Third Country Training Program (TCTP) for Iraq

Technical Report

ICARDA-JICA Joint Training Course

on

Improving Water Productivity in Agricultural Systems with emphasis on irrigated production systems

International Center for Agricultural Research in the Dry Areas
May 3-21, 2015
Amman, Jordan

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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)

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

National Center for Agricultural Research and extension (NCARE) - Hashemite Kingdom of Jordan

Purpose

To enhance capacity development of government officials and researchers who are engaged in irrigation projects and agricultural development mainly in Iraq

Specific objectives

Up-to-date knowledge and enhanced capacity in Improving Water Productivity in Agricultural Systems with emphasis on irrigated production systems

Specific outputs

9 professionally-trained NARS partners from Iraq, 2 from Jordan, 1 from Eritrea, 2 from Pakistan and 2 from Egypt on Water Productivity in Agricultural Systems with emphasis on irrigated production systems.

Amongst them 9 Iraqis, 2 Jordanians, 1 Eritrean and 1 Egyptian were funded by JICA (see Annex VI).

Specific outcomes

Trainees able to

- Design, implement, manage, analyze and report on research and development in the area of water productivity in irrigated 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 irrigated agriculture

Introduction

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 capture of new water resources, and there is a tendency toward 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 livelihoods 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 irrigated environments. The purpose of the course is to provide participants with the necessary practical and theoretical information to improve water productivity in irrigated 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 irrigated 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 irrigated agriculture

Organization of the Course

With financial support from the Japan International Cooperation Agency (JICA), through its overseas office in Syria and 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 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 material was 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

- Dr. Theib Oweis, Director, ICARDA Integrated Water & Land Management Program (IWLMP)
- Mr. Charles Kleinermann, Head, ICARDA Capacity Development Unit (CDU)
- Dr. Vinay Nangia, ICARDA Agricultural Hydrologist, Course Coordinator

Course Content

The course comprised of four modules:

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 irrigation water management and water productivity and on one of the two agro-ecosystems covered by the course (supplemental irrigation and full irrigation). 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 irrigation 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 irrigated farming
- Improving traditional irrigation systems and modernization
- Planning, design and implementation of irrigation systems
- Soil-water relations (measurements, monitoring and modeling)
- Salinity assessment and management at different scales
- 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 (4 trainees in each group) on a water management research projects under guidance. They gained experience in the development and evaluation of water-management systems for irrigation and for improving water productivity in irrigated 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 the program of the course). This way the trainees could directly and actively experience and practice what they heard and discussed in the lectures. During the research module at the end of the course, the trainees received 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. Next day, Dr. Usman Khalid Awan refreshed the knowledge of the trainees on soil-water-plant relationship, and Dr. Claudio Zucca delivered lectures on soil texture and water retention, and photosynthesis and plant water relations.

Next day, Prof. Shimizu from Tottori University delivered guest lecture on the topic of principles and methods of hydrological observations, and Prof. Hachum from Mosul University delivered lectures on surface irrigation management and introduction to modern irrigation systems.

On Wednesday, the trainees heard lecture on sprinkler and drip irrigation system performance evaluation and improvement. On Thursday, 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 Saturday, the trainees were taken for a field visit to University of Jordan research station in the Jordan Valley which was a very well-received trip.

Week 2

Dr. Rahbeh of University of Jordan on the first two days of second week delivered lectures on the burning topic of groundwater use for agriculture.

Prof. Hachum devoted two days of the week lecturing on salinity assessment and management, and drainage principles and design.

On Monday afternoon, Prof. Fujimaki of Tottori University lectured on determination of irrigation depth to maximize net return.

On Wednesday morning, the trainees were taken to Mushaggar research station of ICARDA where they visited experiments on supplemental irrigation, rainwater harvesting for olive and shrubs growing and laboratories analyzing soil and water samples for physical and chemical parameters. In the afternoon, Dr. Stephan Strohmier lectured on application of Soil & Water Assessment Tool (SWAT).

The Saturday field visit was to hydroponics experiment of EcoConsult Company. The project is funded by the USAID and the visit was facilitated by the team of EcoConsult. This was first time that the course introduced the topic of use of hydroponics for agricultural production.

Week 3

Week 3 was devoted to multidisciplinary topics. The week started with lecture by Mr. Atef Haddad who shared his knowledge and experience on the topics of conservation agriculture and water-efficient agricultural production. Later, Dr. Werner lectured on rangeland resource governance which was followed by a lecture on economics of water0use efficiency and productivity and a lecture on research-for-development approach.

On Monday, 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. Same afternoon, the trainees were divided into four groups for group presentations the next day. Each group was given a topic to prepare and present. They had choice between water productivity, full irrigation (two groups) and water harvesting topics to choose from.

Wednesday and Thursday were devoted to evaluation of the trainees. They were required to make group presentation for 20 minutes followed by questioning 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 tests on the topics covered during the preceding three weeks of training. After the break, 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. In the afternoon, JICA and CDU representatives conducted an evaluation of trainers by the trainees.

The last day of the training started with certificate awarding ceremony, followed by group photos, tea break and feedback from trainees on their experience and suggestions on how to improve the course in the following years. For the lunch break, ICARDA staff joined the trainees.

All trainees departed for their respective destination on Friday, May 22nd.

ZERO and FINAL TEST ASSESSMENT

A zero assessment test was conducted on the first day of the training in which trainees were unprepared and were tested for their background knowledge on the topics to be covered during the training course. The test was out of a maximum 44 point and the highest score was 38 whereas the lowest score was 7 with 52% being the average.

The same test (with additional questions added to cover lectures given by Japanese professors) was taken by the trainees at the end of the course and the average group scores improved by reached 79% with the lowest score now being 18 and the highest now being 49 (out of 51 maximum possible score) with an group average score improving by 27%. (See details in Annex III).

GENERAL COURSE EVALUATION by TRAINEES

Overall, the evaluation of the course by the participants was positive (details in annex V). The list of the three most interesting ideas/concepts that the trainees learned in the course actually includes all course topics. This shows the heterogeneity in the scientific and professional background of the trainees but also that all topics were relevant to trainees. They stressed that the main relevant topics were on concept of water productivity, deficit irrigation and different irrigation designs-schedules and spacing.

The trainees also suggested that more time should be dedicated to cost-benefit analysis.

CONCLUSION

The participants nominated for the course were of high quality. The participants were eager to participate.

The mixture between lectures and discussions appeared to work well, and the enthusiasm of the participants over the three weeks course appeared to remain high.

The course evaluations support the approach taken, and the pre and post knowledge assessment tests show an overall improvement in understanding the material, trainees gained knowledge on Design, implement, manage, analyze and report on research and development in the area of water productivity in irrigated agriculture; acquired up-to-date information on research and practical activities in the management of water resources in each participating country and on integrated natural resource management approach to optimize the use of scarce water resources in irrigated agriculture.

LIST of ANNEXES

ANNEX I: Program

Week 1 (3 -7 May 2015) Theme 1: Introduction to Agricultural Water Management		
Date	**Topic**	**Responsibility**
Sunday 3 May		
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	T. Oweis, V. Nangia
13:00 – 14:00	Lunch	
14:00 – 16:00	Improving water productivity for sustainable development of agricultural systems	V. Nangia
Monday 4 May		
09:00 – 10:30	Soils and soil fertility	C. Zucca
10:30 – 11:00	Coffee break	
11:00 – 12:30	Soil properties affecting water retention and soil-water-plant relationship	C. Zucca
12:30 – 13:30	Water infiltration and surface runoff in irrigated fields	U. K. Awan
13:30 – 14:30	Lunch	
14:30 – 16:00	Surface irrigation principles	U. K. Awan
Tuesday 5 May		
09:00 – 10:30	Principles and methods of hydrological obs. - I	K. Shimizu
10:30 – 11:00	Coffee break	
11:00 – 12:30	Principles and methods of hydrological obs. - II	K. Shimizu
12:30 – 13:30	Surface irrigation systems and management	A. Hachum
13:30 – 14:30	Lunch	
14:30 – 16:00	Introduction to modern irrigation systems	A. Hachum
Wednesday 6 May		
09:00 – 10:30	Sprinkler and Drip/Trickle irrigation systems	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 13:30	Irrigation systems' performance evaluation & improvement - I	A. Hachum
13:30 – 14:30	Lunch	
14:30 – 16:00	Irrigation systems' performance evaluation & improvement - II	A. Hachum
Thursday 7 May		
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	
14:30 – 16:00	Irrigation scheduling using FAO 56	A. Hachum
Friday 8 May (Free)		
Saturday 9 May (field visit: Jordan Valley – irrigated agriculture)		

Week 2 (10 – 14 May 2015) Theme 2: Improving Water Productivity in Irrigated Agro-ecosystems (with focus on drainage and salinity management)		
Date	**Topic**	**Responsibility**
Sunday 10 May		
09:00 – 10:30	Case study – irrigated agriculture in Uzbekistan	F. Akhtar
10:30 – 11:00	Coffee break	
11:00 – 13:30	Sustainability of surface and ground water resources	M. Rahbeh
13:30 – 14:30	Lunch	
14:30 – 16:00	Quality and quantity consideration	M. Rahbeh
Monday 11 May		
09:00 – 10:30	Interaction between surface and ground waters	M. Rahbeh
10:30 – 11:00	Coffee break	
11:00 – 12:30	Effects of over pumping	M. Rahbeh
12:30 – 13:30	Determination of irrigation depth to maximize net return – I	H. Fujimaki
13:30 – 14:30	Lunch	
14:30 – 16:00	Determination of irrigation depth to maximize net return - II	H. Fujimaki
Tuesday 12 May		
09:00 – 10:30	Salinity problems in soil and water in irrigated agriculture	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 12:30	Salinity assessment on a large scale base	A. Hachum
12:30 – 13:30	Managing salinity – I	A. Hachum
13:30 – 14:30	Lunch	
14:30 – 16:00	Managing salinity – II	A. Hachum
Wednesday 13 May		
09:00 – 09:30	Travel to Mushaggar Research Station	
09:30 – 10:30	Visit experiments at Mushaggar Research Station	A. Qudeisat
11:00 – 12:00	Visit IWLM Program soil and water labs	L. Abu Atileh
12:00 – 13:00	Coffee break and return to Amman	
13:00 – 14:00	Watershed Modeling for sediment and nutrients losses (SWAT model) – I	S. Strohmeier
14:00 – 14:30	Lunch	
14:30 – 16:00	Watershed Modeling for sediment and nutrients losses (SWAT model) - II	S. Strohmeier
Thursday 14 May		
09:00 – 10:30	Drainage principles and management – I	A. Hachum
10:30 – 11:00	Coffee break	
11:00 – 12:30	Drainage principles and management - II	A. Hachum
12:30 – 13:30	Crop stress due to salinity and impact on yield – I	A. Hachum
13:30 – 14:30	Lunch	
14:30 – 16:00	Crop stress due to salinity and impact on yield - II	A. Hachum
Friday 15 May (Free)		
Saturday 16 May (field visit – Ecoconsult hydroponics facility)		

Week 3 (17 – 21 May 2015) Theme 3: Taking a Multidisciplinary Approach to Look at the Bigger Picture		
Date	**Topic**	**Responsibility**
Sunday 17 May		
09:00 – 10:30	Conservation agriculture for improved water productivity	A. Haddad
10:30 – 11:00	Coffee break	
11:00 – 12:30	Rangeland resources governance	J. Werner
12:30 – 13:30	Economics of water-use efficiency and productivity	B. Dhehibi
13:30 – 14:30	Lunch	
14:30 – 16:00	Questioning the research-for-development approach	B. Dessalegn
Monday 18 May		
09:00 – 10:30	Case study on crop water requirement estimation	M. Jitan
10:30 – 11:00	Coffee break	
11:00 – 13:30	Design and analysis of water resources experiments	M. Singh
13:30 – 14:30	Lunch	
14:30 – 16:00	Introduction to GIS and remote sensing applications in agricultural water management	C. Biradar
Tuesday 19 May		
09:00 – 10:30	Visit Geoinformatics labs	ICARDA GU lab staff
10:30 – 11:00	Coffee break	
11:00 – 12:30	Return to hotel	
12:30 – 13:30	Prepare for group presentations	
13:30 – 14:30	Lunch	
14:00 – 15:00	Prepare for group presentations	
Wednesday 20 May		
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	IWLMP
Thursday 21 May		
9:00 – 10:30	Course evaluation and recommendations	IWLMP
10:30 – 11:00	Coffee break	
11:00 – 12:30	Award of certificates and closing session	ICARDA/JICA
12:30 – 13:30	Lunch	
Friday 22 May (Departure)		

ANNEX II: About the 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.

Mr. Atef Haddad is an Associate Scientist, Agronomist at Diversification Intensification of Production Systems ICARDA, graduated from Aleppo joined Aleppo University as Lecturer Agronomy and Plant Protection International Center for Agricultural Areas (ICARDA) in 1977 as a research unit, conducted an intensive regional special focus on parasitic weeds. In Agronomy team on transfer of ICARDA improved practices to farmers; this includes crop management, variety assessment and technical surveys. In 1995 worked as research associate on the introduction of oil seed and other ICARDA non mandate crops, this includes adoption, crop management, crop rotations and modeling. In 2005 coordinated Conservation Agriculture ACIAR Iraq R&D project as an associate scientist, conducted CA basic research, development of local ZT machinery and dissemination of ZT technology in Iraq and the region. Haddad contributed in delivering crop and weed management training, participatory extension, CA and ZT machinery. Haddad has supervised undergraduate and graduate students and has published many scientific papers and book chapters. He contributed in many national and international technical committees.

and Sustainable Program (DSIPSP) at University-Syria in 1975, Assistant in Botany, departments. Joined the Research in the Dry assistant in weed control herbicide screening with 1985 worked with

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.

Mrs. Bezaiet Dessalegn (Beza) holds an ABD for PhD 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 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 a principal agro-ecosystems scientist who 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 plus other publications. Dr. Biradar has been recognized with a number of international awards and honors such as the Young Scientist of the Year, Outstanding Young Scientist, Best Team Initiative, Outstanding Team Member, Board Member, Steering Committee Member, and Panel Member of Geoinformatics for Agriculture, Working Group chair on high resolution remote sensing, center representative and advisory member of WMO/GWP's Integrated Drought management Program (IDMP). Recently, he also received USA based AASIO's Outstanding Young Scientist Award for 2013. 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 PhD 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.

Mr. Fazlullah Akhtar is a Ph.D student (Water Resources Engg.) and Junior Researcher at the center for development research at the University of Bonn, Germany. He earned his B.Sc in Agriculture Engineering (2006) from the University of Agriculture, Faisalabad Pakistan, M.Sc (Agricultural Science and Resource Management in Tropics and Subtropics-ARTS) with major in Land and Water Management from the University of Bonn, Germany. He worked as an Irrigation Engineer (2006-2007) with Deutsche Welthungerhilfe in Kunduz province of Afghanistan. During 2007-2008, he worked with USAID as a Project officer for Water and Sanitation, Ministry of Rural Rehabilitation and Development-Afghanistan. From June

2008 till April 2009 he worked as a Provincial Governance Advisor with Development Alternatives Inc./USAID in Paktya province of Afghanistan. From Feb 2012-Feb 2013 he served as a coordinator at the Ministry of Higher Education of Afghanistan followed by his work as a National Water Resources Expert at the Food and Agriculture Organization of the United Nations (Mar 2013-Oct 2013) at the UNFAO head office in Kabul. During his master thesis work, he combined AquaCrop and Hydrus-1D models for the development of irrigation schedules for wheat, maize and cotton crops under shallow groundwater conditions in Khorezm province of Uzbekistan.

Dr. Haruyuki Fujimaki is a professor of the division of afforestation and land conservation at Arid Land Research Center, Tottori University. He holds a BSc degree of agriculture (1993), MSc. of agriculture (1995), and PhD in agriculture (1998) from the United Graduate School of Agricultural Sciences, Tottori University, Japan. After working as a post-doc in Arid Land Research Center for two years, he moved to University of Tsukuba, Japan in 2000. After working as a lecturer for eight years and as an associate professor for two years, he returned to Arid Land Research Center, Tottori University in 2010. He has supervised 7 M.Sc. students as the main supervisor including one foreign student. His main areas of research are salinity management and water-saving irrigation. He focuses on developing a software, WASH_2D (http://www.alrc.tottori-u.ac.jp/fujimaki/download/WASH_2D), for simulating two-dimensional movement of water, heat and solute in soils and plant growth for predicting the effect of improved management practices and optimizing irrigation amount and design of irrigation system or water harvesting. He is the first author of 8 papers in journals listed in “Web of Science”. From 2009 till 2015, he worked in a project “Sustainable Systems for Food and Bio-energy Production with Water-saving Irrigation in the Egyptian Nile Basin” as a group (water and salt balance) leader. He is currently working as the leader of a project “Enhancing Food Security using Water Harvesting in West Bank of Palestine” and group (husbandry) leader of “Development of crop husbandry technology in rainfed marginal regions using dryland plant resources”.

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 programme (German International Development Cooperation (GIZ) in Chad. Dr. Werner has a PhD 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. Katsuyuki Shimizu is an associate professor in the Faculty of Agriculture, Tottori University, Japan. He earned his B.Sc.(1996), M.Sc.(1998) and Ph.D.(2001) in agricultural engineering from Osaka Prefecture University of Osaka, Japan. Prior to join Tottori University, he joined IWMI (International Water Management Institute) for two years and National Institute for Rural Engineering, Japan for three years as Postdoctoral Researcher. His main field of interest includes: on-farm water management (Japan), assessment of water delivery performance (China and Egypt), mechanism of soil salinization (China and Kazakhstan), assessment of sustainable use of deep groundwater for agriculture (Thailand) and micro hydroelectricity using irrigation ponds (Japan). Dr. Shimizu is author of more than 60 technical publications, including 35 refereed publications, book chapters and technical reports. His current research is focusing on the improvement of on-farm water management in irrigated agriculture and its assessment. He has taught different subjects such as hydraulics, hydraulic experiment, hydrology, irrigation and drainage engineering, hydrospheric environmental assessment and numerical analysis at universities and JICA training courses.

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.

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. 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 MSc and PhD 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 director of the Integrated Water and Land Management Program at the International Center for Agricultural Research in the Dry Areas (ICARDA), based in Amman, Jordan. 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. Ing. Usman Khalid Awan has obtained his PhD degree from Center for Development Research (ZEF), University of Bonn, Germany. He has practical experience in groundwater hydrology, surface and groundwater interactions, groundwater modeling, soil and water conservation at different spatial scales, agricultural water management, salt and water accounting at different scales, up-scaling water use efficiency and productivity from farm to irrigation scheme, salinity management, actual and potential evapotranspiration through remote sensing, and remote sensing application in hydrology in different continents of the world (Pakistan, Australia, Central Asia and Germany).

Dr. Vinay Nangia is an Agricultural Hydrologist at ICARDA and an adjunct faculty at the Texas A&M University. 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 a 9-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 22 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 board of professional society journals. He has served as research advisor/committee member to M.S. and Ph.D. students and was a visiting assistant professor (2007-2011) at the Institute of Soil and Water Conservation of the Chinese Academy of Science where he co-advised graduate students. Previously, Dr Nangia was a NSERC Visiting Fellow at Agriculture and Agri-Food Canada conducting research on GHG emissions from sub-surface 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: Score of zero and final assessment tests: Average Scores

Name	Zero	%	Final	%	Improvement between zero and final test
Mr. Harith Ayad Abdulazeez	18/44	41%	18/51	35%	6%
Mr. Hasan Yousif Shaher Al-Nasrawi	24/44	55%	48/51	94%	39%
Mr. Aasim Adil Atees Al-Ajeli	26/44	59%	41/51	80%	21%
Mr. Mr. Ahmed Kamil Hassani Al Mhawash	26/44	59%	49/51	96%	37%
Mr. Riyadh Mudheher Salih	25/44	57%	39/51	76%	19%
Mr. Ghassan Lutfi Ahmed	38/44	86%	44/51	86%	0%
Mr. Bassam Moner Yahia	25/44	57%	45/51	88%	31%
Mr. Hani Dakhil Alwan	7/44	16%	40/51	74%	58%
Dr. Mahmoud Mohamed Abd ElHay Shabana	18/44	41%	44/51	86%	45%
Dr. Ahmed Mohamed Taha Abeid-Allah	29/44	66%	42/51	82%	16%
Ms. Ambreen Fatima	28/44	64%	43/51	84%	20%
Mr. Fateh Khan Nizamani	21/44	48%	39/51	76%	28%
Mr. Kiflemariam Abraha Ghebrehiwet	15/44	34%	35/51	69%	35%
Mr. Ali Mahasnieh	19/44	43%	39/51	76%	33%
Group average score %	**319/616**	**52%**	**566/714**	**79%**	**27%**

Note: *Additional questions have been added to the final assessment tests based on additional lecturers involved in the course from Japan*.

Green boxes: highest score; Yellow boxes: lowest score; Blue box: highest improvement between zero and final test and Orange box: lowest improvement between zero and final test.

ANNEX IV: Group Presentation Scores

Group	Score
Water harvesting	55.5/100
Full irrigation – sub group I	56.0/100
Full irrigation – sub group II	65.5/100
Water harvesting	75.5/100

Group 1: Water Harvesting

- Abd Ali Kamil Naser, Iraq
- Ahmed Kamil Hassani, Iraq
- Hasan Yousif Shaher, Iraq
- Abreen Fatima, Pakistan

Group 2: Full Irrigation

Sub Group 1

- Riyadh Mudheher, Iraq
- Ghassan Lutfi, Iraq
- Kiflemariam Abraha Ghebrehiwet, Eritrea
- Ali Mahasnieh, Jordan

Sub Group 2

- Heba Hammad Al-Shawabkah, Jordan
- Ahmed Taha, Egypt
- Hani Dakhil, Iraq
- Harith Ayad, Iraq

Group 3: Water productivity

- Bassam Moner Yahia, Iraq
- Aasim Adil, Iraq
- Fateh Khan Nizamani, Pakistan
- Mahmoud Mohamed Abd ElHay, Egypt

ANNEX V: Course Evaluations- Averages

Course Title: Improving Water Productivity in Agricultural Systems

(With emphasis on irrigated production systems)

Duration: 3 – 21 May 2015 **Location: Amman, Jordan**

I. Contents of the course:

Item/rating/percentage	Averages
Relevance of the course to your job 1=Not relevant; 5=Very relevant	4.91
Accomplishment of subject matter 1=Inadequate 5=Very comprehensive	4.45
Clarity of course objectives 1=Not clear; 5=Very clear	4.73
Level of lectures 1=Too basic 5=Just right	4.36
Time allocated for discussions 1=Too short 5=Just right	4
Interaction with participants enrolled in the course 1=Very low 5=Very high	3.73
Overall, how would you rate this course 1=Poor 5=Excellent	4.27

Schedule and time allocation:

Item/rating/percentage	Averages
Percentage of Time allocated to lectures 1=Too short 5=Just right	4.36
Usefulness of Lectures 1=not useful 5=useful	4.55
Percentage of Time allocated to the technical field/lab visits 1=Too short 5= Just right	4.55
Usefulness of the technical field/lab visits 1=not useful 5=Useful	4.55

Teaching aids:

Item/rating/percentage	Averages
Effectiveness of teaching aids in general 1=Not effective 5=Very effective	4.45
Clarity of slides/overheads/Powerpoint 1=Not clear 5=Very clear	3.63
Handouts and material 1=Not useful 5=Very useful	4.18

Administrative arrangements:

Item/rating/percentage 1=NI 5=Excellent	Averages
Pre-course communication	4.4
Travel arrangements	4.45
Quality of the accommodation	4.4
Payment of allowance on time	4.7
Transportation	4.55
Lecture rooms	4.36

Your comments and suggestions on the course:

1. Please state the three most important ideas/concepts that you learned from this course
    - concept of water productivity
    - deficit irrigation
    - different irrigation designs- schedules and spacing

2. Suggestions for future improvement of the course

More on cost-benefit analysis

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

Yes 100%

ANNEX VI: List of participants

Name/ Country	Position/ Institution	Contact
Mr. Harith Ayad Abdulazeez / Iraq	Agricultural Engineer , Ministry of Water Resources Anbar, Iraq	Mobile: 00964-7700490633 E-mail: ha_ay_1983@yahoo.com
Mr. Hasan Yousif Shaher Al-Nasrawi / Iraq	Supervisor engineer, Ministry of Water Resources Babil, Iraq	Mobile: 00964-7806584430 Email: hassan.yousif72@yahoo.com
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Mr. Mr. Ahmed Kamil Hassani Al Mhawash /Iraq	Supervisor, Ministry of Water Resource, Mayssan, Iraq	Mobile: 00964-7705616302 Email: ahmed_khm@yahoo.com
Mr. Riyadh Mudheher Salih / Iraq	Agronomist, National Center for Water Resource Management, Bghadad, Iraq	Mobile: 00964-7901655849 Email: riyadh_salh@yahoo.com
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Ms. Heba Hammad Al-shawabkah / Jordan	Research assistant at water and environment National Center for Agricultural Research Extension-Irbid, Jordan	Mobile : 00962-791699484 e-mail : shawabkah.heba@yahoo.com