Project 2: ICARDA-CIMMYT Wheat Improvement Program (ICWIP) for Central and West Asia and North Africa (CWANA)

Rationale

ICARDA has the ecoregional responsibility for the improvement of durum and bread wheat within Central and West Asia and North Africa (CWANA), which includes 26 wheat producing countries. Total wheat area in CWANA is approximately 50 million hectares including spring bread wheat, durum wheat and winter/facultative wheats. This compares with 36 million hectares in South Asia, 29 million hectares in Eastern Asia, and 9 million hectares in Latin America. However the overall productivity of wheat in CWANA is lower than all other geographic regions of the world, and lower than the world average of 2.5 ton/ha. From a food security point of view wheat is the most important commodity in CWANA. It is the principal cereal grown in the region and is the staple food in most countries, accounting for 45% of the region's per capita calorie intake. This dependency on wheat is even higher in the Central Asia and Caucasus region, where it contributes 60% of calorific intake in some countries. Production of wheat is not adequate to satisfy the demands of the rapidly growing populations. As a result, substantial imports are made to meet the deficits.

Wheat production systems in CWANA vary from irrigated to completely rainfed but most (70%) wheat production in CWANA is dryland. Productivity and total wheat production in CWANA is generally low and highly variable due to both abiotic stresses (drought, cold and heat) and biotic stresses (for example, rusts, Septoria leaf blotch, root rots, Hessian fly, Sawfly). Year to year variability in wheat production and productivity in CWANA is primarily caused by the highly variable precipitation. Recently the emergence of the Ug99 stem rust race, capable of destroying most of the CWANA wheat cultivars, is an additional threat to wheat production.

The CWANA region especially the area between Euphrates and Tigris rivers is considered the primary center of domestication of bread wheat. Dryland species exhibit high diversity and a wide range of adaptation to prevailing abiotic and biotic stresses. The conservation and utilization of this biodiversity will serve as a valuable source of genetic material for current and future germplasm enhancement needs. Improvement of wheat productivity and production though germplasm enhancement and crop management will therefore contribute substantially to enhancing food security and improving human nutrition for farm families whose livelihood depends on income from wheat based farming systems. This MTP is for the joint ICARDA-CIMMYT Wheat Improvement Program (ICWIP) and its focus is CWANA, however, the output of this program is expected to have impact beyond CWANA on areas of similar stresses especially with the emerging climate change scenarios. The activities and the international public goods (IPGs) produced by this project align with CGIAR System Priority 2, producing more and better food at lower cost through genetic improvements, sub-priority 2A on genetic enhancement of yield and yield potential of staple crops, sub-priority 2B on selection for tolerance to abiotic and biotic stresses, and sub-priority 2C on selection for enhancing the nutritional quality of staples.

In December 2005, ICARDA and CIMMYT signed a Memorandum of Understanding for a joint ICARDA-CIMMYT Wheat Improvement Program (ICWIP) in CWANA hosted at ICARDA and managed by a jointly appointed Director covering both Centers' wheat research in the region. The new alliance between ICARDA and CIMMYT has clearly established the guidelines for operational strategies and options in relation to wheat networking with NARS, joint fund raising and priority setting. Thus, the MTP 2008-2010 on wheat improvement at ICARDA will deviate significantly from the MTP 2007-2009 and, beginning with this MTP (2008-2010), the ICWIP is presented with common outputs, outcomes and impacts pathways for both Centers' MTPs, developed at a common planning meeting in October 2006. The Global Rust Initiative (GRI) instituted by CIMMYT and ICARDA in response to the threat of new stem rust race Ug 99 emerging from East Africa is one of the many immediately visible manifestations of this enhanced partnership. The management of winter wheat breeding based in Turkey in partnership with MARA (Ministry of Agriculture and Rural Affairs, Turkey) is another joint activity within ICWIP. ICWIP produces international public goods that are freely available to clients. These include: trait based products (e.g. drought, heat and cold tolerant germplasm); utilization of crop genetic resources (e.g. disease and insect pest resistant/tolerant gene pools); production technologies (e.g. bed planting) and strategic research (e.g. biotechnology applications).

The ICWIP has focused its agenda for 2008-2010 around seven Outputs. These represent genetically enhanced, seed-embedded technologies developed by multidisciplinary teams (germplasm enhancement, plant health, biotechnology, and genetic resources) charged with generation of products

reflecting integrated solutions for targets end-users. Besides genetic advancement, there are outputs devoted to conservation agriculture, impact assessment and human resource development. ICWIP products are listed below:

- Stress tolerant (drought, heat and cold) wheat germplasm adapted to variable environments of CWANA.
- Enhanced wheat germplasm for water use efficiency.
- Rust resistant especially against stem rust race Ug 99 in addition to yellow and leaf rusts.
- Integrated pest management options for the control of diseases, insects and nematodes.
- Conservation agriculture practices implemented for wheat based production systems against soil degradation, moisture conservation, and for improved productivity.
- Capacity building of NARS programs.
- Impact assessment of ICWIP on livelihood of farmers in dryland areas of CWANA.

ICWIP is engaged in the Challenge Programs on *Water and Food*, *Generation* and *HarvestPlus*.

Project Outputs

The project goal, purpose, outputs, output targets and associated expected outcomes and impacts are provided in the attached Project Logframe. Where an Output Target contributes to a Challenge Program or a Systemwide/Ecoregional Program, this is indicated in the Project Logframe. Below, we describe for each Output: (a) the relation to system priority goals, (b) the impact pathway, (c) the research approach to developing international public goods (IPG), and (d) the role of partner organizations.

Output 1: Improved genetics stocks in winter (WW) and facultative (FW) bread wheat developed through conventional biotechnological and participatory variety selection (PVS) methodologies for CWANA.

1.1 Relation to SP goals

Output 1 aims at delivering sustainable productivity gains in winter and facultative bread wheat through genetic enhancement to improve livelihood and food security of the poor. Output 1 meets specific Goals 1 and 2 of SP 2A, by developing and promoting conventional and novel breeding technologies promoting the use an exploitation of genetic resources, and prioritizing areas where barley is grown by resource-poor farmers; as well as the general goal of SP 2B, by producing stress tolerant (drought, salinity, and cold) germplasm.

1.2 Description of Impact Pathways

The intended users of the outcomes are farmers, NARS and wheat researchers worldwide. Through a breeding methodology involving targeted crossing program that emphasizes selective use of locally adapted cultivars and wild progenitors, coupled with multilocation testing, elite facultative/winter wheat germplasm combining high yield and tolerance or resistance to prevailing biotic and abiotic stresses is developed. The developed germplasm is made available to national programs as international public goods (IPGs) through ICWIP international nurseries and participatory variety selection (PVS) programs. Similarly, sources of resistance to rusts (leaf, stem and stripe rusts), Septoria leaf blotch, Russian wheat aphid and barley yellow dwarf virus as well as adapted elite lines with good end-use quality are assembled as gene pools and made available to national programs for use as parental lines in their breeding programs. In addition, researchers and other NARS partners will acquire increased skills from the new methodologies and techniques used in the project to enable them enhance their research capabilities and efficiency. The adoption of those varieties and knowledge by NARS will stabilize production of wheat in the targeted areas.

This research will have direct impact on reducing vulnerability to abiotic and biotic stresses for farm families whose livelihood depends on income from wheat based farming systems and will improve farm productivity and total production. Thus, this research will contributes to alleviating poverty by increasing farm production and incomes and on so doing will improve livelihoods and nutritional security of resource poor farmers.

1.3 Research Approach to Develop International Public Goods (IPG)

Identification of sources of resistance/tolerance to prevailing biotic and abiotic stresses limiting wheat production is carried out in hotspots in collaboration with NARS and other research partners. Often, networks (e.g. Rust Network, Heat Tolerance Network) are established to address common problems

with regional dimension. In cases of specific and localized stress problem, depending on comparative advantage, specific NARS or research partners are entrusted to lead the research (e.g. Morocco as leader of Hessian fly research). The outputs of such research, which are the outcomes from joint efforts in collaboration with NARS, advanced research institutions, governmental and non-governmental organization, are freely exchanged among the partners and end-users and are International Public Goods. For instance, effective resistance sources are published and germplasm made available to NARS, wheat breeders and international scientific community. All crop and pest management packages developed are distributed to NARS research groups and extension, and to farmers' groups, and these are applied in many countries. Similarly, the germplasm produced by the joint ICARDA-CIMMYT Wheat Improvement Program (ICWIP), would be distributed in CWANA and beyond to NARS, international and advanced research centers, NGOs, private sector.

1.4 Partners' Role

CGIAR Centers: **CIMMYT:** All research in ICARDA – CIMMYT Wheat Improvement Program (ICWIP) for CWANA is a joint undertaking by CIMMYT and ICARDA; CIMMYT is the principal partner in CIMMYT-Turkey-ICARDA joint winter and facultative wheat improvement program.

Other International Partners:

JIRCAS (Japan International Research Center for Agricultural Sciences): Joint research on physiology of drought tolerance in WW/FW.

NARS Partners

Iran: SPII (Seed and Plant improvement institute) of the Agricultural Research and Education Organization **(AREO)** provides testing facility for WW/FW at Karaj, Iran.

Turkey: Ministry of Agriculture and Rural Affairs (MARA): Development of facultative/winter wheat germplasm for semiarid rainfed highlands and scientists Agricultural Research in Turkey (**TAGEM**) provides staff, laboratory, and field facility for WW/FW germplasm improvement.

<u>Output 2</u>: Improved genotypes of spring bread wheat developed through conventional, biotechnological and physiological methods and distribution in CWANA through different mechanism including international nursery network and participatory variety selection (PVS).

2.1 Relation to SP Goals

Output 2 aims at delivering sustainable productivity gains in spring bread wheat through genetic enhancement to improve livelihood and food security of the poor. Output 2 meets specific Goals 1 and 2 of SP 2A, by developing and promoting conventional and novel breeding technologies promoting the use an exploitation of genetic resources, and prioritizing areas where barley is grown by resource-poor farmers; as well as the general goal of SP 2B, by producing stress tolerant (drought, heat, and cold) germplasm.

2.2 Description of Impact Pathways

After 5 years of completion of MTP 2008-2010, the NARS would have identified and released, multiplied seed and distributed to farmers; at least 10 wheat varieties would have been released across CWANA region. These new varieties would be superior in regards to disease resistance, drought tolerance and yield potential and acceptable quality. These new germplasm would replace varieties which have succumbed to new races of rusts. See 1.2 for detailed description of impact pathways.

2.3 Research Approach to Develop International Public Goods (IPG)

The varieties and advanced lines produced under ICWIP would be distributed to all NARS and other public and private institutions. A set of these would be conserved in the gene banks of ICARDA and CIMMYT. See 1.3 for detailed research approach to develop international public goods (IPGs).

2.4 Partners' Role

CGIAR Centers and Systemwide Programs: **CIMMYT:** See Section 1.4. In addition CIMMYT is main partner in Global Rust Initiative (GRI).

Challenge Programs: **CP Water and Food**, through the project on Improving Water Productivity of Cereals and Food Legumes in the Atbara River Basin of Eritrea, led by ICARDA.

Other International Partners:

ACSAD (Arab Center for the Studies of Arid Zones and Dry Lands): Joint development and exchange of spring bread wheat germplasm. ACSAD contributes germplasm to the participatory variety selection program in Syria carried out jointly with the General Commission for Scientific Agricultural Research (GCSAR).

Australia:

- **Plant Breeding Institute, University of Sydney:** Joint evaluation of spring bread wheat germplasm for resistance to stripe (yellow) rust at Cobbity.
- **GRDC (Grain Research and Development Commission):** Partnership and close collaboration in enhancement of productivity and yield stability of spring bread wheat in dry areas of Central and West Asia and North Africa (CWANA) Region

Germany:

- **IPK-Gatersleben:** Association mapping and microarray analysis in spring bread wheat.
- **University of Bonn:** QTL analysis in spring bread wheat.

Japan:

- **JIRCAS** (Japan International Research Center for Agricultural Sciences**):** Joint research on physiology of drought tolerance in spring bread wheat.

NARS Partners:

Algeria: ITGC (Institut Technique des Grandes Cultures) and **INRAA** (Institut National de Recherche Agronomique d'Algerie): joint selection of spring bread wheat germplasm adapted to Mediterranean drylands.

Egypt:

- **AGERI** (Agricultural Genetic Engineering Research Institute).
- **ARC** (Agricultural Research Center): Joint selection of spring bread wheat germplasm adapted to CWANA irrigated areas and collaboration in rust and water use efficiency networks. Development of transformation systems for spring bread wheat: Gene discovery for tolerance to abiotic stresses.

Ethiopia:

- **EARI** (Ethiopian Agricultural Research Institute): Collaboration under the umbrella of GRI in rust surveillance, monitoring and screening wheat germplasm for resistance to stem rust race Ug99.

Eritrea: NARI (National Agricultural Research Institute), Ministry of Agriculture: Joint project on improving water productivity of cereals and food legumes within CP Water & Food.

Iran:

- **SPII** (Seed and Plant improvement Institute) of the Agricultural Research and Education Organization (**AREO**) is partner in the joint development of spring bread wheat germplasm adapted to irrigated low latitude areas of CWANA through contribution of staff, land and facility at Dezful station in south western Iran.
- **DARI**: Joint selection of spring bread wheat germplasm adapted to dry and hot areas.

Morocco: INRA (**I**nstitut **N**ational de la **R**echerche **A**gronomique): Collaboration in Spring bread wheat germplasm improvement in the arid and semi-arid areas of Morocco and development of Hessian fly resistant germplasm: INRA contributes germplasm, conducts trials in Morocco and joint evaluation of Moroccan and ICARDA germplasm.

Sudan: ARC (Agricultural Research Corporation): Joint selection of spring bread wheat germplasm adapted to low latitude areas of CWANA and collaboration in water use efficiency and heat tolerance networks.

Syria:

- **GCSAR** (General Commission for Agricultural Research): joint spring bread wheat participatory variety selection.
- **Al Shark Malting Company**. Selection and testing of spring bread wheat varieties suitable for biscuit making.

<u>Output 3</u>: Improved durum wheat germplasm developed through breeding using physiological and biotechnological tools, distributed in CWANA through international nursery network and promoted through participatory methodologies.

3.1 Relation to SP Goals

Output 3 aims at delivering sustainable productivity gains in durum bread wheat through genetic enhancement to improve livelihood and food security of the poor. Output 3 meets specific Goals 1 and 2 of SP 2A, by developing and promoting conventional and novel breeding technologies promoting the use an exploitation of genetic resources, and prioritizing areas where barley is grown by resource-poor farmers; as well as the general goal of SP 2B, by producing stress tolerant (drought, heat, and cold) germplasm

3.2 Description of Impact Pathways

Within 5 years of this MTS, a set of at least 5 varieties would be released by NARS in CWANA. These varieties would impact the livelihood of poor farmers of CWANA, through superior disease and insect resistance. Improved quality parameters would allow farmers to sell their durum products at premium price. See 1.2 for detailed description of impact pathways.

3.3 ***Research Approach to Develop International Public Goods (IPG):*** See under Output 1.

3.4 Partners' Roles

CGIAR Centers: **CIMMYT:** See Output 1 and Rationale

Challenge Programs: **CP Generation:** Collaboration with CIMMYT in Fingerprinting of 3000 wheat accessions with 50 SSR markers.

Other International Partnerships:

Australia: NSW Agriculture, Tamworth Centre for Crop Improvement / Morocco – INRA (Institut National de la Recherche Agronomique): Collaboration in the Introgression of novel resistance to leaf rust, Hessian fly, Russian wheat aphid, stem sawfly, and use of DART technology, molecular markers.

Italy*:*

- **Italy (University of Bologna); Spain (Centre UdL-IRTA), Lebanese Agricultural**

  Research Institute (LARI); Morocco (INRA); Syria (University of Aleppo): Improving durum wheat for water use efficiency and yield stability through physiological and molecular approaches: development of drought tolerance QTLs and linkage disequilibrium.
- **Italy (University of Bologna); Spain (University of Barcelona); UK (Rothamsted Research), Morocco (INRA), Syria (General Commission for Scientific Agricultural Research); Tunisia (INRAT):** understanding of drought tolerance mechanisms and gene expression under drought conditions, and development of drought candidate genes.
- **Italy/CIMMYT:** CP Generation QTL research in durum wheat: testing for QTLs for yield potential in Obregon, Mexico; Bologna, Italy; and ICARDA, Syria.

Japan*:* **JIRCAS** (Japan International Research Center for Agricultural Sciences**):** Joint research on physiology of drought tolerance in durum wheat with focus on soil moisture dynamics.

Spain: University of Barcelona: Studies of drought tolerance traits in the Mediterranean region; in collaboration with Lleida-IRTA and Grenada University

United Kingdom: RRC (Rothamsted Research Center): Joint research on development of drought tolerance QTLs; and drought candidate genes.

NARS Partners:

Algeria: INRAA (**I**nstitut **N**ational de la **R**echerche **A**gronomique d'Algerie)**:** Identification of improved cultivars; testing of durum cultivars with farmers for productivity and end-use quality

Iran: SPII (Seed and Plant Improvement Institute) of the Agricultural Research and Education Organization **(AREO)** is partner in joint development of durum wheat germplasm adapted to irrigated low latitude areas of CWANA through contribution of staff, land and facility at Dezful station in south western Iran.

Jordan: NCARTT (**N**ational **C**enter for **A**gricultural **R**esearch and **T**ransfer of **T**echnology)**:** Identification of improved cultivars; testing of durum cultivars with farmers for productivity and end-use quality.

Lebanon: LARI (**Lebanese Agriculture Research Institute**)**:** Identification of improved cultivars and testing of durum cultivars with farmers for productivity; QTL determination for continental and favorable conditions.

Morocco: INRA (**I**nstitut **N**ational de la **R**echerche **A**gronomique)**:** Moroccan Competitive Grant Program: Durum wheat: breeding for resistance to drought, cold, heat, Septoria, root rot, and Hessian fly; QTL development for temperate dryland, testing of cultivars with farmers.

Tunisia: INRAT (**I**nstitut **N**ational de la **R**echerche **A**gronomique de Tunisie)**:** Identification of improved cultivars and testing of durum cultivars with farmers for productivity; QTL determination for temperate/and favorable conditions.

Turkey: MARA (Ministry of Agriculture and Rural Affairs): Development of durum wheat germplasm with improved productivity and end-use quality for semiarid rainfed highlands and cold winter areas in Anatolian plateau.

Syria: GCSAR (General Commission for Agricultural Research): joint spring bread wheat participatory variety selection (PVS).

<u>Output 4</u>: Plant health system established using host plant resistance, biological control mechanism and pathogenicity monitoring and surveillance established against diseases and insects.

4.1 Relation to SP Goals

Output 4 contributes to SP2 overall goal of producing more and better food at lower cost through genetic enhancement and specifically meets Goal 1 of SP 2A, by promoting the use an exploitation of genetic resources, and stabilizing production under biotic stress.

4.2 Description of Impact Pathways

Resistant sources for diseases and insects are vital for food production. Yellow rust, Septoria and recently stem rust pathogens can be devastating in many countries and regions of CWANA. The output targets in this MTP, assure that future germplasm is less vulnerable to these problems. An optimum level of investment in these activities would save farmers more than US$ 150 million in fungicidal application against pathogens and insects and reduce environmental damage. See 1.2 for detailed description of impact pathways.

IPM research at ICARDA involves basic and applied research on fungal pathogens, viral diseases, and insect pest of wheat and integrates both strategic research (e.g. the characterization of pathogenic variability) and applied adaptive research (IPM components for diseases and insect managements) through use of pilot sites and farmer field schools (FFS) conducted with NARS. IPM research outputs are technologies that have direct application in breeding programs of ICARDA and NARS. The technologies are being tested in farmers' fields through direct collaboration with NARS researchers, universities, extension specialists, farmers groups, and NGOs. The IPM outputs are of immediate impact on productivity and sustainability of production. The ultimate beneficiaries of IPM products are resource-poor farmers.

4.3 Research Approach to Develop International Public Goods (IPG)

See 1.3 for detailed research approach to develop international public goods (IPGs).
The technical know-how developed to achieve output 4 can be applied elsewhere and would be freely available. Effective resistance sources would be published and resistant germplasm would be made available to NARS and wheat researchers world-wide. All developed integrated pest management technological packages would be distributed to NARS research groups and extension, and to farmers' groups, and such knowledge and practices would be IPGs.

4.4 Partners' Roles

CGIAR Centers and Systemwide Programs: **CIMMYT:** Main partner and collaborator in Global Rust Initiative (GRI).

Other International Partnerships:

USA: USDA United State Department of Agriculture Rust Lab (Minnesota): Collaboration on GRI in rust race virulence analysis.

NARS Partners:

Ethiopia: EARI (Ethiopian Agricultural Research Institute):Collaboration under the umbrella of Global Rust Initiative (GRI) in rust surveillance, monitoring and screening wheat germplasm for resistance to stem rust race Ug99 and partner in Rust Network of the Nile Valley and Red Sea Regional Program (NVRSRP).

Iran: CPI (Crop Protection Institute) of the Agricultural Research and Education Organization **(AREO):** Collaborating institution on Sunn pest control.

Turkey: Ministry of Agriculture and Rural Affairs (MARA): Collaboration on Sunn pest control.

<u>Output 5</u>: Conservation agriculture practices implemented for wheat-based production system in CWANA

5.1 Relation to SP Goals

Output 5 relates to SP4: Poverty alleviation and sustainable management of water, land, and forest resources and meets the specific goals of SP 4C: Improving water productivity in irrigated and rainfed environments to enhance livelihood and aspirations of rural and urban poor.

5.2 Description of Impact Pathways

Throughout the CWANA region, the soil degradation is rampant and consequently per hectare productivity is very low. The organic matter content is low, and many other micro nutrients deficiencies are very visible. Salinity is common in both irrigated and rainfed systems. Water use efficiency is low. The research outputs of this MTP would ensure some degree of recovery in these regards and maintain production sustainability. See 1.2 for detailed description of impact pathways.

5.3 Research Approach to Develop International Public Goods (IPG)

The research output would be applicable in other parts of the world. The results would be published and would be shared with all NARS.

5.4 Partners Roles

CIMMYT and ICARDA (links with P6): Their participation is vital to ensure good coordination.
TAGEM: Collaboration on Conservation Agriculture in Anatolia Plateau.
NARS of Kazakhstan: For coordination in Northern Kazakhstan on Conservation Agriculture.
AERO: For coordination in raised bed technology in Iran.

<u>Output 6</u>: Human Resource Development

6.1 Relation to SP Goals

The research generated in CGIAR priority areas will only be successful when the outputs are implemented by collaborating partners and stakeholders in such a way as to reach the poor. Building the capacity of NARS scientists and institutions is considered as an integral function of that research and to constitute a major international public goods provided by the work of CGIAR. Thus enhanced human resource development will enhance the efficiency of achieving the goals of SP2A and SP 2B.

6.2 Description of Impact Pathways

By 2010, the number of wheat researchers in CWANA would have been increased. This would be necessary for the food security, stability of production in the region and insurance that good scientific programs contribute in the region. Without sufficient human resource availability, the NARS capacity to deliver technology to farmers would collapse.

6.3 Research Approach to Develop International Public Goods (IPG)

The knowledge generated through human resource development is published and freely available to all.

6.4 Partnerships Role

CIMMYT: Provide necessary courses on special breeding methodology such as Shuttle Method in Plant Breeding.
ICARDA: Would organize the integrated regional courses.
University of Aleppo, Syria: Provide PhD program to Arabic students.
Universities in USA & Europe: Provide PhD and MS programs to English speaking students.
FAO: Provide technical back stopping.

<u>Output 7</u>: Impact assessment of ICWIP on productivity, income and rural welfare in the dry areas quantified and accessible to stockholders.

7.1 Relation to SP Goals

Output 7 relates SP5 general goal of enhancing impact of agricultural research in promoting options for reduction of rural poverty and vulnerability.

7.2 Description of Impact Pathways

Although ICWIP is a young initiative nonetheless; it has arisen out of CIMMYT-ICARDA's previous activities over the decades in CWANA. The impact assessment of ICWIP on livelihood of farmers in dryland areas of CWANA would be a pre-requisite to future and continuing investments in wheat based cropping system.

7.3 Research Approach to Develop International Public Goods (IPG)

The impact assessment and livelihood analysis methodology in CWANA would be published. The results would be made available to policy makers and research farmers. The application is very broad over the region.

7.4 Partners' Roles:

CIMMYT: Provides leadership in varietal adaptability research and links with ICARDA P8.
Ministry of Agriculture and Rural Affairs (MARA), Turkey: Provide cooperation and facility for impact assessment.
Agricultural Research and Education Organization, Iran: Provide personnel and local support for impact assessment.

Project 2	**ICARDA – CIMMYT Wheat Improvement Program (ICWIP) for Central and West Asia and North Africa**
Goal	Sustainable conservation and use of bread and durum wheat diversity to increase agricultural production in developing countries
Purpose	Improved livelihoods of resource poor farmers from the conservation, improvement and sustainable use of wheat diversity and the adoption of improved wheat varieties and associated technologies

Output Targets		Intended Users	Outcomes	Impact
Output 1: Improved genetic stocks of winter and facultative bread wheat developed through conventional, biotechnological and participatory variety selection methodologies and distributed in CWANA		Farmers, household consumers, food processors, NARS, international and advanced research centers, NGOs, private sector	Measurable increase in productivity and genetic diversity in farmers' fields. Reduced losses from diseases and increased stability of grain yield. Enhanced input efficiency.	Increased national food security. Reduced vulnerability of farm families whose livelihood depends on income from wheat based farming systems. Improved agricultural productivity, better quality of wheat products and more sustainable utilization of natural resources. Risk for disease epidemics reduced.
2008	150 high yielding lines of winter and facultative bread wheat adapted to CWANA environments developed through partnership between TAGEM (Turkey), ICARDA and CIMMYT	NARS	Increased availability of drought tolerant genetic material to NARS researchers for drought prone areas	Farm incomes improved and risks reduced through fast turnover of cultivars
	25 elite advanced lines of winter and facultative bread wheat identified across the CWANA region and seed stocks established for distribution	NARS, farmers and private sector	Increased availability of drought tolerant genetic material to NARS researchers for drought prone areas	Genetic variability increased in farmers' fields
	International trial data for winter and facultative bread wheat analyzed for genotype x environment (GxE) interaction and environmental clustering completed	Wheat breeders and international scientific community	Knowledge and efficiency of varietal development enhanced	Better targeting of cultivars in farmers' fields
2009	500 winter and facultative bread wheat lines produced through doubled haploid method and evaluated for adaptation in dryland and supplementary irrigation systems	NARS	Increased availability of drought tolerant genetic material to NARS researchers for drought prone areas	Fast turnover of cultivars for CWANA farmers
	CWANA database on area, production, varietal distribution and quality requirements of winter and facultative bread wheat established and published	Wheat breeders and international scientific community	Knowledge and efficiency of varietal development enhanced	Better definition of winter and facultative bread wheat mega environments completed
2010	150 high yielding lines of winter and facultative bread wheat adapted to CWANA environments developed through the partnership between TAGEM (Turkey), ICARDA and CIMMYT	NARS	Increased availability of drought tolerant genetic material to NARS researchers for drought prone areas	Farm incomes improved and risks reduced through fast turnover of cultivars

Output Targets		Intended Users	Outcomes	Impact
Output 2: Improved genotypes of spring bread wheat developed through conventional, biotechnological and physiological methods and distributed in CWANA through different mechanisms including international nursery network and participatory variety selection methods		Farmers, household consumers, food processors, NARS, IARC, ARI, NGOs, private sector	Measurable increase in productivity and genetic diversity in farmers' fields. Reduced losses from diseases and increased stability of grain yield. Enhanced input efficiency.	Increased national food security. Reduced vulnerability of farm families whose livelihood depends on income from wheat based farming systems. Improved agricultural productivity, better quality of wheat products and more sustainable utilization of natural resources. Risk for disease epidemics reduced.
2008	25 elite spring bread wheat lines multiplied and distributed to NARS for participatory variety selection for favorable environments	NARS, farmers and private sector	Broader options for farmers' needs	Enhanced genetic diversity, reduced vulnerability, increased productivity and profitability
2009	Spring wheat regions of CWANA established and characterized using GxE analysis and GIS • Analysis of international nursery data • Characterization of nursery sites	Wheat breeders and international scientific community	Well characterized target environments and knowledge of germplasm interactions with environmental factors	Enhanced understanding of agro-ecological zone leading to better targeting of breeding resources
2010	Bread wheat mapping populations developed and QTLs identified for drought tolerance, heat tolerance and yellow rust resistance	Wheat breeders and international scientific community	Knowledge and efficiency of varietal development enhanced	Better cultivars delivered faster to farmers
Output 3: Improved durum wheat germplasm developed using physiological and biotechnological tools distributed in CWANA through international nursery network and promoted through participatory approaches		Farmers, household consumers, food processors, NARS, IARC, ARI, NGOs, private sector	Measurable increase in productivity, end-use quality and genetic diversity in farmers' fields. Reduced losses from diseases and increased stability of grain yield. Enhanced input efficiency.	Increased national food security. Reduced vulnerability of farm families whose livelihood depends on income from wheat based farming systems. Improved agricultural productivity, better quality of wheat products and more sustainable utilization of natural resources. Risk for disease epidemics reduced.
2008	25 high yielding durum wheat lines adapted to CWANA region with enhanced biotic and abiotic stress tolerance and end-use quality traits	NARS	A diverse and enhanced collection of drought tolerant genetic material used by NARS in their varietal development efforts in drought prone areas.	Risks associated with durum wheat sowing, utilization and marketing reduced and livelihoods in drought prone areas improved.
	Wild tetraploid relatives core collection and progenies evaluated for nutritional quality	ICWIP breeders, NARS	NARS use available genetic stocks with improved nutritional value of grain in crop improvement programs	Nutritional status of populations relying extensively on durum wheat based diets improved

Output Targets		Intended Users	Outcomes	Impact
2009	Four durum wheat mapping populations developed and QTL identified for drought tolerance, heat tolerance, leaf rust resistance and grain quality	ICWIP breeders, NARS	Knowledge of trait genetics and efficiency of varietal development enhanced	Better cultivars delivered faster to farmers
	25 elite spring durum wheat lines multiplied and distributed to NARS	NARS, farmers and private companies	Increased availability of seed of drought tolerant cultivars to NARS in drought prone areas	Faster enhancement of durum wheat farming systems
	Association between physiological parameters and performance under drought evaluated and published	ICWIP breeders, NARS	Knowledge of the physiological basis of drought tolerance enhanced and efficiency of varietal development improved	Better cultivars delivered faster to farmers
2010	100 high yielding durum wheat lines adapted to CWANA region with enhanced biotic and abiotic stress tolerance and end-use quality traits	NARS	Availability of a diverse and enhanced collection of drought tolerant genetic material to NARS researchers for their varietal development efforts in drought prone areas	Risks associated with durum wheat sowing, utilization and marketing reduced and livelihoods in drought prone areas improved
	Spring durum wheat regions of CWANA characterized based on performance of internationally distributed material and its interaction with representative environments	ICWIP breeders, international scientific community, NARS	Knowledge of cultivar by environment interaction enhanced and efficiency of varietal development improved	Better, more targeted and relevant cultivars delivered faster to farmers
Output 4: Plant health systems established using host plant resistance, biological control mechanisms and pathogenicity monitoring of wheat diseases and insects		NARS extension, farmers, NGOs, ARIs, private sector, IARCs	Knowledge on enhanced plant health management	Sustainable increase in yields due to integrated pest management brings wealth and health to producers
2008	Global Rust Initiative (GRI) protocols established in CWANA for: • Pathogenicity surveillance • Breeding and identification of new sources of resistance • Accelerated seed development • Fungicide tools • Capacity building	Wheat pathologists and breeders	Monitoring the spread of a new highly virulent stem rust race from Africa to other areas and testing of germplasm to identify diverse sources of resistance	Farmers risk for crop failure due to rust epidemics reduced; NARS implement proper control strategies and provide resistant germplasm for wheat breeding that will translate into stable high wheat yields
	Yellow rust pathways across CWANA analyzed and mapped	Wheat pathologists and breeders	Early warning systems; multiplication of yellow rust resistant cultivars prior to spread of new virulences diverse sources of resistance	Farmers risk for crop failure due to rust epidemic reduced; NARS implement proper control strategies and provide resistant germplasm for wheat breeding that will translate into stable high wheat yields

Output Targets		Intended Users	Outcomes	Impact
	Five new sources of root disease resistance to different cereal nematodes or dryland root rots identified	NARS breeding programs, ARIs	Incorporation and/or release of these lines by the national programs leading to changes in productivity and sustainability. A clear understanding of the usability of known soil borne pathogen resistances to prioritize crossing	Increased agricultural productivity and more sustainable resource management of soil borne pathogens
2009	1000 *Aegilops squarrossa* derived synthetic lines evaluated for resistance to yellow rust and *Septoria* in CWANA	Wheat pathologists and breeders	Enhanced genetic diversity for cereal rust resistance in farmers fields	Reduced vulnerability of farmers; increased farm income
	Capabilities on use of entomopathogenic fungi developed for Sunn pest control measures in Iran, Turkey and Syria	NARS, extension services	Use of entomopathogenic fungi to control Sunn pest	Reduced vulnerability of farmers; increased farm income; reduced application if insecticides; environmental protection
	New resistance genotypes to Hessian fly developed and QTL identified	NARS, ARIs, IARCs	Enhanced breeding efficiency for incorporating HF resistance through application of MAS	Reduced vulnerability to HF providing improved productivity and crop sustainability
2010	New resistance genotypes to Russian wheat aphid developed and QTL identified	NARS, ARIs, IARCs	Enhanced breeding efficiency for incorporating RWA resistance through application of MAS	Reduced vulnerability to RWA and insecticides use providing improved crop productivity and crop sustainability
	Pathogen diversity and yield losses due to nematode and root rot pathogens assessed in Turkey	NARS, ARI, IARCs	Internal and external changes in knowledge, research capacities and priority setting to control soil borne pathogens	Environmental and economic benefits to improve agricultural productivity and system sustainability
	Soil borne virus identified in Turkey	NARS, IARC	Importance of viruses understood in Turkey leading to reprioritized breeding objectives	Improved agricultural productivity
Output 5: Conservation agriculture practices implemented for wheat based production systems in CWANA		Farmers, NARS, NGOs, ARIs		Poverty reduced and improved by reversing soil degradation and soil carbon losses, improving water productivity and corresponding crop production while reducing production cross and mitigating factors contributing to potential climate change

Output Targets		Intended Users	Outcomes	Impact
2008	Conservation agriculture hub sites to develop appropriate conservation agriculture technologies established in: • Rainfed spring wheat-based production systems in North Africa • Rainfed spring wheat-based production systems in northern Kazakhstan • Irrigated wheat-cotton production systems in Uzbekistan	Farmers, NARS, ARIs, NGOs	Hub sites used to develop, modify and verify appropriate conservation agriculture technologies with the participation of farmers, ensuring their rapid extension Hub sites provide venue for training of farmers and scientists from other areas with similar production systems and for long-term multidisciplinary scientific monitoring of conservation agriculture practices	Improved sustainability and profitability of grain/fodder/fiber production through the enhancement of soil physical, biological and chemical properties and by generating marked improvements in rain and/or irrigation water productivity in order to enrich rural livelihoods
2009	Appropriate conservation agriculture technology developed for raised bed system to increase water productivity in Uzbekistan and Iran.	Farmers, NARS, NGOs, ARIs	Appropriate conservation agriculture for furrow irrigated raised bed planting systems (including permanent raised beds) for small and medium scale farmers that improve agro-ecosystem productivity and sustainability	Improved profitability of grain/cotton fiber production through enhanced soil and irrigation water productivity to enrich rural livelihoods
2010	Conservation agriculture practices applied in rainfed systems in 20 sites in Northern Kazakhstan	Farmers, NARS, NGOs, ARIs		Improved profitability of grain production through reduced soil erosion, improved soil productivity and health and increased water productivity to enrich rural livelihoods
Output 6: Enhanced human resources and NARS research capacity		NARS	Increased effectiveness of partner and ICARDA and CIMMYT research	Improved livelihood of people depending on income from rainfed wheat
2008	Training courses conducted by ICARDA and CIMMYT on wheat improvement	NARS	At least 50 NARS scientists trained per year	Enhanced NARS research capacity
	Five graduate (M.Sc and Ph.D) programs completed in drought tolerance, rust resistance and soil borne diseases	NARS	NARS scientists trained in higher degree	Scientists for leadership position available
2009	Three week training course on wheat improvement conducted in Central Asia with researchers from Central Asia and the Caucasus	NARS	25 NARS scientists trained in breeding, pathology and production	Enhanced NARS research capacity in CAC
2010	Training course on soil borne pathogens in West Asia and North Africa (WANA) conducted and network of researchers in soil borne diseases established	NARS and ARIs	Increased research efficiency and regional exchange of knowledge on soil borne pathogens through an effective network of scientists	Reduced losses to soil borne pathogens

Output Targets		Intended Users	Outcomes	Impact
Output 7: Impact of ICWIP on productivity, income, and rural welfare in the dry areas quantified and accessible to stakeholders		NARS, ARIs and CGIAR	Effectiveness of ICARDA/CIMMYT and NARS research enhanced. With improved feedback on the returns from past investment in agricultural research, policy makers increase future support	Improved food security, farm incomes and rural livelihoods
2008	Diagnostic surveys of wheat varietal adoption in rainfed areas in Turkey and Iran	ICARDA/CIMMYT research program, Turkey and Iranian NARS	Lessons learned used by ICARDA/CIMMYT and NARS	Food security improved
2009	Impact projection models (economic losses and food security assessment) of Global Rust Initiative documented	ICARDA/CIMMYT research program, NARS	Identified likely livelihood coping strategies used by NARS and development project	Improved food security and livelihoods
2010	Results of GRI impact projection models analyzed and communicated to NARS.	NARS, ICARDA/CIMMYT program	Better information available to NARS, policy makers and, ultimately, farmers in Africa, Near East and South Asia, used to support responses that minimize loss of food security and livelihoods from stem rust	Improved food security and livelihoods