AGRICULTURAL RESEARCH FOR DEVELOPMENT PRIORITIES AND ACHIEVEMENTS IN THE DRY AREAS OF THE CENTRAL AND WEST ASIA AND NORTH AFRICA REGION

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ABSTRACT

The Central and West Asia and North Africa (CWANA) region extends from Morocco and Mauratania in the West to Kazakistan in the East and Turkey in the North to Ethiopia and Eritrea in the South. It represents the largest dry land area region in the developing world. Much of the area is characterized by a Mediterranean climate with cold wet winters and dry and hot summer season. Rainfed agriculture is therefore practiced only in winter season. Rainfall is low and highly variable both temporally as well as in magnitude. Drought is therefore of common occurrence in several parts, of the region. CWANA is one of the most water scarce regions in the world. Increasing use of groundwater to meet the demands for domestic and agricultural purposes, far in excess of the recharge, is causing serious environmental threat. Soils are poor in fertility and highly susceptible to water and wind erosion. The region has one of the highest rates of population growth, which is accentuating pressure on the natural resources of land, water and biodiversity. High per capita cereal consumption and low domestic production has made the region the largest importer of grains. Poverty is widespread and is a major cause of rural to urban and the South to the North migration. There is vicious cycle of poverty and natural resource degradation. Agriculture however continues to be the main economic activity on which the livelihood of the majority of the people in the region depends. Sustainable development of agriculture, particularly in the dry areas which were bypassed by the 'green revolution', is therefore a key to meeting several Millennium Development Goals (MDGs), particularly those related to poverty alleviation, food security, and improved nutrition and health of children and women.

The key natural resource limiting agricultural production in the dry areas is water. The West Asia and North Africa (WANA) sub-region of CWANA faces the most serious threat of water shortage, as the per capita renewable water supply here is less than 1500 m^3 and it is expected to fall to less than 700 m^3 by the year 2025, well below the water poverty threshold of 1000 m^3. Even in the Central Asia and Caucasus (CAC) sub-region water scarcity is increasing and excessive water withdrawals from rivers have caused environmental disasters as typified by Aral Sea region. Global climate change is predicted to make the drier areas of CWANA more dry and hot with severe consequences for agriculture and animal husbandry there. With such serious situation regarding the renewable water supply in CWANA, the major priority for research for sustainable development of agriculture in the dry areas of CWANA is all aspects of enhancing water availability and its use-efficiency and productivity. CWANA is also the region for domestication of major food and feed crops and livestock, and therefore has the centers of their genetic mega-diversity. This biodiversity is threatened because of the increasing population pressure. Conservation and sustainable use of this biodiversity is essential not only for the present but also for the future, particularly in light of the more extreme weather conditions expected in the future because of climate change. Biodiversity collection, characterization, conservation and utilization research has therefore emerged as the next important priority area. Desertification and land degradation is another major threat to agriculture. Vast areas in CWANA are under rangelands that are being degraded because of overuse in response to increasing population pressure. Rehabilitation of degraded rangelands and preventing degradation of productive ones through research on integrated crop-livestock systems and natural resource management is another priority in CWANA. The region has a rich heritage of indigenous knowledge, which had enabled the rural people to make sustainable use of the limited natural resources in the desert margins and degraded lands in the past. Unfortunately, increased population pressure, breakdown of traditional social institutions and inappropriate policy environment has caped the affectivity of such traditional knowledge, and it is under threat of extinction. Proper documentation of traditional knowledge and the adaptation of its elements in the context of modern agriculture are essential for sustainable agricultural development.

The national agricultural research systems (NARS) of CWANA, in partnership with regional agricultural research institutes, international agricultural research centers (IARCs), and advanced research institutes (ARIs) in the North and the South, and with financial support from donors, are devoting research efforts on these priority

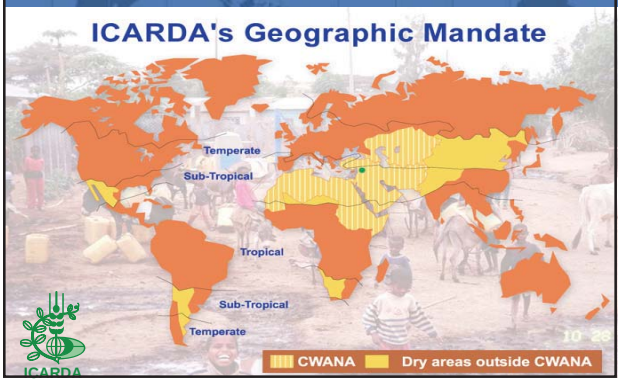
areas to achieve food and nutritional security, improved livelihoods for their people and to ensure sustainable use of natural resources and protect environment. The International Center for Agricultural Research in the Dry Areas (ICARDA) is the only Center operating under the Consultative Group on International Agricultural Research (CGIAR) that has its headquarters in this region. It is therefore playing a pivotal role in undertaking relevant research on priority research areas that are harmonized with the priorities identified by the NARS in collaboration with sub-regional agricultural forums (AARINENA in the WANA sub-region and CACARI in the CAC sub-region) and the priorities identified by the CGIAR System through its Science Council. These priorities excellently address the needs for meeting the major MDGs.

ICARDA seeks to improve the welfare of people in the dry areas of the developing world by increasing production and nutritional quality of food while preserving and enhancing natural resource base through research, training and dissemination of information, in partnership with NARS, national governments, other IARCs (e.g. CIMMYT, ICRISAT, IFPRI, ILRI, IPGRI, IWMI), ARIs (including JIRCAS and ALRC of Tottori University), civil society organizations (CSOs), and donor agencies (including JICA). ICARDA has global responsibility for improvement of three important food crops (barley, lentil, and faba bean), and the sustainable management of natural resources in the dry areas, especially enhancing the on-farm water-use efficiency. The regional responsibilities of the Center focus on improvement of wheat (with CIMMYT), Kabuli chickpea (with ICRISAT) and forage and pasture crops and rangeland management with small ruminants in CWANA. The Center's strategy is to engage NARS and CSOs in the region, sister IARCs, and the ARIs from all over the world into a research continuum that ensures that tools of cutting edge research are harnessed to meet the challenge of sustainable development of agriculture in the dry areas. This strategy has resulted in significant achievements and has positively affected the economic wellbeing of the people and the sustainable management and conservation of natural resources of land, water and biodiversity in CWANA and the dry areas in other developing countries. The spillover has also benefited the dry land agriculture in several industrialized countries.

ICARDA's genebank holds the largest collection in the Mediterranean region, about 131,000 accessions of cultigens (landraces as well as elite material) and wild relatives of its mandate crops, most of which are geo-referenced, characterized and well documented. About 35,000 samples are distributed to collaborators for use in breeding programs. ICARDA scientists and their partners have effectively used this biodiversity for improving adaptation of the mandate crops for yield and yield stability under moisture limited environment and responsiveness to improved moisture supply. Molecular tools and analytical physiological research have helped in making fast progress in identifying desirable genes for such adaptation and their incorporation in suitable phenotypes. Collaboration with ARIs, including JIRCAS, has been very rewarding in this research. Tolerance to common biotic stresses has been combined with adaptation to drought and improved water use efficiency. Participatory breeding involving farmers has helped in faster crop improvement for marginal environments. Crop management techniques to enhance productivity per unit amount of water under rain-fed and supplemental/deficit irrigation have been developed. Water harvesting techniques, using remote sensing and geographical information system, have been developed and disseminated. Work on use of marginal quality water for use in forestry, raising biomass for renewable energy and for feed production has been promising. People-centered participatory research on use of natural resources has helped in identification of promising options for interventions acceptable to local communities. Crop-livestock integration research and research on use of vetches for early weaning of lambs, reseeding degraded pastures with native vegetation and intercropping with saltbush and spineless cacti with barley has helped in improving the productivity of small ruminants and reducing degradation of rangelands. Policy and institutional research has helped identifying factors that could enhance the adoption of improved technologies by farmers and herders and increase the impact of research.

KEYWORDS
Biodiversity, Crop Improvement, CWANA, Drought Tolerance, Natural Resource Management, Research for Development

CWANA Region



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Agricultural Research for Development (ARD) Priorities and Achievements in the Dry Areas of CWANA

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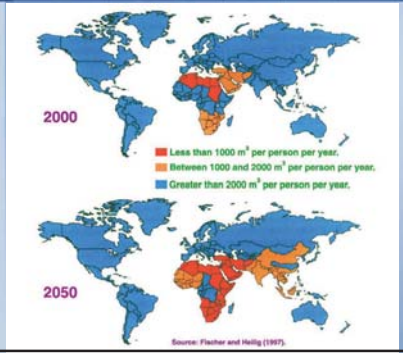
Water Scarcity in CWANA



Characteristics of CWANA Region -1

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- Mostly Mediterranean climate
- Rain-fed agriculture in winters
- Cereal mono-cropping
- Drought and water scarcity, getting accentuated with global climate change
- Water withdrawals exceeding safe limits
- Increasing depletion of ground water

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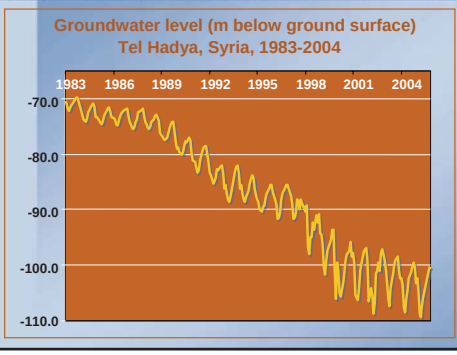
Declining groundwater



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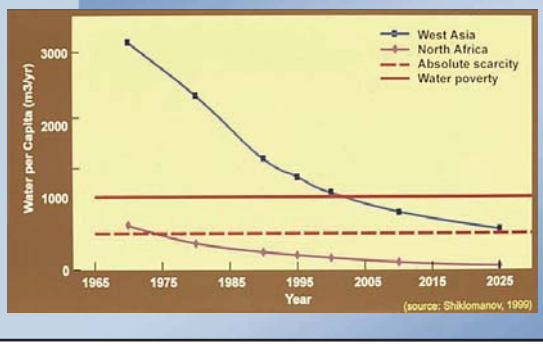
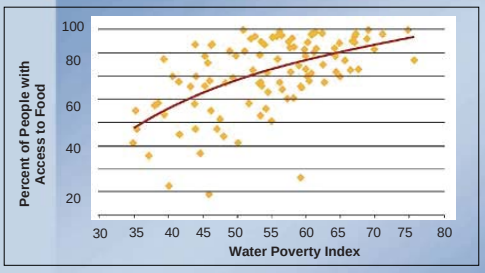
Water availability in WANA



Characteristics of CWANA- 2

- High rate of population growth
- Highest per capita cereal consumption
- Largest importer of grains
- Wide-spread poverty, rural to urban and south to north migration
- High pressure on natural resources of land, water and biodiversity
- Increased environmental degradation

Access to water and food security



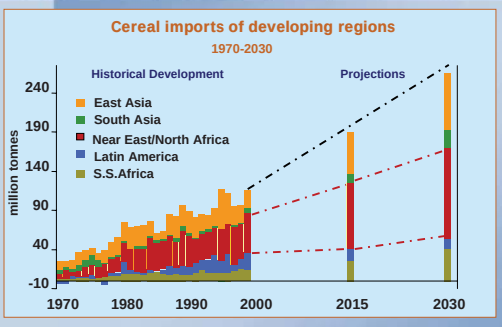
Access to water and food security are dramatically linked (developing countries and countries in transition).

Source: FAO, CEH Wallingford. 2002. The Water Poverty Index: International Comparisons.

Meeting the Millennium Development Goals (MDGs) in CWANA

- **More than 40 million poor in ME alone**
- **More than 50% population dependent on agriculture**
- **Agricultural growth critical to achieving major MDGs**
- **Green Revolution bypassed CWANA**
- **Conflicts accentuating loss of agricultural productivity in many countries**
- **Need for increased RAD efforts in the region**

Food insecurity



Source: FAO, 2002 World Agriculture: towards 2015/30

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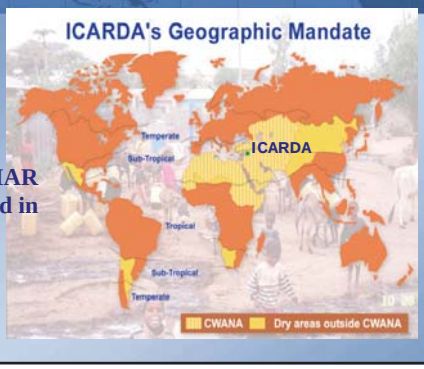
The only CGIAR Center located in the CWANA region



Meeting the Challenge of low Agricultural Productivity and Natural Resource Degradation

Strong partnership needed between:

- **National Agricultural Research Systems**
- **International Agricultural Research Centers (IARCs)**
- **Advanced Research Institutes (ARIs) in North and South**
- **Donor agencies and foundations**

ICARDA's Partnerships for RAD in CWANA

NARS of CWANA including regional fora: AARINENA, CACAARI, APAARI

IARCs: CIMMYT, ICRISAT, IFPRI, ILRI, IPGRI, IWMI

ARIs: Australia, Europe, Japan (JIRCAS & ALRC, Tottori University), North America and in South

Donor countries and organizations (including Japan)

Research Mandate of ICARDA

Major research achievements - Biodiversity

- 133,000 accessions in gene bank
- Large number of landraces and wild relatives of mandate crops collected from harsh environments
- 90% geo-referenced
- 80% characterized for enhanced use
- Valuable source for adaptation to global climate change
- Over 40,000 samples distributed annually to collaborators

Research Priorities

developed with CWANA partners and their relation to key MDGs

- Biodiversity & Integrated Gene Management – MDG 1 (*reduce extreme poverty and hunger*) & MDG 8 (*develop global partnerships for development*)
- Integrated Land and Water Management – MDG 1, 7 (*ensure environmental sustainability*) & 8
- Diversification and Sustainable Intensification of Production Systems – MDG 1, 7 & 8
- Socioeconomic and Policy Research – MDG 1, 7 & 8

Crop improvement for enhanced drought tolerance and WUE

Using advanced technologies in partnership with ARIs

- Use of landraces and wild relatives
- Use of analytical physiology
- Application of molecular markers for gene identification and microarrays for gene expression
- Recombinant DNA techniques using safe sources for specific traits

Major research achievements - Crop Improvement

- NARS partners released 824 improved varieties; of these 80% were in developing countries:

Wheat	309
Barley	151
Lentil	81
Faba bean	45
Chickpea	82
Peas	9
Forage legumes	28

- Impact studies showed very high return on investment in this research

Crop improvement for enhanced drought tolerance and WUE

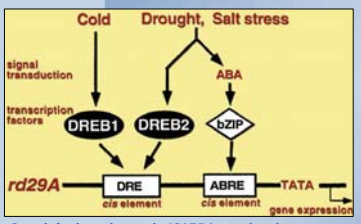
Barley – exploiting wild relatives

Jurn Al Aswad
Raqqa Province, Syria
April 2000
(Total Rainfall: 87 mm)

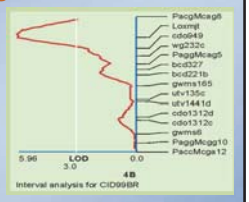
Crop improvement for enhanced drought tolerance and WUE

Use of modern tools in cooperation with JIRCAS

A model for the induction of *rd29A* gene expression under dehydration, high-salt, and low-temperature conditions in Arabidopsis



Search for homologues in ICARDA mandated crops



Interval analysis for carbon isotope discrimination for durum wheat

Crop improvement for enhanced drought tolerance and WUE

Use of farmer participatory plant breeding

- Use of germplasm in ICARDA gene bank for making crosses and developing segregating populations
- Use of indigenous knowledge of farmers for *in situ* selection of adapted cultivars
- Already in practice in Ecuador, Egypt, Eritrea, Ethiopia, Jordan, Morocco, Syria, Tunisia, Yemen
- Seed availability assured

Crop improvement for enhanced drought tolerance and WUE

Lentil - enhancing adaptation to cold

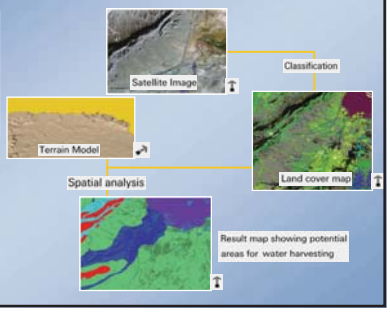
Major research achievements – Meeting the Challenge of Water Scarcity: Water harvesting

Macro- and Micro-catchments for water harvesting


Macro-catchments


Micro-catchments

Geographical Information System for Determination of Potential Areas for Water Harvesting in a Steppe Area



Major research achievements – Meeting the Challenge of Water Scarcity: Improving water availability by use of treated waste water for irrigation of forage crops and agroforestry

Ain Ghazal Sewage Treatment Plant, Jordan

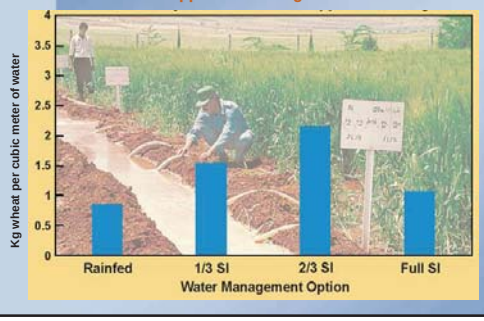

Blending

Agroforestry

Forage crops irrigated with treated sewage effluent in Sorbulak, Kazakstan

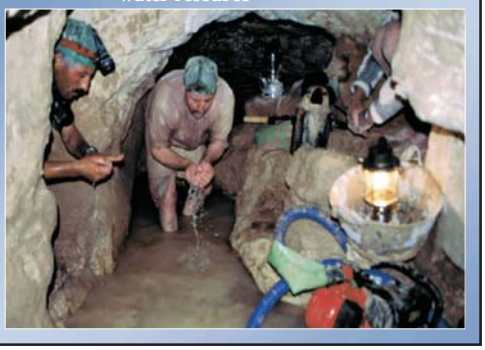
Major research achievements –
Meeting the Challenge of Water Scarcity:
Water productivity as affected by management

Supplemental irrigation



Major research achievements –
Meeting the Challenge of Water Scarcity:
Indigenous knowledge for sustainable use of limited water resource

Kanat system



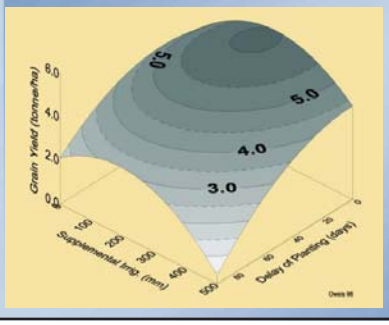
Major research achievements –
Meeting the Challenge of Water Scarcity:
Agronomy for improved WUE

Irrigation methods

- Surface irrigation / flood irrigation
- Micro-irrigation
- Sprinklers

Major research achievements –
Meeting the Challenge of Water Scarcity:
Agronomy for improved WUE

Supplemental irrigation and date of sowing



Major research achievements –
Meeting the Challenge of Water Scarcity:
Agronomy for improved WUE

Soil fertility management

Major research achievements –
Meeting the Challenge of Water Scarcity:
Agronomy for improved WUE

Date of sowing in chickpea

Major research achievements – Integrated Natural Resource Management

Reducing pressure on rangelands

- Bridging feed gap by livestock-crop integration, use of feed blocks to improve weight gain, fertility & lambing % in sheep
- Alley cropping with saltbush (*Artiplex* spp.) and spineless cactus (*Opuntia* spp.) in barley fields
- Impact studies showed very high return on investment
- Reseeding of degraded pastures with native species and micro-catchments for water harvesting

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Major research achievements –

Meeting the Challenge of Water Scarcity:

Agronomy for improved WUE

Conservation tillage

Conservation tillage with sweep –
Residue mulch under cereal/fallow systems

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Diversification of production and diets for poor-

Protected agriculture of vegetables and fruits

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Major research achievements – Integrated Natural Resource Management

Integrated benchmark sites

- Allow holistic understanding of:
  - Challenges
  - Interrelation between human, ecological and economic factors and impact of individual interventions
- Best-bet technologies tested in participatory mode and options generated for INRM and improved livelihoods
- With application of GIS and modelling techniques allows up-scaling and out-scaling of results and improves adoption

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Thank you

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Community approach to RAD with all partners to meet the challenge

- **Foster integration between different disciplines, actors, etc...**
- **Stimulate farmers and communities participation in steering the development process;**
- **Facilitate technology transfer through a participatory technology development**
- **Promote collective action on the basis of a shared consensus**