

Project 7: Improving Water and Land Management in the Dry Areas

Rationale

Non-tropical dry areas include three major agro-ecosystems; (i) rainfed, (ii) fully irrigated and (iii) marginal rangelands. These have evolved as a result of the climate, other environmental factors and a long history of human occupation and management. Agricultural productivity of the natural resources - water, land, and biodiversity - is generally low in the dry areas and their sustainability is threatened by a number of converging trends including water scarcity, land degradation, droughts, high population growth rates and climate change. These trends all add to the increasing uncertainty for the livelihoods of rural poor who depend largely on the natural resource base.

Renewable water resources are limited in the dry areas and rainfall is highly variable and unpredictable both spatially and temporally, increasing the risks and uncertainty involved in agricultural production. This short-term climatic variability is likely to be exacerbated by longer-term climate change. For instance, climate change models predict that West Asia and North Africa (WANA) will become hotter and drier with changes in seasonal and spatial distribution of precipitation and increasing incidence and magnitude of extreme weather events (droughts and floods). Countries in the dry areas with predominantly rural economies and high dependence on agriculture will be at most risk as they are highly vulnerable to shifts in seasonal climatic patterns and changes in hydrological cycles.

The dry area's share of the world's fresh water resources is very limited with many of the countries already below the water "poverty line" of < 1,000 m³/capita/year. The current allocation of over 75% of available water for agriculture is decreasing with increased population and competition from the expanding domestic and industrial sectors. Deterioration in water quality is of increasing concern, as pressure to utilize marginal-quality saline and wastewater is increasing. Public and environmental health are main concerns associated with the increased use of these waters. The effects of the uncontrolled exploitation of groundwater resources is observed throughout the dry areas via dropping groundwater tables, abandoned wells, dried up springs and qanats, and salt-water intrusion.

Opportunities to expand cultivated rainfed or irrigated lands are minimal. As little new water is expected to be available, increases in food production must come from increased water productivity of the rainfed, irrigated and rangelands agroecosystems or, as stated by the UN Secretary General, producing "more crop per drop". This is also vital to sustain ecosystem health. Despite the scarcity of water, current water use in agriculture in the dry areas is highly inefficient. ICARDA's research shows that water productivity can be substantially increased by adopting improved technologies, adopting improved water related policies, and establishing and strengthening institutions. Modifications in the existing soil, irrigation, and crop management practices will be required in order to cope with the expected increases in water scarcity and salinity. To ensure sustainable groundwater use, attention needs to be given to local and national technical, policy and regulatory options that address their comprehensive management.

The key to sustaining rural livelihoods is improving the productivity and reliability of rainfed agriculture by (i) using rainfall more productively, through optimal on-farm soil and crop management practices, and by conserving and augmenting water supplies through rainwater harvesting. (ii) by the strategic use of renewable water resources to augment essentially rainfed production in supplemental irrigation application of a limited amount of water to rainfed crops. Through controlled concentration of runoff into target areas, water harvesting increases water availability and controls soil erosion, and can provide a buffer against drought. Water harvesting is particularly important for the rangelands that occupy over 50% of the dry areas providing important environmental services such as carbon sequestration and maintenance of biodiversity.

Some 10-20% of the dry areas are degraded including irrigated and rainfed arable land together with the vast areas of rangelands. Some degradation occurs naturally, but in many areas the dominant processes are accelerated degradation resulting from human activities. These include: (i) in rainfed areas soil erosion by water and loss of biodiversity due mainly to inappropriate land management practices, (ii) in marginal rangelands soil erosion by wind and water and loss of vegetative diversity due mainly overgrazing and (iii) land salinization due to inappropriate irrigation management and lack of adequate drainage capacity. Degradation of the natural vegetative diversity applies to the three agroecosystems.

The number of people affected by land degradation is larger than the number of people affected by any other environmental problem. Land degradation has been identified as the most pressing form of desertification which is not only an environmental problem but more a development one. This is due to

human mismanagement and lack of development in regions that are often far from the desert margins. This includes centers of population and where there is intensification of land use. Thus the challenge is to protect the entire region from internal abuse of its natural resources by investing in the development of these areas and securing livelihoods of the people that live in them.

Land degradation of dry areas is often considered as a reinforcing vicious downward spiral of population growth, poverty, over-use and degradation of resources, and decline of productivity, etc. Although there are many examples that confirm such a pessimistic scenario, it overlooks the farmers' and the institutional capacity to respond to resource decline. There are many examples where farmers started to invest in their land as a result of increased population pressure and land degradation. This shows that the simple pessimistic and deterministic land degradation scenarios are not always applicable, and that there is a need to look at mechanisms for both land degradation and resource resilience.

Given the complexity of causal factors of land degradation, an integrated approach including broad stakeholder participation is essential if the livelihoods – and security needs – of the people inhabiting the dry areas are to be improved without further degrading their environments. Technology, institutional and policy options are required to prevent further land degradation and build viable livelihoods.

Project description

This project is formulated after the recent structural change of ICARDA where MegaProject 1 on water and drought, and MegaProject 3 on land management were merged to form an "Integrated Water and Land Management Program". The new project is fully compatible with ICARDA's mission to promote productive agriculture while preserving and enhancing the resource base, and with the new CGIAR System Priority 4 Poverty alleviation and sustainable management of water, land and forest resources and particularly with 4A, C and D. The program also includes elements of priority 5C on 'improving rural institutions and their governance', with respect to water users associations and other institutional options. The project's outputs are relevant to the Millennium Development Goals on poverty and hunger, and environmental sustainability and the United Nations Convention to Combat Desertification (UNCCD).

The program of research on water and land management and drought mitigation continues to evolve in response to global and regional structural and socioeconomic changes, particularly with regard to water scarcity, land degradation and food security, and in light of the expressed priorities of ICARDA's NARS partners. The Project aims to produce technologies, institutional and policy options specific to increasing water and land productivity, preventing/reversing land degradation and mitigation the effects of drought in dry areas. ICARDA plans to address land degradation globally via the establishment of a research consortium called Oasis with 10 other CGIAR centers that is co-convened with ICRISAT. ICARDA will focus on the non-tropical drylands, with ICRISAT focusing on the semi-arid tropics. Both Centers will adopt the holistic approach to combating desertification and the program will run either as a systemwide program or as a Challenge Program.

Major elements of Project 7 comprise:

- Research on the strategic issue of sustainably increasing water and land productivity at the levels of farm, watersheds and basin. Focus will be on supplemental irrigation in rainfed areas, water harvesting in rangelands and the management of irrigation water in fully irrigated areas. Strategic partnerships within the Challenge Program for Water and Food (CPWF) with IWMI and the Oasis consortium with ICRISAT and other centers have been established to achieve this in a complementary approach based on the comparative advantages of each of the Alliance Centers.
- Emphasis is given to the assessment of water and land resources, and their allocation to sustainable uses. The project will also assess the causes and driving forces of land degradation, including regional assessments of desertification, in dry temperate and subtropics with partnership with ICRISAT covering the tropical dry areas.
- Developing technologies for improved management of water and land resources to control degradation and combat desertification. The project will focus on controlling salinity in the irrigated areas, water erosion in rainfed areas and wind and water erosion in the marginal rangelands agro-ecosystems. Partnerships with ICRISAT through the Oasis initiative and with ICBA on salinity issues.
- Research on drought preparedness and mitigation through the optimal management of water and land resources and use of adapted crops and crop varieties (linking with P 2 through P 5) and

appropriate cropping patterns (linking with P 6). The research and capacity building across the dry areas on developing drought mitigation packages is conducted within a network with FAO, CIHEAM and NARS. The drought network benefits from the intergovernmental system of the FAO and the Mediterranean partners of CIHEAM.

- Studies on policies and institutions are included in the project to model the biophysical and socioeconomic components of the system and develop improved policy and institutional options. Partnership with IFPRI on policies regarding improving water productivity has been initiated within the CPWF.
- Increased emphasis is given to the development and dissemination of improved options through integrated, interdisciplinary and participatory research approaches at the community level at selected benchmark research sites. This also includes institutional strengthening and capacity building to improve productivity and sustainable NRM utilizing the CGIAR's INRM approach.

Project Outputs

The outputs presented below were developed through the merger of the previous MegaProjects MP1 and MP3. The Project Logframe is attached. Where an Output Target contributes to a Challenge Program or a Systemwide/Ecoregional Program, this is indicated in the Project Logframe. Outputs and activities related to rangelands were transferred to the new project on diversification (P 6). Since the new project is not a simple addition of MP1 and MP3, but rather is a new integrated project, several of the output targets planned in the two previous projects had to be modified to meet the objectives and outputs of the new project. Some output targets were merged, some new output targets have been added and the majority were maintained.

Below, we describe for each Output: (a) the impact pathway, (b) the research approach to developing international public goods (IPG), and (c) the role of partner organizations.

Output 1: Assessment of water and land resources use in agriculture, productivity and degradation under present and future scenarios.

1.1 Relation to SP goals

This output contributes to SP's 4A by assessing the impact of introducing new technologies and potential tradeoffs associated with resources productivity at the farm, the ecosystem system and the basin levels. The output contributes to SP4C by developing methodologies for the assessment of current and potential water and land productivity and degradation at the farm and basin levels using developed interventions.

1.2 Description of Impact Pathways

The research is community-based with full participation of farmers, community leaders, local institutions and policy makers. Benchmark sites have been selected, representing both rainfed and irrigated conditions. Experiments and demonstrations are being conducted under researcher- and farmer-managed conditions to develop, test, apply, and improve the adoption of water management options. ICARDA's role is multi-dimensional, involving partnership with NARS in designing, implementing, and synthesizing the participatory and on-farm adaptive research activities and results. The tested and proven water productivity assessment methodologies at the field and farm levels are to be out-scaled across the basin leading to a basin-wide methodology. Since the Karkheh River basin in Iran, one of the target basins in the CPWF, reflects in many ways the problems of water management in other basins in the dry areas, the methodology developed by ICARDA in the Karkheh River basin will be applied and tested by NARS in the Euphrates and Amu-Darya basins. As a result, NARS should be in a better position to target their policies and projects regarding improving water productivity at the basin level.

ICARDA is also working with NARS in benchmark sites to identify the constraints in water harvesting techniques, supplemental irrigation and deficit and full irrigation. The results will contribute to the identification of ways to increase the efficient allocation of water resources and use of run-off water in the extremely water scarce rangelands and improve the adoption of new water use strategies in rainfed and irrigated benchmark sites. ICARDA will have a role as a secondary research provider and catalyzer through combining each benchmark site's outputs and providing the information to national decision makers. Development projects in the countries concerned will benefit from the output in that areas with high potential for the improved techniques will be identified.

The NARS of Central Asia are engaged with ICARDA in several projects, including on-farm water and soil fertility management and combating salinization in the Aral Sea basin through the creation of “bright spots”. The assessment of water harvesting and supplemental irrigation will be conducted by NARS with support from ICARDA. The methodology and the assessment will be discussed in a workshop after its completion. It is expected that based on the output, project proposals will be jointly developed to address the gaps in knowledge and provide solutions to the problems associated with water use in these areas to move the results to other ultimate beneficiaries - resource users beyond the bright spots - in the region.

Outputs regarding the management of land degradation will be used by NARS, NGO's, universities and research organizations. Starting from case studies and large scale assessments (via remote sensing), a better understanding of the occurrence, extent, rate and driving forces of desertification can be established. These insights are expected to make technologies and strategies to combat desertification more effective.

1.3 Research Approach to Develop International Public Goods

The methodologies for assessment are intended to be tools to evaluate basin-wide water productivity by researchers and practitioners and should be applicable in other comparable basins. Two approaches are used, the first based on outscaling methodologies that have already been developed and tested to other similar areas, and the other using remotely sensed data with pre-set criteria to identify potential areas for using the approaches.

The project is developing simple and rapid methodologies to assess the costs and benefits of water harvesting and supplemental irrigation practices and evaluate water productivity in the selected sites. This is carried out through surveys, analyses and modeling activities. Outputs will be relevant at both local and international scales. At the local level, the emphasis is on informing NARS, decision makers, and national development agencies in the benchmark countries. At the international level, results will be analyzed to develop peer-reviewed international publications and other media for wider dissemination of the project results, especially for water scarce countries in the dry areas.

The tools, approaches and methodologies as well the method of translation of the findings into coping strategies are IPGs. Thus the outputs are mainly knowledge, methods and capacity building. The research is done in selected countries of CWANA and at integrated research sites. Collaboration with other efforts towards the implementation of the UNCCD done by organizations such as FAO and ACSAD (Arab Center for the Studies of Arid Zones and Dry Lands) is on-going.

1.4 Partners' Roles

ICARDA in collaboration with partners coordinates the research implementation and contributes to consolidated analysis of information, interpretation of research results, and promotion of outcomes.

NARS of Tunisia, Syria, and Uzbekistan are full partners in planning and evaluation of research, collecting and assessing data, preparation of project reports and promotion of uptake of research findings. IWMI and International Center for Biosaline Agriculture (ICBA) are partners in Central Asia in research on salinity assessment. Project 8 coordinates socioeconomic and policy and institution analysis and interpretation of data and policy option formulation. Water productivity assessments are conducted in cooperation with NARS of Iran, Turkey, Syria, Iraq, Tajikistan, Turkmenistan, and Uzbekistan and with IWMI and University of California, Davis within the CPWF.

Activities are conducted through three major projects:

- (a) Community-based optimization of the management of scarce water resources in agriculture in West Asia and North Africa, implemented through benchmark sites representing three major agroecologies in the region: irrigated areas, rainfed areas, and the steppe (rangelands). Partners in the adaptive research include: Algeria (ITGC, Institut Technique de Grande Cultures), Egypt (ARC, Agricultural Research Center), AERI (Agricultural Economics Research Institute), and the Ministry of Irrigation, Iraq (Ministry of Agriculture), Jordan (NCARTT, National Center for Agricultural Research and Technology Transfer) and the University of Jordan, Morocco (INRA, Institut National de la Recherche Agronomique) and ORMVAT (Office Régional de Mise en Valeur Agricole du Tadla), Saudi Arabia (RADRC, Range and Animal Development Research Center), Sudan (ARTC, Agricultural Research and Technology Corporation), Syria, GCSAR, General Commission for Scientific Agricultural Research) and Tunisia (INAT, Institut National Agronomique de Tunisie)

- (b) Improving on-farm agricultural water productivity in the Karkheh River Basin, within the CPWF. Project partners include: International Water Management Institute (IWMI): basin level integration, University of California, Davis, USA: agricultural hydrology and system modeling.

Iranian NARS and Universities are partners in the selection of benchmark sites, collection of baseline information, trials on research stations and farmers' fields, economic appraisals, and policy and institutional assessments: Agricultural Research and Education Organization (AREO), Agricultural Engineering Research Institute (AERI), Drylands Agricultural Research Institute (DARI), Soil and Water Research Institute (SWRI), National and Provincial Planning Organizations, National Salinity Research Center (NSRC), Shaheed Chamran University,

- (c) Strengthening Livelihood Resilience in Upper Catchments of Dry Areas by Integrated Natural Resources Management (CPWF PN12)

The tools are developed together with NARS (Extension, Syria; Agricultural Research and Education Organization (AREO), Iran; Forest, Range and Watershed Management Organization (FRWO), Iran) and advanced research centers (Catholic University of Leuven, Belgium; Wind Erosion Unit, USDA/ARS, Manhattan). ICARDA's roles are primary research and capacity building. Partners from advanced research organizations also undertake primary research mainly through student theses and thus via capacity building. NARS partners will undertake primary research and facilitation.

Output 2: Options and strategies for improved water and land productivity in rainfed, irrigated and rangeland agro ecosystems.

2.1 Relation to SP goals

This output is at the heart of SP 4C as it develops technologies and improved management practices in rainfed, irrigated and rangeland areas to increase water productivity at the plant, field, farm and basin levels. It contributes to SP 4A by identifying the constraints to improved water and land productivity and evaluating consequences of improving productivity at the spatial and temporal scales. It also contribute to SP4D by developing tools, methods and indicators for understanding and develop preventive measures associated with sustainability and degradation in marginal rangelands, rain fed systems and irrigated agriculture.

2.2 Description of Impact Pathways

The project targets three agro-ecosystems, rangelands, rainfed cropping systems, and fully irrigated systems through research at selected representative benchmark sites, the results of which are then disseminated through out-scaling to similar agro-ecosystems.

The primary beneficiaries are the rural poor who depend on rangeland and rainfed and irrigated agriculture for their livelihoods and, ultimately, all consumers of water. Impact will be achieved by the direct involvement of the communities in the target environments but also through national researchers, who will acquire experience and skills in advanced research methodologies as well as a range of improved water management practices and options for use in other areas. For example, ICARDA is working with national programs in benchmark sites in Morocco, Algeria, Syria and Tunisia (rainfed systems), Jordan, Libya and Saudi Arabia (rangelands), and Egypt, Iraq and Sudan (irrigated systems) on adapted and tested economically viable and socially acceptable technologies that sustainably improve water productivity, which will be scaled out to other countries in the dry areas.

ICARDA and IWMI are working together to address the widespread environmental deterioration in the form of land salinization and water quality deterioration in the Aral Sea basin in Central Asia. ICARDA is addressing similar problems in the benchmark site in Egypt. ICARDA is working with the NARS of Kazakhstan, Turkmenistan, Uzbekistan, and Egypt to improve the productivity of saline water and land resources in a sustainable manner. It is expected that at least two soil- and crop-based management options for the use of saline waters and soils will be adopted by the farmers in pilot areas in Central Asia and Egypt. This will result in higher productivity and improved environment in pilot areas where saline water is used for irrigation or salt-affected soils exist. Since the target Central Asian countries have not addressed the root cause of salt-prone environmental degradation, the envisaged out-scaling of these options will depend on the enabling policies and institutional support.

The institutional arrangements within the benchmark sites allow interaction with various development agencies in the participating countries. These include government development projects, NGOs, and individuals in the project areas. There are also links with policy makers and high-level decision makers at the Ministerial level. A framework for transfer of technologies and adoption is under development with NARS. These, in addition to the community-based approach adopted in the benchmark sites and recommendations of enabling policies, will ensure that pathways lead to adoption by the ultimate beneficiaries – resource-poor users in dry areas. Workshops and meetings will be held over the project period to enhance this understanding.

2.3 Research Approach to Develop International Public Goods

On-farm field trials are conducted to develop and verify the assessment methodologies. Research results will be disseminated widely through community-based adaptive research. Research reports, peer-reviewed publications and other media will be available for all stakeholders outside the benchmark sites.

In the process of developing soil- and crop-based management options for the use of saline waters and soils, field trials will be carried out in collaboration with NARS partners. The data sets collected from multiple sites will be analyzed to develop research reports, peer-reviewed publications and other media for wider dissemination of the project results to ecologically similar conditions throughout the dry areas.

The community-based, participatory and integrated approach used in the benchmark sites is itself an IPG in increasing water productivity sustainably. The approach will result in methodologies and practices that are relevant across the dry areas. The nature of the water scarcity problem which is relevant to most of the countries in the dry areas makes the benchmarking approach and the tools to out- and up-scale to other dry areas a real opportunity to make impact in all these countries. The coverage of most of the environments and systems in the benchmark sites makes the approach inclusive and comprehensive.

2.4 Partners' Roles

ICARDA in collaboration with partners coordinates the research implementation and contributes to consolidated analysis of information, interpretation of research results, and promotion of outcomes.

NARS participate in the planning and evaluation of research, collecting and assessing data, preparation of project reports and promotion of uptake of research findings. Major NARS partners are those involved in the water benchmark sites, as listed under Output 1.

Water use efficient packages are developed in cooperation with NARS in Egypt, Morocco, and Jordan; with NARS in Iran within the CPWF; and with scientific support from University of California, Davis; Centre International de Hautes Etudes Agronomiques Mediterraneennes (CIHEAM), Bari; Institut National de la Recherche Agronomique (INRA) France; and University of Delaware, USA.

Research on water harvesting and watershed management in the marginal dry areas is conducted in cooperation with the Iranian NARS within the CPWF, together with NARS of Syria, Jordan, and Tunisia, and with scientific support from Purdue University, USA, United Nations University, UNESCO, Wageningen University, Netherlands, and the Universities of Gent and Leuven, Belgium.

Research on technical management options for sustainable use of salt-prone waters and soils in agriculture is carried out in partnership with IWMI and the International Center for Biosaline Agriculture (ICBA), in collaboration with the NARS of Central Asia within the Ecoregional Program for CAC.

Output 3: Options and technologies for combating water and land degradation using an INRM approaches.

3.1 Relation to SP goals

The output contributes to SP4A through adopting the INRM approach to improved water and land management and associated technologies and options development for halting and reversing degradation in dry areas. The output also contributes to SP4C by developing options for improving the productivity of low quality water and salt affected soils. The work on combating desertification in the marginal dry lands contributes to SP4D

3.2 Description of Impact Pathways

Successful best-bet technologies, developed in representative agro-ecological benchmark sites using participatory approaches, are expected to have relevance well beyond the pilot sites. Interventions will

focus on building on existing practices in benchmark sites and the identification of innovations developed by farmers themselves. New science and technologies will be adjusted/added on with participation of farmers, NARS and where relevant NGOs and CBOs.

The INRM approach is further developed together with NARS and land users, NGOs and community-based organizations (CBO) who participate in primary research, facilitation and advocacy. The adoption of the approach by NARS and policy makers will result in more main-streaming of land degradation in government ministries and policies, and improved adaptive capacity to cope with desertification.

3.3 Research Approach to Develop International Public Goods

Interventions produced from benchmark site studies will be incorporated into future projects and training courses on better management of the natural resources and analyzed across a range of different ecosystems. Collation of the interventions and results will be formulated into site specific contexts by extrapolation and further analyses using tools such as GIS and modeling.

The INRM approach is an IPG that features new knowledge, practices, policy and capacity building that can be used by NARS, NGOs, and CBOs. These outputs correspond well to the IPGs listed by Harwood et al. in 2005 for NRM outputs from the CGIAR centers.¹

Outputs on community-based approaches to rangeland management from the MP3 MTP 2007-09 (former Output 4) - have been absorbed into this output but will be constrained by the current vacancy for a Rangeland Specialist in ICARDA. The former MP3 Output 6 on guidelines for scaling up is also now incorporated under this Output.

3.4 Partners' Roles

Technologies are developed together with NARS (AREO, Iran; Olive Research Bureau in Syria) which conduct joint research with ICARDA, and other organizations such as NGOs and CBOs. NARS in Syria and Morocco will cooperate with NGOs (Fund for Integrated Rural Development of Syria (FIRDOS) and CBOs (Khaltan CBO, Syria) who will undertake extension activities.

Technologies and practices developed under this output will contribute to the proposed systemwide program on Climate Change.

The INRM approach has been developed by the CGIAR's Task Force on INRM and is a shared output of all CGIAR centers that contributed to its development. This is clearly indicated in the Task Force's publications and website now managed by ICARDA.² The INRM approach is adapted and further refined together with the NARS. All implementation activities are done with partners in joint projects. In Syria partners are the Atomic Energy Commission of Syria, Bonn University, and Syrian Olive Bureau. In Morocco and Iran partners are Institut National de Recherche Agronomique (INRA) and Agricultural Research and Education Organization (AREO)/ Forests, Rangeland and Watershed Management Organization (FRWO)/Extension/ Centre for Sustainable Development & Environment (CENESTA) respectively. ICARDA's role is in primary research, catalytic, facilitative and advocacy. Partner roles involve joint primary research facilitation and advocacy.

Many activities in this output contribute to the CPWF through a project on Strengthening Livelihood Resilience in Upper Catchments of Dry Areas by INRM.

Output 4: Methods, options and strategies for drought characterization, preparedness and mitigation in the dry areas

4.1 Relation to SP goals

Research on drought is a new emphasis of the SPs (page 71). This output contributes to SP4A, C and D by developing options for improving natural resources productivity and preventing degradation during the events of drought. And by evaluating the effects of climate change on drought in the dry areas and the options for adoption.

¹ Harwood, R.R., F. Place, A.H. Kassam and H.M. Gregersen. 2005. *International Public Goods through Integrated Natural Resource management Research*. Draft paper submitted for publication. September 2005

² <http://www.icarda.cgiar.org/INRMsite/index.htm>

4.2 Description of Impact Pathways

The Network on Drought Management for the Near East, Mediterranean and Central Asia (NEMEDCA) was initiated by ICARDA in partnership with FAO and CIHEAM. The founding partners have substantial collaboration with NARS of the region. These relations and existing programs will serve in making the network effective in reaching target NARS institutions. The Network is open to membership from government and non-government institutions and individuals, which will enrich the experience and allows wider interactions. Annual meetings and training courses have started and should continue in the future. An Internet-based communication tool will be developed to allow for discussions and interactions among members. The intergovernmental action plans of FAO will be utilized to strengthen the network. Furthermore the partnership of this project in the CIRCE (Climate change EU- supported project) to conduct adaptation case study in Syria will help developing the project strategy to do climate change research associated with water and land productivity and sustainability.

Research outputs will be communicated through the national coordinators for drought, which are institutionalized within most of the countries. It is anticipated that member countries and interested NARS will be involved in developing packages for drought mitigation and management. Since drought is a global phenomenon, the packages to alleviate the effects of drought will be received by countries of the dry areas. The water benchmark project will be a venue for developing the drought packages. The approach used in the benchmarks will ensure that the output is relevant to the whole network of countries involved. Collaboration with advanced research institutes such as UC Davis and the US Center for Drought, in addition to FAO and CIHEAM, will help refining these approaches. The NEMEDCA Drought Network will be used to disseminate the results of the drought mitigation project. The water benchmarks project will also be a venue to enhance adoption of the technologies developed. Policy briefs will be developed in collaboration with NARS and communicated to policy makers to help in implementing drought mitigation plans. Annual meetings with decision makers and relevant institutions will be held to convey results. The network will strengthen NARS capacity to mitigate drought, which will in turn improve the resilience and coping capacity of poor resource users.

Interventions and innovations will be developed with NARS in Syria and North Africa (Tunisia and Morocco) and Iran. Successful community-based best-bets, developed in representative agro-ecological benchmark sites using participatory approaches, are expected to have relevance beyond the pilot sites. Results will be linked with the formation of community-based rangeland users in Syria and North Africa, some of which will be nomadic tribes of Bedouins. Activities on watershed management are being done in Iran as part of the Challenge Program on Water for Food.

4.3 Research Approach to Develop International Public Goods

The Drought Network is international involving ICARDA, FAO and CIHEAM as international organizations serving dry areas and beyond. Most of the members are public institutions or organizations concerned with public goods research. The development of drought mitigation packages for the dry areas is dependent on special project funding to support a scientist to lead project implementation. The project will adopt the same approaches used in the water benchmark sites. Involvement of all stakeholders and particularly communities will ensure that packages respond to the needs. The network will be used to select issues relevant to the majority of the countries and to test solutions across countries. A framework for out-scaling and up-scaling will be developed to disseminate the outputs to similar areas. Meetings with policy makers to develop policy briefs to help adoption of the improved packages will be planned.

Emphasis is placed on the co-management of rangelands and watersheds by land users and government departments in Syria, Morocco, Tunisia and Iran using community-based approaches. These will be extrapolated to other sites by NARS and extension services. Thus a common approach to community-based land management practices under marginal dryland conditions will be formulated.

4.4 Partners' Roles

FAO and CIHEAM are partners in NEMEDCA and will be full partners with ICARDA in developing the drought plans with NARS. They collaborate in delivering training courses and convening meetings. IWMI is a partner in the Karkheh River Basin within the CPWF and helps to develop policies at the basin level. Collaboration is being established with the US Drought Center in Nebraska to provide technical backstopping to the program.

Community-based approaches are developed together with NARS (FRWO, Iran, INRA, Morocco), NGOs (CENESTA, Iran) and CBOs (Khaltan CBO, Syria; Karkheh CBOs, Iran). All will be involved in the

research process with ICARDA developing the common approach and other partners undertaking facilitation and advocacy roles.

Output 5: Improved policy and institutional options to enhance sustainable water and land productivity, combat land degradation and mitigation of drought.

5.1 Relations to SP goals

This output contributes to SP4A by developing indicators for water and land productivity and degradation and evaluating the impact of policy changes and institutional setups in the dry areas. It contributes to SP4C by evaluating economic water productivity and trade offs of water use in various sectors. It also contributes to SP4D by looking at the land tenure systems in the marginal areas and to options of payment for environmental services.

5.2 Description of Impact Pathways

In partnership with the NARS of Jordan, Egypt, and Morocco, ICARDA will develop the methodologies for the valuation of water resources, as the benchmark sites in these countries represent the major typologies of conditions in the three agro-ecologies of irrigated and rainfed systems and rangelands. However, some conditions and issues in the region related to the natural resources, the environment and/or the socioeconomics unrepresented in the benchmark sites may need to be addressed. Specific research associated with these conditions and issues will be conducted involving NARS in the satellite sites in Algeria, Iraq, Libya, Saudi Arabia, Sudan, Syria and Tunisia. Research results and experiences will be exchanged between the benchmark site and satellite sites for the benefit of researchers, policy makers and water user associations in these countries. The role of ICARDA will be that of developing guidelines, packages, and technologies for improving WP as well as a catalyst in the documentation and dissemination of the valued recommendations by NARS. In 2008, ICARDA will continue working with the NARS to provide the policy makers and water user associations improved policies and institutional options for improved water demand management and drought mitigation. These options are required to implement efficient water management practices including water valuation and management for the benefit of farmers of the water scarce environments. It is expected that farmers will have a more rational water supply and schedule and improved environment for producing at higher water productivity.

Groundwater management will be the focus in 2009. ICARDA and NARS partners will work together to develop policies for groundwater-based farming systems. Based on modeling approaches, these farming systems will be expected to adopt improved strategies for sustainable groundwater use. ICARDA will hold meetings with the stakeholders of the countries in the water benchmark project with groundwater-based irrigated systems to discuss and adopt policies and institutional setups for facilitating sustainable use of groundwater by the farmers.

The policy and institutional options are designed and further developed together with NARS and land users, NGOs and CBOs who participate in primary research, facilitation and advocacy. The adoption of the approach by NARS and policy makers will increase the main-streaming of land degradation in government ministries and policies, greater investments in the management of drylands, and improved adaptive capacity to cope with desertification. The work will link to the activities undertaken by the UNCCD and its various collaborators. An example of this is the linkages ICARDA has with the UNCCD country partnership program in Central Asia. The Central Asian Countries Initiative for Land Management (CACILM) aims to encourage greater government and non-government investment in dry areas and is funded by GEF under its OP-15 program on sustainable land management. The efforts in central Asia will be done in collaboration with IFPRI after further development of the outputs and activities by the national steering committees. We expect closer collaboration with IFPRI in central Asia around the themes of this Output.

5.3 Research Approach to Develop International Public Goods

The project will generate guidelines and recommendations for improved water valuation by NARS and other researchers in water scarce regions, which will be documented and disseminated to stakeholders through research reports, peer-reviewed publications and other media.

The project will develop recommendations to policy makers for improved policies and institutional options that will, if implemented, help improve water management and productivity. Outcomes will be relevant across the countries involved and more broadly to other countries with similar environments.

Modeling approaches will use standardized parameters across countries and sites. Institutional arrangements will be based on discussion with the various countries involved. Modeling outputs will be of use more broadly in the countries involved and beyond to other parts of the dry areas.

Policy and institutional options are developed through on-the-ground research with the involvement of local organizations in benchmark sites in Syria, Morocco and Tunisia and in the future with Central Asian countries. Research findings will be presented to land users, research and extension agencies and government policy decision makers. The formation of local committees will be catalyzed by ICARDA. These committees will be the main avenue into government policies. The up-scaling via policy options and policy advocacy is expected to have impacts at the national and regional levels and will be done mainly by NARS and government agencies.

5.4 Partners' Roles

ICARDA links with IWMI in the CPWF for policies and institutions at the basin level. This partnership, based on the comparative advantage of both the centers, capitalizes on the respective expertise of ICARDA in on-farm water management and IWMI on basin-level studies. The cooperating NARS provide requisite databases and case studies and work with ICARDA and IWMI to develop policy and institutional options for water resources management.

The collaboration of ICARDA with FAO and CIHEAM on policies addresses drought management and mitigation in water scarce countries. The experts of both institutions and ICARDA organize joint training courses and meetings for the collaborating NARS partners on drought assessment and mitigation. They are also ICARDA partners in NEMEDCA and work together in developing drought management plans with NARS.

ICARDA will undertake primary research comparing policy and institutional options across the dry areas. The up scaling exercises are conducted together with the relevant stakeholders (NARS in Syria, Iran, Morocco, Egypt, Jordan and Tunisia). Government agencies will undertake facilitation and advocacy roles. All five countries in C. Asia participating in the CACILM program will catalyze, and facilitate up-scaling of the outputs.

Output 6: Enhanced human capacity to improve agricultural water and land productivity and to combat land degradation in dry areas

6.1 Relations to SP goals

This output contributes to SP4A, C, and D by enhancing the NARS capacity to prioritize, plan and conduct relevant research to improve natural resources productivity and reduce degradation. Also by developing the capacity to absorb advancements in water and land sciences within the national systems.

6.2 Description of Impact Pathways

NARS from CWANA improve their skills in the development and implementation of problem-solving research for improving water use efficiency, drought preparedness and mitigation and the transfer of results to farmers. The impact depends largely on the resources and management systems of NARS but our selection of trainees and approach to enhanced capacity helps to overcome difficulties. NARS with a higher capacity to conduct research will have a profound impact on the integration of resource management and eventually on farmers' productivity and the sustainability of the resources.

The training undertaken in this output will be a mixture of in-house training of NARS personnel and on-the-ground research involving training with multiple stakeholders. Improved capacity in sustainable land management is expected to have long-lasting impacts on the institutional capacity, and improve capacities to achieve greater impact. Primary targets will be trainers in NARS, NGO's and CBOs. Trained NARS will undertake further training of their staff and local communities.

6.3 Research Approach to Develop International Public Goods

ICARDA conducts on the job training, formal and graduate degree training. The training is associated with skills needed for conducting the research planned. The nature of the research as a producer of IPG reflects the training itself.

Training will involve multiple stakeholders in participatory action research as well as formal training of researchers and extension agencies. Training modules and guidelines will be offered to NARS outside the immediate research areas or integrated research sites. Training modules and guidelines will be

developed by ICARDA involving alternative approaches to the classical in house and formal training courses for capacity building.

6.4 Partners' Roles:

Training courses are supported by selected scientists from NARS partners and advanced research institutes.

ICARDA will develop the training modules and guidelines with the involvement of external trainers from NARS, advanced research organizations and where appropriate, NGO's partners. The main partners are:

National Programs: National Agricultural Research and Extension programs in Central and West Asia, North Africa, sub-Saharan Africa (Eritrea, Ethiopia, Mauritania, Sudan), and Asia (Pakistan).

Advanced Research Institutes: Laboratory of Experimental Geomorphology, Catholic University of Leuven, Belgium; Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France; University of Bonn, Germany; Berne University, Switzerland; World Overview of Conservation Approaches and Technologies (WOCAT) Consortium; Wageningen University, Netherlands; Atomic Energy Commission of Syria.

The project participates in the CP Water & Food through a project on "Strengthening Livelihood Resilience in Upper Catchments of Dry Areas by Integrated Natural Resources Management".

Project 7	Improving water and land management in dry areas
Goal	Viable and resilient livelihoods through improved management of water and land resources and mitigation of drought
Purpose	Sustainable agricultural production in dry areas through efficient and improved use of water and land resources and mitigation of drought

	Output Targets	Intended Users	Outcomes	Impact
	Output 1: Assessment of water and land resources use in agriculture, productivity, and degradation under present and future scenarios.	NARS, NGOs, community-based organizations (CBOs), land users and associations, universities, research organizations concerned with land degradation. Policy makers.	Better assessments of water and land resources and land degradation in the dry areas	Better utilization of water and land resources for improved productivity and agricultural sustainability. Improved allocation of water resources and more efficient water use reduces conflicts and improves livelihoods. Greater awareness of land degradation at local, regional and national scales and its costs. Extent and causes of land degradation better known and mainstreamed into poverty reduction strategies
2008	Current and future quantity and quality of water resources available for agriculture in the dry areas determined and constraints to improved allocations identified in project benchmark sites (<i>CPWF</i>)	NARS researchers and decision makers; CGIAR center partners.	Methodology for water productivity assessment used in the river basins of the <i>CPWF</i> and by NARS globally to overcome low water productivity	
	Guidelines for assessing the economic and environmental impacts of improved land management options made available to NARS in at least two countries	NARS, NGOs, CBOs, land users and associations	Factors affecting improved land and water productivity at the basin level understood by specialists and means to improve it developed and adopted by NARS.	
	Methodology for quantifying water erosion in rangeland environments published	NARS, land users and associations, research organizations concerned with land degradation, policy makers.	NARS use the methodology in their own research	
2009	Water harvesting and supplemental irrigation potential and their consequences completed for WANA	NARS decision makers and national and international research and development agencies in water scarce countries in the dry areas	Information used to plan water resource projects and allocation to various sectors NARS have better capacity for and assessment of the economic valuation of land degradation	

Output Targets		Intended Users	Outcomes	Impact
	A multi-level framework and set of multi-thematic indicators of desertification	NARS, NGOs, CBOs, land users and associations, universities, concerned with land degradation, research organizations, and policy makers	NARS in five pilot areas use multi-level frameworks and indicators of desertification for the economic valuation of land degradation.	
2010	Assessment of basin water productivity in Karkheh, Euphrates and Amudaria river basins completed (<i>in collaboration with IWMI</i>)	Policy makers, specialists and planners in the dry areas	NARS use the information for planning allocation of water resources and prevention of land degradation.	
Output 2: Options and strategies for improved water and land productivity in rainfed, irrigated and rangeland agroecosystems		NARS, NGOs, CBOs, water and land users and associations, local authorities, policy makers, development agencies	NARS and CBOs, communities and policy makers use improved water and land management strategies	Water productivity (production per unit of water) improved in target environments, reflected in improved farm incomes and rural livelihoods. Higher productivity and improved environment in areas where saline water is used for irrigation or salt-affected soils exist
2008	Options for conservation tillage tested in Morocco and results available for use by NARS	NARS in cooperation with land users	Improved tillage practices implemented by farmers.	
	Technical management options for sustainable use of salt-prone waters and soils in agriculture developed in dry areas (<i>in collaboration with IWMI</i>)	NARS and farmers use saline/sodic waters for irrigation and/or salt-affected soils for crop production systems	Soil- and crop-based management options for the use of saline waters and soils adopted in pilot areas	
	Guidelines for watershed management in dry mountain areas available	NARS, policy makers, CBOs	Community-based management strategies and supporting policy and institutional measures documented and practiced by NARS and CBOs.	Better collective watershed management, prevention and reduction of land degradation and improvement of agricultural productivity and household livelihoods
2009	Integrated technical packages that optimize water productivity in irrigated, rainfed and rangeland systems discussed and conveyed to NARS.	NARS, technicians and farmers in the dry areas	NARS use the packages in national programs	
	Guidelines for assessing the economic and environmental impacts of improved land management options made available to NARS in at least two countries.	NARS, NGOs, CBOs, land users and associations	Improved sustainable land management options implemented by farmers.	
2010	Package to improve crop-livestock water productivity in dry areas developed and conveyed to NARS	Policy makers, NARS specialists and farmers associations	NARS and farmers use the packages to improve water productivity and income	
	Outscaling strategies for land management practices developed for project areas	NARS, policy makers, CBOs	NARS use output to develop more productive land operations	

Output Targets		Intended Users	Outcomes	Impact
Output 3: Options and technologies for combating water and land degradation using an INRM approaches.		NARS, NGOs, CBOs, universities	INRM approaches used in research and development projects and mainstreamed into NARS research agendas in dry areas	Better collective management of natural resources, prevention and reduction of land degradation and improvement of agricultural productivity and rural livelihoods. Farmers increase their adaptive capacity and greater agroecosystem resilience in marginal areas
2008	INRM framework disseminated to users	NARS research leaders and NGOs	Users adopt and adapt the INRM framework	Better co-management of natural resources in targeted communities and areas.
	Spatial drought monitoring products and guidelines for identifying hot-spots of water erosion and drought	NARS and NGOs	NARS use the guidelines to identify erosion hot spots in their countries	
2010	Interventions to maximize the safe use of treated wastewater and minimize threats to the environment and human health	NARS and farmers use treated wastewater for crop production systems	Management options developed for the use of treated wastewater in an environmentally feasible manner	
Output 4: Methods, options and strategies for drought characterization, preparedness and mitigation in the dry areas		NARS, drought specialists, meteorologists, and policy makers	Integrated approaches to drought preparedness and mitigation	Reduced risks and vulnerability to drought of communities in drought affected areas
2008	Assessment of existing strategies, measures and policies (including indigenous knowledge and practices) for drought preparedness and mitigation.	NARS and policy makers	Constraints to improved drought management strategies identified and measures taken to alleviate these.	
2009	Action plans using mitigation packages developed and approved for the member countries of the Drought Network	Policy makers, NARS, environmental agencies and extension services in member countries of the drought network	National agencies develop mitigation plans based on these options and integrate them in national drought measures	
	Case study on adaptation of rainfed systems in Syria to climate change	NARS and policy makers in Syria and the Mediterranean rainfed areas	Adaptation strategies may be developed by NARS and research institutions	
2010	Projects developed with NARS to implement relevant elements of national action plans	NARS leaders	NARS adopt the integrated packages for drought preparedness and mitigation	
	Scenarios of climate change effect on droughts in the dry areas and options for adaptation	NARS, drought specialists	National drought preparedness and mitigation plans revisited.	

Output Targets		Intended Users	Outcomes	Impact
Output 5: Improved policy and institutional options to enhance sustainable water and land productivity, combat land degradation and mitigate drought		NARS, government ministries, research organizations	Institutional and policy options to prevent/reverse desertification adopted by NARS and policy makers	Enhanced private and public investments to prevent/reverse desertification and to sustain livelihoods of dryland populations.
2008	Analysis of the impact on water productivity of existing policies and institutional setups completed for selected projects (CPWF)	Policy makers and NARS leaders	Report used to develop new options for improved productivity in participating countries	
	Regional workshop on impact of policies and institutional arrangements on land degradation	NARS and CBOs	Regional cooperation in establishing transboundary policies and institutions to prevent/reverse desertification	
2009	Policy and institutional options for sustainable use of groundwater developed with NARS and policy makers.	NARS and policy makers	Decision makers and users are better informed in rationalizing groundwater use in agriculture. NARS use the packages to develop own policies	
2010	Development of alternative policy options to combat desertification	NARS, policy makers	Policies on combating desertification revisited by NARS in CWANA	
Output 6: Enhanced human capacity to improve agricultural water and land productivity and to combat land degradation in dry areas		NARS, universities, NGOs, CBOs, civil society organizations (CSOs), land users	Improved adaptive capacity for sustainable land management	Strengthened national research programs capable of generating development options for more productive water use and for reducing the vulnerability of agricultural communities to drought.
2008	20 NARS specialists acquire skills in drought preparedness and mitigation	NARS researchers and policy makers	NARS conduct appropriate research and transfer technologies more effectively	
	Guidelines for up-scaling successful technological, institutional and policy options developed and on-the-job training provided to 20 trainees from various countries	NARS, universities, NGOs, CBOs, CSOs, land users	Improved capacities of NARS and extension workers, land user, CBOs, and students for land management	
2009	20 NARS specialists acquire skills in improving water productivity in irrigated agriculture	NARS researchers, extensionists and NGOs	Participants utilize knowledge and skills in conducting research and implementing development programs.	
2010	100 engineers trained in planning, designing and implementing modern irrigation systems	Farmers, farmers water user associations, NARS and farming communities	Modern irrigation systems adopted	