
- Experimental design and data analysis
- Scientific research, writing and presenting
- Socio-economic aspects of water resources management

- Module 3: Supervised group research work

During the last week of the course, participants worked in small groups (four~~4~~ trainees in each group) on a water management research project~~s~~ under guidance. They gained experience in the development and evaluation of water-management systems for water harvesting and for improving water productivity in rainfed environments, using an integrated approach.

- Module 4: Presentation and evaluation

At the end of the course, all four groups of participants were required to prepare and present a formal seminar on their output. ICARDA scientists participated in these seminars to discuss results and provide suggestions for improvement and further research work. Trainees were granted a "completion certificates" only if they passed the course evaluation.

Course Implementation

Practical sessions were scheduled throughout the course (see Annex 1 ~~the~~ course program ~~of the course~~). This way the trainees could directly, actively experience and practice what they heard and discussed during the lectures. At the end of the course, by preparing and presenting a formal seminar on their outputs, the trainees got the chance to apply what they had learned during the first three weeks of the course.

Lecture notes, handouts, and manuals were given to the trainees throughout the course. At the end of the course, each trainee received a flash drive with all presentations, lecture material, manuals, software, pictures and research data. The flash drives also included the group presentations prepared by the trainees.

Week 1

Week 1 provided the trainees with the **soil and water, agronomic, and meteorological** aspects of irrigation management. After the official opening session, Dr. Vinay Nangia introduced the trainees to the course and to each other. An informal interactive learning session was held to test the background knowledge of the participants. The level of English, computer use and general knowledge about climate analysis and water scarcity was low. But the informal interaction among the trainees and with the trainers was very good. The ~~N~~next day, Dr. Nangia refreshed the knowledge of the trainees on the **soil-water-plant relationship**, and Dr. Ayman Suleiman delivered lectures on **soil texture and water retention, as such as on photosynthesis and plant water relations**.

On Tuesday, Prof. Ahmed Hachum delivered lectures on **supplemental irrigation** including the concept, management, system design, control and measurement of supplemental irrigation.

On Wednesday, Prof. Hachum covered the topics of **evapotranspiration and crop water need**, when and how much to irrigate, and irrigation scheduling using the FAO 56 manual. On Thursday, the entire day was dedicated to the topic of **rainwater harvesting – planning, designing, managing and evaluating water harvesting projects**.

On Saturday, the trainees were taken for **a field visit to the Jordan Valley of NCARE**.




Week 2

Dr. Michel Rahbeh of the University of Jordan on the first two days of the second week delivered lectures on the burning topic of **groundwater use for agriculture**. On Monday, Dr. Stephan Strohmeier lectured on the application of the **Soil & Water Assessment Tool (SWAT)** for watershed management. On Tuesday, the trainees visited **ICARDA's water harvesting research experiments in Majedieh** near Amman ~~the i~~International ~~a~~Airport. This was a useful visit since it linked the water harvesting lectures of the previous Thursday to the implementation in the field. On Wednesday and Thursday, Dr. Bogachan Benli and Prof. Suleiman lectured trainees on **improving water productivity and conservation agriculture**. Dr. Boubaker Dhehibi lectured on **economics of water**

productivity which was very well received by the trainees. On Saturday morning, the trainees were taken to **Mushaggar research station of ICARDA** where they visited several experiments on supplemental irrigation and laboratories analyzing soil and water samples for physical and chemical parameters.

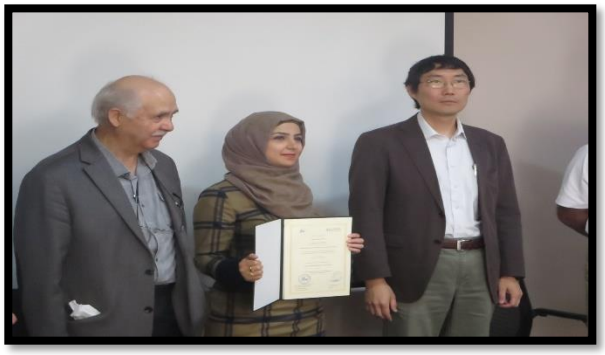
Week 3

Week 3 was devoted to multidisciplinary topics. The week started with a lecture by Drs. Claudio Zucca, ~~Dr.~~ Jutta Werner and ~~Dr.~~ Kathryn Clifton on **rangeland management and resource governance**. On Monday, Mrs. Bezaiet Dessalegn delivered an interesting lecture on **research-for-development approach** which was followed by Dr. Murari Singh's lecture on design and analysis

of water resources experiments using statistics, and lecture by Dr. Chandrashekhar Biradar on the topic of **application of GIS and RS in water and land problem solving**. On Tuesday, the trainees visited **ICARDA's geo-informatics lab** where they got hands-on experience using GIS and remote sensing software and hardware for agricultural water management research and decision making followed by in the afternoon, the trainees were divided into four groups for group presentations for the next day. Each group was given a topic to prepare to present to be chosen among improving water productivity, micro water harvesting, macro water harvesting, and supplemental irrigation topics.

Wednesday was devoted to evaluation of the trainees. They were required to make **group presentations** of 20 minutes each followed by questionsing and group discussion for 10 minutes. The presentations were evaluated for their quality of introduction, definition of objectives, materials and methods to be used, site characterization, techniques for analysis and finally expected results. After the conclusion of group presentations, the trainees took a final test on the topics covered during the preceding three weeks of training. The training coordinator discussed solutions of the questions in the quiz and returned the marked answer sheets to the trainees. This quiz was the same as the quiz the trainees took during the interactive learning session on the first day of the training. The objective of this exercise was to help trainees gauge if their scores had improved at the end of

the training (Please refer to Annex VI). In the afternoon, JICA and CDU representatives conducted an evaluation of trainers by the trainees (Please refer to Annex III).



The last day of the training started with a keynote lecture by Dr. Theib Oweis and was followed by a certificate award ceremony, and feedback from trainees on their experience and suggestions on how to improve the course in the following years.

Group Assessment

The course evaluation was carried out using a knowledge gain measurement method through which participants were subjected to a zero assessment test at the beginning and at the end of the course. The difference in scores of the participants between the two tests are reported in annex IV. The results showed an average of 76% gain in knowledge from the course ranging from 23.6/51pt to 41.6/51pt which is significant for a 3 weeks of training (please refer to Annex IV).

Trainees were divided into 4 groups and were given a topic to prepare for presentation: improving water productivity, micro water harvesting, and macro water harvesting, supplemental irrigation. They were to apply the knowledge gained in the training to prepare the presentations. The score achieved by each group shows that quality of their presentation as the ~~minimum~~ lowest score was 79/100 and the highest 93/100 (please refer to Annex V).

General Course Evaluation by Trainees

At the end of the training, each participant provided feedback on their perception of the effectiveness of the training process, format and content. This gives ~~us~~ ICARDA~~a~~ valuable information from which to validate or fine-tune each training component (sessions, format, content, tec.), as well as the overall training program.

Through training evaluation questionnaires, various evaluations were carried out during the course, including a specific evaluation for each part of the course. Here we present an overview of the final evaluation. Issues considered were the topics and thematic areas of the course, the trainers and the organization, as well as general suggestions (Please refer to Annex III).

Regarding the overall methodology of the training course, most ~~of~~ participants qualified it as excellent (57%) and 36% of participants expressed very good. Participants expressed their interest in giving more time for discussion, case studies~~y~~ and group work.

With respect to the technical level of the topics covered in the training, 84% of the participants considered that the delivered material was useful and effective. Some of them commented that it

i~~'~~s better to have a meeting after two or three years for feedback on~~f~~ how the training affected their work.

Conclusion

The course has provided both theoretical and practical guidance to the trainees in improving water productivity in agricultural systems. The participants nominated for the course were of high quality and appeared eager to participate. ~~ and t~~The mixture between lectures and discussions appeared to work well, and the enthusiasm of the participants over the 3 weeks course appeared to remain high.

The course evaluations support the approach taken, and the pre and post knowledge assessment tests showed an overall improvement in understanding the material.

As per the comments from the trainees and the scientists, trainees would benefit more if the follow up sessions ~~will be~~were held after 2 -3 years. The course is evaluated as successful by the lecturers. However, in the view of capacity development to actually improve skills and techniques on water management with its use efficiency for higher agricultural production, more follow-up (ex. such as a mentoring program) for those who get the highest score in the training should be offered as a non-degree training program under the supervision of ICARDA scientists to apply and tailor~~ing~~ the knowledge gained to the specification of their research and field activities in their own country.

Annex I: Course Program

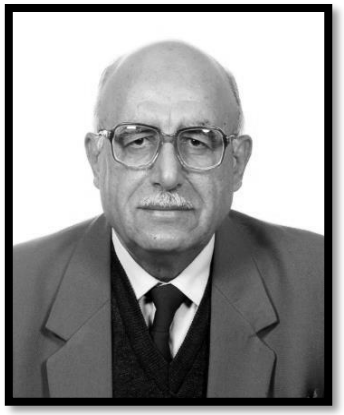
Week 1 (April 24 – 30) Theme 1: Introduction to Agricultural Water Management		
Date	**Topic**	**Responsibility**
Sunday April 24		
08:00 – 09:00	Registration	IWLMP-CDU
09:00 – 10:00	Opening session	ICARDA and JICA
10:00 – 10:15	Course presentation	V. Nangia
10:15 – 11:00	Coffee break and group photo	
11:00 – 13:00	Interactive learning session	A. Hachum, V. Nangia
13:00 – 14:00	Lunch break	
14:00 – 16:00	Improving WP for sustainable dev. of Ag. sys	A. Hachum
Monday April 25		
09:00 – 10:30	Soil moisture relations and monitoring	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 12:30	Photosynthesis and plant water relations	V. Nangia
12:30 – 13:30	Soil nutrient availability/dynamics and crop nutrition under various water regimes – I	A. Suleiman
13:30 – 14:30	Lunch break	
14:30 – 16:00	Soil nutrient availability/dynamics and crop nutrition under various water regimes - II	A. Suleiman
Tuesday April 26		
09:00 – 10:30	Supplemental irrigation (SI): concept & implémentation	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 12:30	SI systems management	A. Hachum
12:30 – 13:30	SI systems evaluation and improvement	A. Hachum
13:30 – 14:30	Lunch break	
14:30 – 16:00	Control and measurement of SI water (delivery systems and distribution)	A. Hachum
Wednesday April 27		
09:00 – 10:30	Evapotranspiration and crop water need	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 12:30	When to irrigate and How much water to apply	A. Hachum
12:30 – 13:30	Irrigation scheduling using FAO 56	A. Hachum
13:30 – 14:30	Lunch break	
14:30 – 16:00	Irrigation scheduling using FAO 56	A. Hachum
Thursday April 28		
09:00 – 10:30	Planning water harvesting systems	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 12:30	Design criteria for water harvesting systems	A. Hachum
12:30 – 13:30	Water harvesting storage system and management	A. Hachum
13:30 – 14:30	Lunch break	

14:30 – 16:00	Water harvesting implementation	A. Hachum
Friday April 29 (Free)		
Saturday April 30 (field visit: Jordan Valley)		
Week 2 (May 1 - 7) **Theme 2: Improving Water Productivity in Rainfed Agro-ecosystems**		
Date	**Topic**	**Responsibility**
Sunday May 1		
09:00 – 10:30	Sustainability of surface and groundwater resources	M. Rahbeh
10:30 – 11:00	Coffee break	
11:00 – 12:30	Quality and quantity consideration	M. Rahbeh
12:30 – 13:30	Interaction between surface and ground waters	M. Rahbeh
13:30 – 14:30	Lunch break	
14:30 – 16:00	Effects of over-pumping	M. Rahbeh
Monday May 2		
09:00 – 10:30	Concept and practices of watershed management science - I	S. Strohmeier
10:30 – 11:00	Coffee break	
11:00 – 12:30	Concept and practices of watershed management science - II	S. Strohmeier
12:30 – 13:30	Watershed modeling for sediment and nutrients losses – I	S. Strohmeier
13:30 – 14:30	Lunch break	
14:30 – 16:00	Watershed modeling for sediment and nutrients losses - II	S. Strohmeier
Tuesday May 3		
09:00 – 16:00	Visit *Mahreb* region to see water harvesting research	
Wednesday May 4		
09:00 – 10:30	Importance of improving water management in rainfed agriculture - I	B. Benli
10:30 – 11:00	Coffee break	
11:00 – 12:30	Importance of improving water management in rainfed agriculture - II	B. Benli
12:30 – 13:30	Conservation agriculture for improving soil water conservation and soil health - I	A. Suleiman
13:30 – 14:30	Lunch break	
14:30 – 16:00	Conservation agriculture for improving soil water conservation and soil health - II	A. Suleiman
Thursday May 5		
09:00 – 10:30	Interventions for improving water productivity in rainfed agriculture - I	B. Benli
10:30 – 11:00	Coffee break	
11:00 – 12:30	Interventions for improving water productivity in rainfed agriculture - II	B. Benli
12:30 – 13:30	Economics of water productivity - I	B. Dhehibi
13:30 – 14:30	Lunch break	
14:30 – 16:00	Economics of water productivity - II	B. Dhehibi

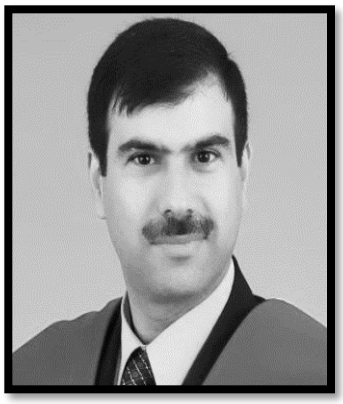
Friday May 6 (Free)		
Saturday May 7 (field visit Mushaggar supplemental irrigation project, in-charge: A. Qudeisat, A. Hachum, V. Nangia)		
Week 3 (May 8 – 12) **Theme 3: Taking a Multidisciplinary Approach to Look at the Bigger Picture**		
Date	**Topic**	**Responsibility**
Sunday May 8		
09:00 – 10:30	Sustainable land management, strategies and indicators of effectiveness	C. Zucca
10:30 – 11:00	Coffee break	
11:00 – 12:30	Case study: Scaling sustainable land management with multiple stakeholders	J. Werner
12:30 – 13:30	Review of Payment for Ecosystem Services (PES)	K. Clifton
13:30 – 14:30	Lunch break	
14:00 – 15:00	Review of rangelands	K. Clifton
Monday May 9		
09:00 – 10:30	Questioning the research-for-development (R4D) approach	B. Dessalegn
10:30 – 11:00	Coffee break	
11:00 – 12:30	Design and analysis of water resources experiments - I	M. Singh
12:30 – 13:30	Design and analysis of water resources experiments - II	M. Singh
13:30 – 14:30	Lunch break	
14:30 – 16:00	Introduction to GIS and remote sensing applications	C. Biradar
Tuesday May 10		
09:00 – 10:30	GIS applications in rainfed agriculture water management decision making	M. Haddad
10:30 – 11:00	Coffee break	
11:00 – 12:30	Visit Geoinformatics labs	ICARDA GU lab staff
12:30 – 13:30	Return to hotel and prepare for group presentations	
13:30 – 14:30	Lunch break	
14:30 – 16:00	Prepare for group presentations	
Wednesday May 11		
9:00 – 10:30	Group presentations by trainees	IWLMP
10:30 – 11:00	Coffee break	
11:00 – 13:30	Testing and evaluation of trainees	IWLMP
13:30 – 14:30	Lunch	
14:30 – 16:00	Feedback to trainees, course evaluation and recommendations	IWLMP
Thursday May 12		
9:00 – 10:30	Special lecture	T. Oweis
10:30 – 11:00	Coffee break	
11:00 – 12:00	Award of certificates and closing session	ICARDA/JICA
12:00 – 13:00	Farewell lunch	
Friday May 13 (Departure)		

Annex II: Trainers

Mr. Abdallah A. Qudeisat holds a B.Sc. degree in land, water and environment from the University of Jordan. He is employed as field research assistant in Integrated Water & Land Management Program of ICARDA since Jan, 2015. Prior to this, Mr. Qudeisat was a science teacher teaching physics, biology and geology to high school students in Ma'an. He also worked as site engineer implementing landscaping and irrigation system projects for Mahmud and Bassam Al-Akhras Company.



Dr. Ahmed Y. Hachum is a professor of Farm Irrigation and Water Management at the College of Engineering, University of Mosul (MU), Mosul, Iraq. He earned his B.Sc. in civil and irrigation engineering from University of Baghdad (1967) and M.Sc. (1973) and Ph.D. (1976) in Agricultural and Irrigation Engineering from Utah State University, Logan, Utah, USA. He joined Utah State University staff for one year as Postdoctoral appointee and worked for one year as consultant in **Keller-**Bliesner **Engineering, USA.** Head of the Irrigation and Drainage Engineering Department, MU during 1992 to 1997; Editor in Chief for the *Al-Rafidain* Engineering Journal (MU) for several years; consultant for the Ministries of Irrigation and Agriculture in Baghdad for many years. His main field of interest includes: farm irrigation systems design and management, water harvesting, supplemental irrigation, deficit irrigation, and improvement and optimization of agricultural water productivity. Dr. Hachum is the author of more than 80 technical publications, including 74 refereed publications, book chapters and technical reports, and two textbooks on irrigation principles, planning, Design, and management. His current research is focusing on the improvement of water productivity for rainfed and irrigated agriculture through improved farm water management and better production input. He is privileged for being visiting scientist and consultant at ICARDA several times during the last 17 years. He supervised numerous graduate students and teaches different graduate courses in mechanized and modern irrigation systems, farm irrigation water management, drainage engineering, simulation and mathematical modeling, optimization and system analysis.



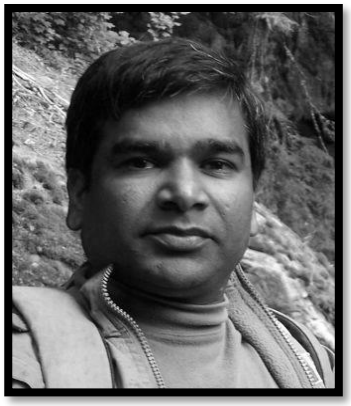
Dr. Ayman Suleiman is a professor of crop and agricultural water modeling in the Department of Land, Water and Environment, Faculty of Agricultural, University of Jordan. He obtained his B.S. and M.Sc. degrees from the University of Jordan and his Ph.D. degree from Michigan State University, USA. He has taught Environmental Soil Physics, Environmental Systems Modeling, and Continuum and Soil-Water-Plant Relations courses and supervised many graduate students. He has developed simple physically-based models to simulate soil water dynamics during evaporation and vertical and lateral drainage some of these models have been incorporated into different crop models in the USA (DSSAT) and in Europe (GLAM). Also, his soil evaporation model was included in the American Society for Civil Engineers (ASCE) Manual 70 – Second Edition: Evaporation, Evapotranspiration and Irrigation Requirements that was published in 2015. He developed Analytical Land-Atmosphere Radiometer Model (ALARM) which estimates actual crop water requirements from remotely-sensed data. He worked for five years in the USA after completing his Ph.D. before joining the University of Jordan. He is the most-cited faculty member at his department at the University of Jordan with a Google Scholar h-index of 13 and 642 citations. He has published 29 peer-reviewed journal articles, one book chapter and about 10 proceeding articles and given more than 25 national and international conference presentations. His main research areas are agricultural water modeling and management, crop simulation modeling, climate change impact on crop water requirements and production, evapotranspiration and soil water dynamics modeling.

Mrs. Bezaiet Dessalegn (Beza) holds an ABD for Ph.D. in International Relations and Public Policy from Purdue University (USA), two Masters Degrees one in International Relations and Public Policy from Purdue University and another in International Development from Clark University (USA). Beza has over 15 years of experience in the field of development working for various international non-governmental organizations and donor agencies such as USAID. Beza also worked as an independent instructor on teaching Public Policy at Purdue University. Beza has been with ICARDA since 2011 working under different capacities. Currently she holds the position of Associate Scientist under the Integrated Land and Water Program. Her areas of focus are *Livelihoods, Gender, and Monitoring and Evaluation*. Beza's areas of research interests include women in agriculture, food security, livelihoods, and linking research to development.

Dr. Bogachan Benli is a Water Management scientist, with 21 years of experience in Pressurized

Irrigation Systems, Supplementary Irrigation, Deficit Irrigation, Water Management, Modeling, Water Harvesting, Water and Sanitation, Adaptation to Climate Change, Irrigation Economics and Monitoring and Evaluation. He holds a Ph.D., in Drip Irrigation Systems from Natural Sciences Department of Ankara University. A post Universitarie degree on Agricultural Economics and Modeling from IAMM in Montpellier (France). He is presently a Senior Irrigation and Water Management Specialist at ICARDA's Nile Valley office in Cairo. He was a post-doc specialist between the years 2004-2007 at ICARDA HQ, and responsible for the Water Benchmarks project regional coordination, in some 10 countries of Middle East and North Africa. Following his tenure at ICARDA, he has joined at United Nations Development Program (UNDP), where he managed a Regional Water Partnership program called "Every Drop Matters" between the years 2007 and 2010 in the countries of East Europe and CIS region. Between the years 2010 and 2014, he managed the Global Program of "Inclusive Community Based Water Management and Adaptation to Climate Change Project for Catalyzing Achievement of the MDGs" in East Europe, CIS, Middle East and Asia Pacific Countries at UNDP. He has wide experience in Agricultural Water Management, Water & Sanitation and Adaptation to Climate Change in some 30 developing countries. He has authored and co-authored more than 9 peer-reviewed publications, 6 book chapters, 9 technical reports and 20 conference papers, etc. He is an active member of Turkish Scientific Council since 2006. His current research interests focus on Water Management and Modeling.

Dr. Boubaker Dhehibi is an Agricultural Resource Economist Specialist in the Social, Economics and Policy Research Program (SEPRP) at ICARDA. He is distinguished for his research and teaching on production economics, climate change, economics of natural resources management, applied micro-econometrics, food demand analysis, international trade, economic modeling, competitiveness and productivity analysis of the agriculture sector in MENA region, growth analysis and economics of development. He has published more than 80 research publications in peer reviewed journals, book chapters, international conferences, working papers and proceedings.



Dr. Chandrashekhar Biradar (Chandra) is a principal agro-ecosystems scientist and heads ICARDA's Geoinformatics Unit which provides Geospatial Science, Technology and Application (GeSTA) for ICARDA and the CGIAR Research Program on Dryland Systems. Dr. Biradar received a B.Sc. degree from University of Agricultural Sciences, and M.Sc. degree in genetic engineering and a Ph.D. in remote sensing and environmental sciences from the IIRS, Department of Space, ISRO and University of Pune, India. Dr. Biradar was subsequently a post-doctoral fellow at IWMI and then at the Institute for the Study of Earth, Ocean and Space (EOS), USA. Then served as a research professor, research scientist, senior research scientist, and EOS manager at the University of New Hampshire and University of Oklahoma, USA while working on number of federally-funded projects. Over the last 15 years, he has played a key role, as one of the lead researchers, in producing the first satellite sensor based global irrigated and rainfed croplands, developed a number of remote sensing based innovative methods, algorithms, and tools related to agro-ecosystems, biodiversity assessments, water productivity, eco-epidemiology, climate change and ex-ante impact assessments. Dr. Biradar has authored over 150 publications, which include 43 refereed journal publications, 18 books/chapters, and over 90 other publications. His current research interest is towards developing geospatial mechanisms for delivering better interventions and a package of practices to reach out to smallholding farmers to improve food security and livelihood in the dry areas of the world.

Dr. Claudio Zucca is Soil Conservation and Land Management specialist within the Integrated Water and Land Management (IWLM) Program of ICARDA, in Amman, Jordan. Dr. Zucca has a Ph.D. in Pedology. Before joining ICARDA he was employed as a senior researcher at the University of Sassari (Italy), where he worked at the Department of Agricultural Sciences and at the Desertification Research Centre (NRD). His studies mainly addressed land degradation, particularly soil erosion, and land evaluation, and were characterized by interdisciplinary approaches integrating fieldwork and geomatics. His most recent research was focused on evaluating the impacts of land restoration and soil conservation practices on the provision of ecosystem goods and services. Additionally, as a consequence of his strong interest in soil genesis and geography, he performed basic pedologic research and took part to several soil survey and mapping studies. He has 25 ISI publications.

Dr. Jutta Werner is a Rangeland Scientist at ICARDA's Diversification & Sustainable Intensification of Production Systems (DSIPS) Program. Dr. Werner has 12 years of professional experience in sustainable land management in the scope of development cooperation in various countries. One of her main areas of work was the development of sustainable agropastoral land use management systems in conflicting environments by means of local use agreements. During three years, she has managed the component "natural resources management" of a rural development program (German International Development Cooperation (GIZ) in Chad. Dr. Werner has a Ph.D. degree in Agronomy from Humboldt-University, Berlin, Germany. The subject of her dissertation was the development of a scientific basis in order to determine appropriate measures to implicate pastoralists in sustainable land management projects in dry areas in Morocco. Further, she has successfully completed a Master of Advanced Studies in Economics and Management (Technical University Kaiserslautern, Germany). During the last six years Dr. Werner was employed as a "Senior Scientist" at the Swiss Federal Institute of Technology in Zurich (ETH) where she developed training courses in the fields of rural development, adaptation to climate change, project management and results based monitoring. Further, she was engaged in research and consultancy assignments for ministries and various actors of development cooperation. The main responsibilities of Dr. Werner at ICARDA are to address key issues related to environmental change and/or food security in drylands pastoral and agro-pastoral ecosystems.

Dr. Kathryn Clifton is a Landscape Ecologist in the Rangeland Ecology & Management. Dr Clifton is a USA national and belongs to the Diversification & Sustainable Intensification of Production Systems (DSIPS) Program. She has completed her PhD degree in Ecosystem Science and Management from Texas A&M University, USA in May 2014 where she did her dissertation on Linking Institutional Characteristics to Successful Communal Land Management in Cumbres de Monterrey Nationa Park, Mexico. Dr. Clifton has practical experience working in developing countries including the Philippines on a USDA funded Agro-Enterprise project and as a Technology Adviser for Asia, as a GIS Specialist in Baltimore, and as a Research Assistant on a Forage Prediction project in Mongolia with Texas A&M University. Before joining ICARDA she spent a semester at the FAO through the Texas A&M Agriculture and Natural Resources Policy Fellowship. Dr Clifton has worked as part a team on the following projects: forage prediction modeling, pine beetle infestation modeling for different climate change scenarios, household surveys creation and analysis, and the application of GIS and remote sensing in rangelands.

Ms. Luma Ibrahim Abu Atileh holds B.Sc. degree in chemical engineering from Jordan University (2003). Her work experience includes position of soil and water laboratory supervisor at ICARDA since April, 2014, quality assurance and supervisor of fertilizer analysis laboratory at Al Mada for Chemical Industries Co. and as quality officer and lab supervisor at National Center for Agricultural Research and Extension of Jordan.

Dr. Michel Rahbeh is an assistant professor at the Department of Land, Water and Environment, Faculty of Agricultural, University of Jordan. He teaches hydrology, water resources management, and irrigation courses. He obtained his Ph.D. degree from Purdue University, USA (2004). He has a comprehensive expertise in soil water flow, contaminant transport, and numerical as well as conceptual modelling He was instrumental in developing and writing a multi-phase numerical flow and transport model for the evaluation of soil and groundwater remediation by air sparging. He also participated in the "Watershed Evaluation for Beneficial Management Practices (WEBs)" of Agriculture and Agri-Food Canada as the principal hydrological modeler for the WEBs watershed, the Lower Bow River watershed (LLB), in Alberta, where he devised a methodology for the automatic calibration and validation of SWAT. His recent research endeavours includes the preferential soil water flow and contaminant transport, watershed modelling for evaluation of sustainable management practices aimed at minimizing soil erosion and adapting watershed water management to the impacts of climate change.

Mrs. Mira Haddad is an agriculture engineer/water and environmental management. She is specialized in spatial analysis and database management. Mira joined ICARDA three years ago as research assistant in the Integrated Water and Land Management Program. Mira assists the Program scientists by providing and preparing databases, function hydrological models for watershed management and predicting climate change impacts, in defining suitable and similar areas to adapt agriculture technologies, and research project implementation including communication and facilitation between scientists and local communities and government institutions. Through her work, she has specialized in data collection and working with large set of database, she is aware of different scientific global, regional, and national data available. Also, she helps in providing

training workshops organized by the Program. Before ICARDA, she worked in United Nation University, private and public sectors as environmental and GIS specialist with a private sector she worked to identify site location and site characteristics for big projects locations in Jordan.

Dr. Murari Singh is Senior Biometrician and Executive Assistant to the Deputy Director General – Research at ICARDA. He holds a Ph.D. in Agricultural Statistics, with a major in design of experiments and minors in genetic statistics and agricultural economics, from the Indian Agricultural Research Institute, New Delhi, India. He is a Professional Statistician accredited by Statistical Society of Canada. Over the past 38 years, he has served in various capacities, including assistant professor, associate professor, scientist, statistician and senior biometrician – at three Indian institutions, three North American Universities and two CGIAR Centers. He has jointly published over 160 journal articles. He is currently serving as an Associate Editor on two journals in Statistics and was a Guest Editor for a Journal. He has served as the Sessional President of the 67th Annual Conference of the Indian Society of Agricultural Statistics and delivered a talk on "Statistical Research Issues in Crop Experiments for Enhancing Food Security Support" on 18 December 2013. He has contributed to the development of databases on Long-term Trials, Seed Management and a Data-care project. Dr. Singh has taught undergraduate and postgraduate students (4 years in a Canadian University) and has conducted over 100 in-country/regional short-term specialized training courses in statistics and computer applications at ICARDA since 1989. He has guided more than ten students of M.Sc. degrees, Post-graduate diplomas and Ph.D. degrees in Statistics, Genetics and Plant and Animal Breeding.

Dr Naem Mazahrih is currently Assistant Director General for Research, National Center for Agricultural research and Extension (NCARE). He worked for the ICARDA Arabian Peninsula Regional Program (APRP) as Irrigation and Water Management Scientist from 2012 to 2016. Dr. Naem undertook one sabbatical year of research on soil physics and water management at the Agricultural Research Service, Parlier, CA, USA with the USDA scientists during 2005, and he has a Ph.D. in Agriculture and Environmental resources awarded in 2001 and a Master degree in Soil and Irrigation awarded in 1993 from the University of Jordan. Experience of Dr. Naem extends to 20 years in the area of Water management in the National Center for Agricultural Research and Extension (NCARE). Dr. Naem worked as a director for Deir-Alla Regional Center for Agricultural Research and Extension from 2009 to 2012, and he was coordinator for several different projects of water saving, fertigation and crop water requirements under protected cultivation and in the open field. He was a part time instructor, teaching Irrigation system design Course at AL-Balq'a Applied University and participated in many scientific conferences and as trainer also he published more than 25 scientific papers and seminars.

Dr. Stefan Strohmeier is postdoctoral Soil and Water Conservation scientist at IWLMP at ICARDA Amman. He earned his M.Sc. in Environmental Engineering and Water Management at BOKU University in Vienna, Austria, in 2009, and his Ph.D., in Environmental Engineering, also at BOKU University Vienna in 2014. Moreover, he has an engineering grade (Ing.) in Civil Engineering gained from Higher Technical School in Villach, Austria. He worked at a Geo-Technics company in Vienna from 2009 to 2010, and as Research Assistant at BOKU University from 2010 to 2014. During this time, he lectured various courses related to the Institute of Hydraulics and Rural Water Management at BOKU University, and moreover, he co-supervised multiple Master students of the Environmental Engineering and Water Management program. His main research focus is on agricultural hydrology, land degradation and soil erosion issues on experimental basis as well as using hill slope and watershed scale hydraulic/hydrologic models. He published different papers in international ISI journals focusing on surface hydrology and soil and water conservation.

Dr. Theib Oweis is a water resources planning and management scientist, with over 40 years of experience in international research and education, development and human capacity building and in the management of water for agriculture especially in water scarce dry environments. He holds an M.Sc. and Ph.D. degrees in Agricultural and Irrigation Engineering from Utah State University, Logan, Utah, USA in 1979-1983, and BSc in Agriculture from Aleppo University in Syria in 1968-1972. He is the former director of the Integrated Water and Land Management Program at the International Center for Agricultural Research in the Dry Areas (ICARDA). Since 1991, he has joined ICARDA and worked in several capacities as scientist, principal scientist, research team leader and research manager. Earlier, he joined the University of Jordan, in Amman, as an assistant professor in irrigation and drainage engineering and in the 70's worked for Dar Al Handash Consultants (Shaer and Partners) as a field irrigation engineer in south Yemen. He is an author of over 200 refereed journal publications, books/book chapters and conference proceedings in the areas of water use efficiency, supplemental irrigation, water harvesting, water productivity, deficit irrigation, salinity and the management of scarce water resources; coordinating Lead author of water productivity and the Rainfed Agriculture of the Comprehensive Assessment of water management.

Dr. Vinay Nangia is a Senior Agricultural Hydrologist at ICARDA, associate professor at International Platform for Dryland Research & Education of Tottori University (Japan) and an adjunct faculty at the Texas A&M University (USA). He received his Ph.D. in Water Resources Science and two M.S. degrees - one in Biosystems & Agricultural Engineering and another in Geographic Information Science - all from the University of Minnesota (USA). Throughout his career, he has applied skills in hydrologic and crop modeling, and GIS and remote sensing to research issues relating to climate change, climatic variability, conservation agriculture, water quality, water productivity, land degradation and sustainable crop production. During an 11-year research career, he has served as a PI or co-PI on research projects worth about $5.75 million, authored or co-authored 59 technical publications that include 35 refereed journal articles in national or international journals. Dr. Nangia is an internationally-recognized authority in hydrologic and water quality modeling and GIS applications in water resources management. He has offered more than 20 trainings (covering a total of 400 participants) on hydrologic modeling in 10 countries. Dr. Nangia serves on the editorial boards of professional society journals. He has served as research advisor/committee member to M.S. and Ph.D. students and was a visiting professor (2007-2011) at the Institute of Soil and Water Conservation of the Chinese Academy of Science. Previously, Dr. Nangia was a NSERC Visiting Fellow at Agriculture and Agri-Food Canada conducting research on GHG emissions from subsurface tile-drained croplands of Eastern Ontario prior to which he was a post-doctoral fellow at the International Water Management Institute (IWMI), where he started his career in 2005.

Annex III: General course evaluation

I. Contents of the course:

Item/rating/percentage	1	2	3	4	5
Relevance of the course to your job 1=Not relevant; 5=Very relevant			4.4		
Accomplishment of subject matter 1=Inadequate 5=Very comprehensive			4.2		
Clarity of course objectives 1=Not clear; 5=Very clear			4.3		
Level of lectures 1=Too basic 5=Too			3.9		
Time allocated for discussions 1=Too short 5=Too long			3.5		
Interaction with participants enrolled in the course 1=Very low 5=Very high			4.2		
Overall, how would you rate this course 1=Poor 5=Excellent			4.6		

II. Schedule and time allocation:

Item/rating/percentage	1	2	3	4	5
Percentage of Time allocated to lectures 1=Too short 5=Too long			3.8		
Usefulness of Lectures 1=not useful 5=useful			4.5		

III. Teaching aids:

Item/rating/percentage	1	2	3	4	5
Effectiveness of teaching aids in general 1=Not effective 5=Very effective			4.2		
Clarity of slides/overheads/PowerPoint 1=Not clear 5=Very clear			3.4		
Handouts and material 1=Not useful 5=Very useful			4.2		

IV. Administrative arrangements:

Item/rating/percentage 1=NI 5=Excellent	1	2	3	4	5
Pre-course communication	4.4				
Travel arrangements	4.8				
Quality of the accommodation	4.9				
Payment of allowance on time	4.6				
Transportation	4.6				
Lecture rooms	4.1				

V. Your comments and suggestions on the course:

1. Please state the three most important ideas/concepts that you learned from this course

- Management water resources and soil
- Water harvesting technique and supplemental irrigation
- The important of water productivity to improve water use
- Exchange knowledge with different countries
- How to measure water productivity
- Seeing the fields on site
- Water economic
- New irrigation methods
- Water shed modeling-range land
- Climate change

2. Suggestions for future improvement of the courses

- Increase visit to the farms to effected subject
- Field visits and lab visit are very useful, if possible visit more sites
- Increasing the time to lectures
- Tell the trainees about the case study topics earlier. Exams can be in a separate day from the presentation day, give notice to trainees before attending the course about the assessment exam.
- Lectures should be more based on excises and case studies
- The presentations subjects that the trainees had to do at the end should have been given since the first week so we could have more time to prepare
- Good to have a meeting after two or three years for feedback of how the training affected our work.

3. Do you recommend this course to be repeated in the future?

Yes ☐ No ☐

100%