Increased economic growth and improved livelihoods in the ECA maize and wheat systems while enhancing the quality of the environment.

Medium Term Plan 2006-2008

Submitted to: **Association for Strengthening Agricultural Research in East and Central Africa (ASARECA)**

By: **Eastern and Central Africa Maize And Wheat research network (ECAMAW)**

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ECAMAW is a network under the auspicious of ASARECA that links and networks maize and wheat researchers for most effective utilization of capacity in the region and globally, facilitate knowledge sharing and effective use of research results, identifies and prioritizes research areas through effective networking of stakeholders and leverage funds to support research activities in ECA. Working through effective partnerships ECAMAW is committed to efficient and sustainable economic growth, improved social welfare and enhanced quality of environment in the ECA region.

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Abbreviations

A-AARNET	ASARECA Animal Agriculture Research Network
AHI	African Highlands Initiative
AMS	African Maize Stress Project Advanced Agricultural Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU	African Union
BMZ	Bundesministerium fur Wirtschaftliche Zusammenarbeit und Entwicklung
CBO	Community Based Organization
CCF	Consolidated Conceptual Framework
CD	Committee of Directors of ASARECA
CMRT	Crop Management Research Training Project
CIDA	Canadian International Development Agency
CGIAR	Consultative Group on International Agricultural Research
CGS	Competitive Grant System
CIMMYT	International Maize and Wheat Improvement Center
COMESA	Common Market for East and Southern Africa
CORAF	Conférence des Responsables de Recherche Agronomique en Afrique de l'Ouest et du Centre
CR	Collaborative Research
CRS	Catholic Relief Services
DAE	Days After Emergence
DRC	Democratic Republic of Congo
EAC	East African Community
EACP	East African Cereals Program
ECA	Eastern and Central Africa
ECAMAW	Eastern and Central Africa Maize and Wheat Research Network
ECAPAPA	Eastern and Central Africa Policy Analysis Program
EDF	European Development Fund
EU	European Union
FOODNET	Post Harvest Processing Network
GLS	Grey Leaf Spot disease of maize
IARC	International Agricultural Research Center (e.g. CIMMYT)
IAR4D	Intergrated Agricultural Research For Development
ICARDA	International Center for Agricultural Research in the Dry Areas
ICIPE	International Center for Insect Physiology and Ecology
ICRAF	International Center for Research on Agro- Forestry
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
IGAD	Inter-Governmental Authority on Development

ILRI	International Livestock Research Institute
IR	Imazapyr Resistant
ISNAR	International Service for National Agricultural Research
KARI	Kenya Agricultural Research Institute
LGB	Large Grain Borer
MAW	Maize and Wheat
ME	Mega Environment
MOA	Ministry of Agriculture
MSV	Maize Streak Virus disease
NARO	National Agricultural Research Organization
NARS	National Agricultural Research Systems
NGO	Non-governmental organization
NEPAD	New Partnership for Africa's Development
NLB	Northern Leaf Blight
NPP	Networks, Programmes and Projects of ASARECA
NUE	Nitrogen Use Efficient
OPV	Open Pollinated Variety
PRA	Participatory Rural Appraisal
QPM	Quality Protein Maize
QPMD	Quality Protein Maize Development
RAIN	Regional Agricultural Information Network
SADC	Southern Africa Development Community
SC	Steering Committee
SG2000	Sasakawa Global 2000
SIDA	Swedish International Development Agency
SSA	Sub- Saharan Africa
SWMNET	Soil and Water Management Network
UNDP	United Nations Development Program
UN- ECA	United Nations Economic Commission for Africa
WP	Work Programme
WTO	World Trade Organisation

1.0 Introduction and context

1.1 ECAMAW in relation to ASARECA

The population in the Eastern and Central African region is predominantly rural, deriving its livelihood chiefly from agriculture. Thus, the agricultural sector offers tremendous opportunities for accelerating broad-based economic development and reducing poverty in both rural and urban areas, thereby improving food security. Agricultural development can only be achieved if there is a sound research system. However, new technologies from research should be designed and disseminated in ways that foster their relevance to small, resource poor farmers including women in the region.

In recognizing that resources to advance agricultural research are scarce and to take advantage of the existing potential and facilities in ECA, the Association for Strengthening Agricultural Research in east and central Africa (ASARECA) was formed and covers ten ECA countries namely: Burundi, Ethiopia, Eritrea, Madagascar, Democratic Republic of Congo, Kenya, Rwanda, Tanzania and Uganda. ASARECA's primary goal is to contribute to increased economic growth and improved social welfare in ECA through increased agricultural productivity, while enhancing the quality of the environment. The Eastern and Central Africa Maize and Wheat (ECAMAW) Research Network, one of the 19 networks, projects and programs (NPPs) operating under the auspices of ASARECA, was established in 1997 to promote cooperation and integration among NARS and their partners based on comparative advantage and complementarity. Improved maize and wheat production technologies have been developed through such collaborative efforts over the years and are expected to enhance the food security of resource poor farmers and consumers and, in the context of the region's agriculture-driven economies, contribute to overall welfare and development.

The development of the ASARECA consolidated conceptual framework (CCF) in 2003, improved in 2005, necessitated all NPPs to develop their frameworks in harmony with ASARECA CCF, which is results-oriented. The Strategic Objective (purpose) of ECAMAW CCF is therefore enhanced sustainable productivity, value addition and competitiveness of the regional maize and wheat system in ECA. The impact of maize and wheat on increased productivity and improved livelihoods in the region will be accomplished through realization of four results/outcomes including a) demand driven maize and wheat technologies/innovations b) enabling regional and national policy options for transformation of maize and wheat systems c) strengthened regional and national capacity for IAR4D in maize and wheat systems.and d) enhanced availability of information on maize and wheat research and development. These outcomes drive the ASARECA CCF that ECAMAW will emphasize in the next three years.

In the past ten years, ECAMAW focused on improvement of maize and wheat productivity for alleviating the livelihood of rural poor farmers in all agro-ecological zones of the region. In partnerships with NARs, CIMMYT, NGOs and private companies, ECAMAW has contributed to a number of achievements: (i) increased availability of adapted germplasm (ii) development of associated agronomic and cultural practices (iii) farmer participatory approach to germplasm evaluation and agronomic practices, (iv) increased seed availability (v) strengthened capacity of national agricultural research systems (NARS) in maize and wheat research, and (vi) greater regional team work in improvement and management of research undertakings.

1.2 Major Features of the Plan

In 2004 ECAMAW conducted its second priority setting exercise in which various stakeholders including, researchers, farmers, extension agents, processors, seed companies, ASARECA, CIMMYT and development partners were consulted and participated extensively. Following the analysis of research domains, constraints and existing results, stakeholders identified and approved major research themes and sub-themes for the next five years. Execution of this research portfolio agenda is expected to lead to impact on economic growth, social welfare and environment quality in the ECA region and also strengthen the research and development capacity of all partners. In the next three years, the network is therefore placing emphasis on the following prioritised research and development themes:

1. Improving productivity;
2. Improving market and trade opportunities;
3. Strengthening institutional support and infrastructure;
4. Developing and promoting of appropriate post harvest technologies and utilization options; and
5. Influencing policy issues.

The sub-themes were prioritized as:

1. Development and dissemination of efficient soil and water management strategies
2. Development and dissemination of integrated crop management options
3. Development and dissemination of appropriate varieties
4. Promotion, access and use of improved inputs
5. Promotion of demand driven products of maize and wheat
6. Establishment of favorable marketing policies and suitable infrastructure
7. Identification and promotion of favorable policies
8. Establishment and strengthening partnerships
9. Strengthening human and institutional capacity
10. Development of appropriate processing technologies
11. Establishment and support of market and trade information mechanisms
12. Development and dissemination of appropriate technologies to reduce post- harvest losses

1.3 Resource Strategy- Human and Institutional Resource

This MTP will be implemented primarily through collaboration involving the constituent NARS, CIMMYT as the scientific partner of ECAMAW, NGOs, CBOs and seed enterprises operating in ECA. CIMMYT is the recognized center of global expertise in maize and wheat research for development and training with regional offices and fully fledged research programs in Kenya, Zimbabwe and Ethiopia.

2.0 Background and justification

Increasing maize and wheat productivity remains one of the most effective ways to combat hunger and poverty in ECA. Maize is the main staple crop in Africa where about 90% of it is used as food with the exception of Southern Africa where 50% of it is used as animal feed. In eastern Africa, it provides 30% of the calories with consumption of about 100 kg of per capita per year. In Central Africa the per capita consumption is 23 kg per year, providing about 13% of the calories (Pandey, 1999). The average share of maize area to total cereal area in the ECA region was 44% for 1995-99 period (Table 1).

Table 1: Average maize area as a percentage of total cereal area, 1995-97 and 1997-99

Country	1995-97	1997-99
Burundi	55	56
Ethiopia	21	23
Kenya	77	79
Madagascar	14	14
Rwanda	36	na
Tanzania	51	56
Uganda	44	45
Sudan	na	2
DRC	65	69
Mean	45	43

Source: Heisey *et al.,* 1999b and Pingali *et al*., 2001
Note: na= not available

Although all ASARECA countries produce maize, the main maize producing countries in ECA are Ethiopia, Tanzania, Kenya, Democratic Republic of Congo (DRC) and Uganda. While trends in production, area and yield increases and decreases differ among ECA countries, an average of 9 million tonnes of maize are produced on 5 million ha with an average yield of 1.2 t ha^{-1} every year. These yields are relatively low as compared to the potential of 4.5-7.0 t ha^{-1} (CIMMYT, 2001).

Wheat is also an important staple crop in the ECA region. Although it is less important than maize, it is increasingly a valued grain among the cereals in terms of consumption due to rising population and incomes, increased urbanization and the associated changes in dietary patterns. In 1998-2000, the wheat was planted on average on 6% of the total cereal area in the main wheat growing ECA countries –Ethiopia, Kenya, Sudan and Tanzania – (Ekboir, 2002). Average wheat production for ECA countries from 1992-2003 was 1.8 million tones on 1.2 million ha with an average yield of 1.4 t ha^{-1}.

2.1 Problem Statement

Regardless of the economic, social and cultural importance of the maize and wheat, productivity is severely constrained by many and various factors, including the low yield potential of the varieties used by the farmers. Breeding activities in many ECA countries began in the 1950s and 1960s. Several improved varieties have been released since that time. However, the yield gap between farmers and researchers is still wide. Farmers' average yields stand at 1.3 tons per hectare while yields from the experimental plots vary between 5 to 10 tons per hectare.

Due to its adaptability to diverse agro-ecologies and high yield per unit area, maize (*Zea mays* L.) is among the leading cereals used to achieve food self-sufficiency in many countries in Africa. However, more than 80% of the farmers grow maize under rainfed conditions and cannot afford to purchase and apply inorganic fertilizers. Drought and soil fertility are, therefore, the two most important constraints limiting maize and wheat production, incomes and food security in the ECA region. With the rapid increase in urban population, research and extension programs in ECA face a great challenge of increasing maize productivity in the low yielding farming systems. Furthermore, the environment for smallholder maize and wheat production in East and Southern Africa has drastically changed over the last decade, as governments have reduced support to inputs and product marketing and as credit is no longer available to most smallholder farming communities. Accordingly, smallholder farmers are confronted with high input costs and unreliable input and product markets. The situation is expected to deteriorate with the effects of HIV/AIDS on labor productivity and climatic change. Therefore, smallholder farmers urgently need access to useful technologies and information that helps them to make appropriate decisions as socio-economic conditions and the physical environment change. As soil infertility is widespread it needs to be improved to get better returns on other farming resources and investments such as land, seed and labor.

Major biotic factors constraining productivity of maize and wheat include diseases and pests. In maize, the most important diseases include northern leaf blight (NLB) caused by *Exserohilum turcicum*, common rust caused by *Puccinia sorghi,* maize streak virus (MSV), gray leaf spot (GLS) caused by *Cercospora zeae- maydis*, ear rots caused by *Fusarium* and *Sternocarpella spp*, and head smut caused by *Sphacelotheca reiliana.* Yield losses due to these foliar diseases vary depending on the season, country and environment. For instance, in Uganda where disease pressure tends to be high, *E. turcicum* causes 16-64% (Adipala *et al.,* 1994), maize streak virus 10-80% (Kyetere*,* 1996), gray leaf spot 8-47% (Asea *et al.,* 2002) and ear rots 5-32% (Bigirwa *et al.,* 2003) yield loss.

In wheat the occurrence of 30 fungal, three bacterial, one viral and four nematodal diseases have been identified in Ethiopia (Eshetu, 1985). Among them, only the rusts, *Septoria tritici* and *Fusarium spp.*, and smuts have been problematic. Yield loss assessments due to diseases have been documented in several ECA countries. Yellow rust causes up to 96%, stem rust up to 61%, leaf rust up to 75%, and *Septoria tritici* blotch up to 82% yield losses in Ethiopia. In extreme situations, yellow rust can cause 100 percent losses (Singh *et al.,* 2002).

The major diseases causing significant yield losses have been given priority in the development and release of wheat varieties by the national programs. However, diseases remain the major constraint to system productivity. This is mainly due to the nature of the rust inciting pathogens and new sources of resistance are required. Moreover, there is still need to integrate the varietal field resistance with management practices to obtain more effective, durable and economical approaches to managing these diseases.

Insect pests are among the major limiting factors to ECA maize and wheat production. Stemborers and termites cause much damage on maize although occasionally army worm also devastate crops. Commonly used approaches for their control are chemicals. PRA studies in different agro-ecological zones of Kenya revealed that farmers systematically list stem borers and storage pests among the most important pests. Stem borers account for 13% annual loss of maize yields in Kenya valued at over US$76 million (De Groote, 2002). The most prevalent species include spotted stem-borer (*Chilo partellas* Swinhoe), pink stem borer (*Sesamia calamistis* Hampson), Africa maize stalk borer (*Busseolla fusca* Fuller) and the sugarcane borer (*Eldana sacharina* Walker).

Farmers in ECA lose 15-40% of maize and wheat produced due to storage pests. The major storage pests for maize are weevils (*Sitophilus zeamais*) and the larger grain borer (LGB) (*Prostephanus truncates*). The LGB was introduced to ECA in early 1980s and has spread to most countries in southern and eastern Africa causing tremendous losses due to its efficient feeding behavior and high rate of reproduction. Control methods like chemical and cultural practices have for a long time been used but with little success. Presently focus is on host resistance. Most of the elite germplasm that has been developed in the region lacks resistance to these pests. Lack of suitable storage facilities force farmers to dispose their grain immediately after harvest leading to loss of income and food insecurity. ECAMAW and its collaborators need to focus on identifying storage pest-resistant germplasm in conjunction with indigenous and novel control measures that are environmentally and consumer friendly.

Striga is a major parasitic weed attacking cereals in many African countries. Thousands hectares of arable land in ECA countries are devastated by this weed causing considerable losses in maize production. Losses range from 15 to 80%, however, total crop failure has been observed under conditions of heavy infestation. This weed results in at least US $1 billion in lost yield and impacts the welfare and livelihoods of more than 100 million people in Sub-Saharan Africa (CIMMYT, 2004). Several integrated approaches have been and continue to be used to overcome the problem. They include crop rotation, soil fertility management (Odhiambo *and Ransom,* 1999), tolerant varieties (Odongo *et al.,* 1999), habitant management (Push-pull strategy, a technology that combines napier grass and *Desmodium uncinatum* intercropped with maize in a particular lay-out to control both stemborer and striga) (Khan *et al,.* 2000) and herbicide use (Berner *et al.,* 1995). These technologies have shown value in reducing losses. However, adoption by small-scale farmers has been poor, so these measures have failed to slow the spread of the weed.

As an alternative to agronomic and conventional breeding approaches to *Striga* control, CIMMYT and its partners have developed a novel approach involving seed coating herbicide-resistant maize with low doses of imazapyr herbicide (30 g/ha) prior to planting (Kanampiu *et al.,* 2003). Herbicide resistance is conferred by a mutant gene identified in maize under tissue culture and ingressed into other maize genotypes by conventional breeding methods; that is, it is not a transgenic (GMO) organism. Extensive on-farm testing in several African countries has demonstrated that this technology has tremendous potential for high immediate impact in controlling the weed (CIMMYT, 2004). Dissemination of this technology requires incorporation of resistance to this herbicide coating into varieties adapted to the various ecologies in ECA where *Striga* infestation occurs. The few newly developed resistant varieties require wide testing for adaptability before they are in the hands of the targeted end-users. While these innovative approaches have shown considerable promise, Striga devastation still exists and requires disseminating these various options depending on circumstances and resources.

Although maize is one of the most important staple foods consumed throughout ECA, conventional maize varieties are deficient in two essential amino acids – lysine and tryptophan – so that populations dependent upon this crop and without access to adequate amounts of other protein sources may suffer from protein malnutrition. The potential contribution of Quality Protein Maize (QPM) to improving human nutritional status has been accorded worldwide attention in recent years—highlighted with the award of the World Food Prize for 2000 to the CIMMYT scientists who launched the research effort on QPM more than 30 years ago. QPM cultivars contain 70-100% more lysine and tryptophan than conventional maize varieties and the nutritional quality of the protein in QPM grain approaches that of protein derived from cow's milk. Since 2000, strong collaboration for research and technology dissemination amongst the relevant stakeholders in the region—including donors such as CIDA, The Nippon Foundation, BMZ and the Rockefeller Foundation, NARSs in all ASARECA countries, NGOs (especially SG2000), and CIMMYT has led to the release of several varieties in a number of countries as well as dissemination and utilization campaigns in Ethopia, Kenya, Tanzania and Uganda. Research programs continue to develop improved QPM varieties and to convert current popular non-QPM varieties to QPM in order to cover all major maize growing ecologies in the ECA region.

While there has been considerable progress made to develop and avail improved varieties to farmers and significant adoption of improved varieties, farmer adoption of improved crop management practices is still poor resulting in low yields and the failure of improved varieties to realize their full genetic potential. These poor agronomic practices include low plant density, inadequate application of fertilizers/manure, poor weed management and poor soil conservation practices. The ECAMAW network has supported experimentation to develop and evaluate agronomic practices to enhance maize and wheat productivity. However, more effort is required to adapt and disseminate the technologies identified.

Seed is considered as one of the most important strategic inputs in production. Although breeders continue to develop varieties that address farmers' needs (e.g. high yielding or disease resistant) seed of improved varieties often does not reach the targeted end-users. Unavailability of seed and high costs involved are some of reasons for this lack of impact. Monyo *et al.* (2004) reports that adoption of improved seed in Sub-Saharan Africa remains at less than 5%, partly due to the inefficiency of local seed systems, which includes the timely delivery of seed as well as the availability of sufficient quantities. The seed delivery system is also affected by limited production of quality seed, limited awareness of the potential improved maize and wheat cultivars, poor linkages between public breeders and seed producers, variable demand, poor distribution network, inappropriate packaging and promotion of improved varieties. Availability of seed is also hampered by difficulties in cross border seed trade. Some varieties bred in one country perform well in another but lack of seed harmonization policies in variety release, germplasm exchange and certification. For the benefits of improved varieties to reach small-scale, resource-constrained farmers, the farmers must have access to affordable seed of improved varieties. To this end, significant emphasis must be put on determining factors that constrain seed production and distribution.

Social-economic factors influence operation, development and profitability of the maize and wheat sectors. Major constraints include limited access to markets, poor infrastructure, inadequate capacity of the actors and their institutions and unfavorable policy environment. Maize and wheat grains are sold mostly in local and regional markets and very little in international markets. However, returns to farmers are low and unstable because of various constraints including limited access to market information, limited product differentiation, inadequate post-harvest processing capacity, a narrow processed maize and wheat product range, large fluctuations in prices, high distribution costs and mismatch between supply and demand. Farmers are unable to access market information because they are poorly organized and have insufficient business orientation. The present extension delivery system hardly provides appropriate market information. Most of the extension agents have limited training in agribusiness and do not readily access or consider market information as part of the extension package.

Finally, maize and wheat research and development in ECA is constrained by an inadequate number of well-trained and skilled scientists and research support staff. Moreover, there is rapid staff-turnover since available staff seek opportunities elsewhere or pursue further training abroad. Lack of well-designed programs for professional development and poor remuneration contribute to poor morale among both scientists and technical personnel. This is further exacerbated by inadequate and often obsolete physical facilities and the inability of institutions to respond adequately to these constraints. To conduct sustained and well-focused research that would revolutionize maize and wheat production in ECA, it is essential that researchers and technicians receive periodic training to update and sharpen their skills and knowledge.

2.2 Previous research and scientific basis for this MTP

The East and Central Africa Maze and Wheat Research Network and its partners have made considerable progress in addressing many of the problems facing the maize and wheat sectors since its inception in 1997. Activities have focused on technology development and dissemination, capacity building and institutional development.

Development of appropriate varieties

Breeding efforts for improved varieties through collaboration between NARS and CIMMYT began in the 1970s with dispatch of maize and wheat germplasm from CIMMYT-Mexico to ECA. Thousands of maize germplasm entries from CIMMYT have been introduced and evaluated for over thirty years in most ECA countries. Several improved varieties based on this germplasm have been released during that time. Similar releases have been made for wheat in the region. During the 1996-2002 period, 25 improved wheat varieties containing CIMMYT germplasm were released with network support. However, the majority of these released wheat varieties are out of commercial production due to susceptibility to diseases. In recent years the outbreak of rusts has been a recurrent problem, demanding global attention in breeding for rust resistance. Despite the releases of improved maize and wheat varieties, the yield gap between farmers and researchers is still wide. Farmers' average yields stand at 1.3 tons per hectare while yields of maize from experimental plots vary between 5 to over 10 tons per hectare. There is urgent need for ECAMAW to continue support in the participatory development of appropriate maize and wheat varieties so as to enhance adoption by the farmers in the region.

Overcoming susceptibility to diseases

Several important diseases place limits on maize productivity in the ECA region. Maize streak virus prevalent in the region and most of the popular commercial varieties are susceptible. With assistance from CIMMYT, national programs have successfully introduced resistance to MSV in recent years. Gray leaf spot (GLS) appeared in 1993 and spread very quickly across the entire region; it continues to be a threat and is an important component of the regional breeding programs executed under ECAMAW. Presently, ear rots appear to be on the increase and many national programs as well as CIMMYT have begun to address them in their breeding programs. Selection for resistance to these diseases is an integral part of germplasm improvement programs in the region and regional "hot spots" for each have been identified by the ECAMAW network for collaborative screening. In Kitale, Kenya, and Ambo, Ethiopia, breeding nurseries for disease resistance in highland maize are established annually for advancement, studying their adaptation and formation of test-crosses. The testcrosses are evaluated across the highland areas of the region to identify useful materials for release.

The most challenging wheat diseases include the rusts (stem rust, leaf rust and yellow rust) *septoria* and leaf blotch. These major diseases cause significant yield losses and, consequently, have been given emphasis in the development and release of wheat varieties by the national programs. The development of broadly adapted disease resistant, high yielding and stable germplasm within the context of various agro-ecological zones (AEZ) has been the primary goal of wheat breeding programs in Kenya, Tanzania, Uganda, Ethiopia, and Sudan. Emphasis is also given to maintenance of genetic diversity within each AEZ to counter the effects of genetic vulnerability. However, diseases remain the main constraint to wheat system productivity.

Overcoming susceptibility to field insect pests

As discussed earlier, stem borers cause significant economical losses in maize yield every year. There are various control methods for stem borers that vary in efficacy, farmer acceptance and management, cost, and applicability in diverse agro-ecologies. The most widely used methods are chemical, cultural, biological, and host resistance. Host plant resistance can be achieved through conventional breeding or through the use of biotechnology including the *Bacillus thuringiensis (Bt)* technology. Conventional breeding for resistant to stem borers has been difficult because of lack of genetic variation and the fact that one has to deal with two organisms – the plant as host and the pest. Host plant resistance has been found to be quantitatively controlled and, hence, difficult to maintain using conventional methods. *Bt* maize offers farmers an effective control of stem borers as novel genes from the soil bacterium, *Bacillus thuringiensis*, are genetically engineered into maize to control lepidoptera stem borers.

Other efforts being tried in ECA countries to combat stemborers include classical biological control methods. Exotic and natural enemies (*Cortesia flavipes* and *Cortesia sesamia*, respectively) have been released in Kenya, Uganda and Ethiopia. Their potential and establishment are being evaluated. Other approaches include habitat management strategies whereby maize is intercropped with desmodium with napier grass surrounding the field. The desmodium repulses the borers because of the offensive smell while the napier grass attracts the borers, hence the term 'Push- Pull' Strategy (Khan *et al*., 2000). Despite these various control strategies, field insect pests particularly stemborers and termites still remain a serious problem.

Storage pests

Storage pests account for an estimated 15-40% in lost maize and wheat produce annually. Genetic approaches have been used by CIMMYT and its ECAMAW collaborators to reduce storage pest losses through breeding utilizing the local varieties like Kilima from Tanzania, which are reported to have moderate resistance to maize weevil and LGB. Genetic studies revealed that the resistance to storage pest is a quantitative trait with strong maternal effects (Derera *et al.,* 2001a, 2001b). Eight synthetics with weevil resistance and good levels of foliar disease resistance were developed and are being used in breeding programs. Resistant lines have also been developed from divergent selection studies (Dhliwayo and Pixley, 2003) and are now being used to incorporate weevil resistant into germplasm adapted to different agro-ecologies.

The pericarp has been found to be a critical tissue in kernel resistance as well as good husk cover. Both traits are being improved as they do not appear to adversely affect the nutritional or processing quality of the maize. New OPVs targeted at ECA and southern Africa have been developed, for example Pool 15 QPM selected for drought and low-N tolerance and screened for storage pest resistance. NARS in ECA are using the Weevil A/B in breeding and evaluation trials.

There is need for ECAMAW and its partners to continue aggressively on post-harvest research and encourage NARS to use screening for storage pests as an integral and routine part of their breeding programs. NARS need to develop and disseminate improved local storage facilities and other control methods concomitantly with the genetic improvement to solve the storage pest constraint.

Abiotic stresses in maize and wheat systems

Drought is a common occurrence in many ECA countries and the frequency of drought appears to be increasing, leading to total crop failure and severe food shortages some years. Most maize and wheat is grown under rainfed conditions with little irrigation available save for some on wheat in the Sudan. Low soil fertility particularly nitrogen (N) is a major factor limiting maize and wheat production in the region.

Historically, breeders have typically selected germplasm for all environments under agronomically well-managed conditions including optimal soil fertility and soil moisture. During the late 1980s and early 1990s, CIMMYT developed breeding methods that enabled improvement of maize for tolerance to individual abiotic stresses such as drought, low-N and soil acidity (Banziger and Cooper, 2001). These methods were introduced in ECA in 1998 through collaborative efforts of CIMMYT and NARS in the African Maize Stress Project (AMS) implemented through ECAMAW. One of the objectives of the project was to strengthen the capacity of NARS to develop their own stress-tolerant maize varieties. Presently, thirteen managed abiotic stress screening sites have been developed in East Africa: Bako ARC in Ethiopia for low nitrogen; Nazareth ARC in Ethiopia for drought; Alupe RRC in Kenya for *Striga*; Kiboko ARC in Kenya for drought and low nitrogen; Ilonga ARI in Tanzania for low nitrogen; Namulonge ARI in Uganda for low nitrogen and stem borers; Selian ARI in Tanzania for drought; and Embu RRC in Kenya for low nitrogen.

Maize growing environments have also been characterized and incorporated into a CD-ROM based GIS tool to allow site similarity comparisons and targeting of adapted germplasm to appropriate agro-ecological environments (Hudson *et al*., 1999, 2002.). About 250 scientists from the public, private, and NGO sectors in ECA and Southern Africa have been trained in using the tool and have had impact far beyond maize research. However, more training of stakeholder partners is required for sustainable application and impact of such tools in the region.

Lack of wheat varieties tolerant to drought is one of the constraints to wheat production in the semi arid areas. Some attempts of germplasm evaluation and selection of varieties have resulted in the identification of relatively drought tolerant varieties for marginal low rainfall areas (Desalegn *et al.,* 2001; Kimurto *et al.,* 2000; Kinyua *et al.* 2000). Reports have also showed that early and terminal drought are critical in bread wheat, causing the highest yield reduction.

Development of Varieties with special attributes

Quality protein maize (QPM) looks and tastes like normal maize, and has similar yield and agronomic performance. In Colombia, studies have shown children suffering from a severe protein deficiency disease (Kwashiorkor) were restored to normal health on a diet containing only QPM as the protein source. As an added benefit, recent studies have shown that increased levels of lysine aid in the assimilation of zinc and iron from maize grain. When QPM is fed to pigs, the gain weight is roughly twice the rate of animals fed on normal maize, an advantage to smallholder farmers, who typically cannot afford balanced animal feeds. The utilization of QPM in ECA can help alleviate malnutrition problem leading to healthier population, increased productivity and higher incomes for better livelihoods. Communities have also been identified to grow and use QPM varieties through projects with government extension services, NGO's and other partners. Stress tolerant QPM varieties have been officially released in Uganda, Tanzania, Ethiopia and Kenya for use by farmers.

Support for QPM research and dissemination activities within the ECAMAW network need more emphasis for the target communities to fully benefit. Involvement of all partners especially seed producers, extension, human nutritionists, and governments' political bodies in the promotion of stress tolerant QPM is essential for farmers to adopt the technology. SG2000 is aggressively promoting QPM dissemination in Ethiopia, Tanzania and Uganda, and the organization has a coordination unit for pan-African QPM initiatives. As one example, SG2000 in collaboration with small seed companies and Makerere University is actively promoting QPM utilization as feed for livestock production in Uganda, and is also supporting the establishment of a grain quality verification laboratory at Namulonge A.R.I. of NARO. It is apparent that QPM may play a very important role in ECA in human nutrition where maize constitutes a staple food in the diets of children and adults. ECAMAW need to put more efforts on dissemination of QPM varieties and conduct human and animal nutrition studies to convince the majority of people on the important role of QPM.

In addition to protein enhancement, The Harvest Plus project (i.e., a CGIAR "Challenge Program") supports the bio-fortification of six staple crops including maize and wheat. The Harvest Plus maize subproject began in 2004 to support the development of maize with enhanced levels of pro-vitamin A, iron and zinc in the grain. Opportunities for synergies between QPM and Harvest Plus activities will be exploited to promote nutritional advocacy and dissemination of nutritionally enhanced varieties. In ECA, Ethiopia was selected to participate in the bio-fortification project.

Improved agronomic practices

Low plant density is a result of a couple of reasons; farming systems particularly intercropping and lack of knowledge. Nearly all national programs in ECA region have conducted trials to establish optimum spacing. Plant population densities of 44,000 and 53,000 plants per hectare are widely recommended in the region. Onset and distribution of rainfall and soil physical properties are known to have big influence on time of sowing of wheat. Wheat seed rate in traditional broadcasting and drilling method of planting has been recommended. Accordingly, varieties with poor tillering capacity require higher seed rates and the semi-dwarf varieties with good tillering capacity gave good result with the optimum seed rates.

Recognizing the constraints faced by farmers in purchasing inorganic fertilizers, much emphasis is placed on the use of organic sources available or produced on-farm, or in the integration of inorganic and organic sources. Work carried out in Ethiopia has shown that manures combined with inorganic fertilizer reduce rates of fertilizer required for optimal maize growth. For instance, enriched farm yard manure increase grain yield of maize by 40% compared to conventional farm yard manure and fertilization fertilizer can be reduced by 75% (Tolessa and Friesen, 2002), In Kenya, where 7 t/ha of manure is recommended on Nitosols, only 3.5 t/ha is required when applied in combination with NP fertilizer. However, variable responses are observed partly because of poor or variable manure quality. Although both animal and compost manure may be readily available and the benefits well known by farmers, there is still limited use because of the high labor costs involved in its collection, preparation and application.

Nitrogen (N) and phosphorous (P) fertilizers are found to have significant effect on maize and wheat grain yields. However, majority of the small-scale farmers use sub-optimal rates of fertilizer owing to the unavailability of organic fertilizers, the often high price of the inorganic fertilizers, poor access to or lack of credit facilities and sometimes unavailability. Given the high costs associated with inorganic fertilizers, national programs in the ECA region have been evaluating several options to address soil fertility problems. Among these are the evaluation of different legumes for adaptation and N contribution in Ethiopia, Kenya, Tanzania and Uganda (CIMMYT, 2001). Results have been variable with legumes producing more consistent positive benefites in rotations with maize than in intercrops. However, farmers are usually reluctant to adopt legume rotations unless there is a direct consumable or marketable product derived from them.

Among the agronomic approaches to compliment breeding for drought tolerance in maize is use of tied ridges. The method has been tried by national programs of Kenya, Tanzania and Ethiopia, and plays a double role of soil and water conservation. Results from these countries have been variable, indicating the need to refine and adapt the technology to conditions of the region. The effectiveness of the tied ridges appears to depend on the season and severity of moisture stress, the soil type on which it is applied and the maize variety planted (CIMMYT, 2001). One of the impediments to adoption of the practice in the region is the lack of an implement to reduce the added labor costs associated with it.

Post-harvest and processing methods
Post harvest losses of maize and wheat grain due to storage insect pests are a significant nutritional and economic burden to ECA's farmers. The lack of improved storage facilities for grain as well as absence of improved technologies for proper storage management force farmers to sell their produce right after harvest when market prices are very low, hence reducing their farm incomes. There is need for ECAMAW partners to aggressively pursue post harvest research and processing methods including the need to improve local storage facilities.

Utilization options and value-added products
There is limited knowledge in the ECA region on maize and wheat product development. Studies from other parts of the world show that a wide range of products can be made from these two commodities which not only improve on the market of maize and wheat but consequentially create jobs in the fields of processing and marketing as well as nutrition. Linkages need to be established with the private sector to exploit this field of product development where research would be required to identify varieties for different product needs and for different environments.

Maize is often grown in crop livestock farming systems where maize stover makes a crucial contribution to livestock feeding (Thorne *et al.* 2002). Increasing demand for fodder, shortage of arable land and water together with shrinking and deteriorating common property resources will further increase the demand for maize as a food-feed-crop. The demand for dual purpose maize genotypes that provide good stover fodder quantity and quality besides grain yield was strongly voiced by the ECAMAW stakeholders workshop of November 2003 and agrees with and confirms the observation of ILRI and others in the region (Desta *et al.* 2000). There is need to develop maize varieties superior in stover production and quality in addition to grain yield.

Markets and trade
A strong domestic market is a building block for export markets. Farmers should be able to access market where they can obtain agricultural inputs and consumer goods and sell their produce. To effectively achieve this requires strong institutional capacities and the implementation of relevant policies, e.g. competition, tariff policy, financing, market development among others.

Farmers are often constrained by lack of information about markets, lack of business and negotiating experience, and lack of a collective organization which can give them the power they need to interact on equal terms with other, generally larger and stronger, market intermediaries. The result of these deficiencies is poor terms of exchange and little influence over what they are offered. Remunerative markets are essential elements in making agriculture progressively entrepreneurial. Income from well functioning markets, when combined with credit, can offer real prospects of the sustainable farmer investments needed for productive agriculture.

In order to achieve viable market development in this region, governments and their development partners need to (i) speed up the rate of market development, (ii) remove or reduce barriers to market access, and (iii) promote dialogue between the main stakeholders to generate the policy, institutional and legal context required for enhanced market linkages.

Unfavorable policies

There is general agreement that, although various viable technologies have been developed in the past, productivity of wheat and maize in the region remains low. Different factors affect the adoption of improved maize and wheat technologies including the socio-economic circumstances of the end users. These circumstances need to be known beforehand in order to develop appropriate technologies. Institutional issues including input and output marketing and policy issues are often very important in limiting production of maize and wheat. A regional database is lacking that would help to formulate different policies and interventions. Thus, there is a need to establish the database, identify the constraints and recommend intervention strategies for improvement of maize and wheat production in the region.

Technology transfer and impact

Developed maize and wheat technologies have not been adequately disseminated within the ECA region. For technologies to have impact in farmers' fields, it is imperative that strong links be forged between research, extension, farmers and other stakeholders. ECAMAW has continuously emphasized partnerships as the cornerstone for achieving wider impact. and attempted to break the barriers between researchers and extension agents in ministries of agriculture and NGOs. To strengthen these linkages, the collaborators prepare and disseminate extension publications, technical information, and training manuals and materials. In addition, ECAMAW and its collaborators have promoted client participatory research through on-farm activities, and by involving extension agents, NGOs, end-user clients and farmer and civic organizations in technology development activities.

The "Mother and Baby" participatory evaluation method is a novel and effective approach for testing and exposing new varieties to farmers and obtaining their input in varietal development. Using this methodology, maize varieties that performed well under managed stresses and optimum conditions have been taken to farmers' fields and exposed to farmers' own management practices ("Baby trials"), while centrally located trials in the community under researcher management ("Mother trials") have allowed farmers to compare varieties under both optimal and sub-optimal management conditions. The collaborative nature of mother-baby trials allows all stakeholders to play their respective roles and provide feedback to researchers and seed companies so that decisions on release and seed multiplication of best varieties can be made. Breeders are made aware of farmers' preferences and priorities creating a bottom-up approach to technology generation enhancing dissemination and adoption of new varieties. Similar innovative participatory approaches are required while scaling out the use of the mother/baby technique in all ECA countries to accelerate the process of releasing the improved varieties for use by farmers.

National programs through ECAMAW collaborative projects are adopting rapid methods for seed dissemination that include use of affordable small packs, use of print and electronic media for promotional activities, multiple distribution points, seed production programs based within target regions and supported by national researchers to ensure seed quality. For example, in Eastern Tanzania, the Usagara Womens Group is producing seed of QPM and drought tolerant maize OPV in collaboration with researchers at Ilonga Agricultural Research Institute and national seed certification agency, TOSCA.

One important output of the Network activities has been an improved flow of information developed through research with extension workers and farmers. To facilitate this, the Network has supported the cost of extension bulletin publication and multi-media preparation, field days at research stations or at on-farm experiment/demonstration sites, stakeholders' meetings, and establishment of upstream and downstream linkages with farmers and clients. Technologies have been developed and tested in collaboration with farmers and other end users in different countries are now ready for dissemination (Table 2).

Table 2. Technologies, research findings and recommendations available for transfer to farmers in ASARECA countries.

Recommendations / technologies for transfer to farmers	Research findings
Improved disease resistant maize and wheat varieties with their agronomic practices	ECAMAW existing knowledge document, leaflets
Quality Protein Maize OPVs and Hybrids with their agronomic practices	Leaflets, posters, brochures, radio tapes, ECAMAW existing knowledge document
Stress tolerant maize and wheat varieties (drought and low-N) with their agronomic practices	Leaflets, posters, ECAMAW existing knowledge document
IR striga tolerant maize varieties	Leaflets
Integrated management practices for maize and wheat systems	ECAMAW existing knowledge document
Green manures and legume cover crops technology	ECAMAW existing knowledge document

Strengthening the capacity of stakeholders

Within the region there are deficiencies in trained manpower and research facilities to conduct effective and efficient maize and wheat research. This deficiency can be partly alleviated if the resources available in the region are rationally used. Avoiding duplication in research efforts and promoting efficiency through the sharing of experiences among national and international researchers can only be achieved if effective channels of communication are established.

Over the years, the network has contributed to strengthening he scientific and technical capacity of a large number of scientists and technicians from diverse institutions in crop improvement and laboratory techniques at the CIMMYT Mexico and regional programs, crop production aspects at the CMRT facility at Egerton University and through visiting scientist opportunities with breeders, socio-economists and agronomists at the CIMMYT regional programs in Zimbabwe and Kenya. Participation of national and regional scientists in regional events organized by network partners and international institutions has also been facilitated.

On physical capacity development, the ECAMAW through CIMMYT special projects has contributed to improvement/renovation of infrastructures used for regional collaborative research activities such as establishment of regional stress management screen sites including provision of irrigation, renovation of seed stores, and greenhouses/screenhouses for breeding. Some projects have been able to provide vehicles and laboratories and have made donations of computers to partners' institutions for facilitating data processing.

Although there has been significant progress in building human and material support for agricultural research and development in the ECA region, the capacity still falls short of meeting the region's needs. Improvements are required not only in the amount and quality of technical resources but also in research program planning, systems management and governance. This equally extends to other service providers, NGOs and technology end-users themselves. ECAMAW must continue to organize and support research workshops, joint ventures and seminars where they are clearly relevant to the partners.

3.0 Medium Term Project (MTP) Framework

The ECAMAW 5-Year Log-frame and the MTP framework are shown in Appendices 1 and 2, respectively. The 5-Year Framework has been aligned with the consolidated conceptual framework (CCF) of ASARECA to whose goal the network is expected to contribute. The MTP framework is based on the outcomes of ASARECA NPP meeting held on 15-28 August 2005 at Entebbe, Uganda, and the ECAMAW Priority Setting Stakeholders Workshop held on 14-18 October 2004 at Nairobi, Kenya. Stakeholder participants included researchers, extensionists, public and private seed producers (including women farmer groups engaged in informal seed production), farmers, non-governmental organizations, ASARECA MEAPU, national and regional program leaders, and other stakeholders.

Overall Objective (Impact)
The overall impact of this MTP is increased economic growth and improved livelihoods in the East and Central Africa region while enhancing the quality of the environment.

Outcomes
The network outcomes are based on the appropriate level of verifiable indicators on productivity, value addition and competitiveness of the maize and wheat systems.

1. *Productivity*

   Two % Increase in maize/wheat production per unit of input by 2010

2. *Value Addition*

   Two % increase in the value of pre harvest maize and wheat products by 2010

   Two % increase in the value of post harvest maize and wheat products by 2010

3. *Competitiveness*

   Two % reduced cost in the maize and wheat production to consumption continuum in relation to competitors by 2010

   Two % increase in the inter-regional market share of maize and wheat products by 2010

Results (Outputs)
The *Results* are what ECAMAW will deliver. They mirror the r*esults* of ASARECA's CCF and provide a strong basis for the harmonization of all activities with the Association, further reinforcing and strengthening capacity. The four r*esults* listed below provide the necessary and sufficient conditions for achieving the p*urpose*, provided the a*ssumptions* hold.

R1 – Enhanced utilization of demand driven technologies/innovations for maize and wheat.

R2 – Enabling regional and national policy options for transformation of maize and wheat systems facilitated

R3 – Regional and national capacity for IAR4D in maize and wheat systems strengthened

R4 – Availability of information on maize and wheat research and development enhanced.

Output Targets
These are the intermediate stage towards the outcomes. The network's output targets are the indicators of the results derived from the eight projects that will produce interventions in the 12 priority sub-themes identified by the stakeholders.

Intended users
This MTP will contribute to operations of several groups and communities in rural and urban areas within its mandate countries. It will receive and contribute to several institutions including related research projects, sub-regional and regional organizations and donor organizations.

Activities
Eight projects will be implemented in this MTP. ECAMAW aims at carrying out activities addressing interventions in the network's priority research themes in the continuum from production to consumption. However, for the coming 3 years funds have not been obtained for activities in value addition, post-harvest losses, and marketing and policy issues. The projects described in this MTP address technology development, seed production and distribution, capacity building, partnerships and pathways for dissemination of information.

Project 1: Response farming technology to strengthen maize production in semi-arid areas in ECA

Project goal: Contribute to utilization of resources in ways that sustain agriculture and respond effectively to trade opportunities

Project Purpose: Innovative Response Farming Adaptive Strategies for stabilizing and enhancing maize production.

Project Background/Rational
In the ECA sub-region dry land areas, rainfall variability and its related problems in any given season form the greatest source of risk to maize and wheat production. As a result, frequent severe droughts and crop failure reduce their productivity contributing to massive food shortages. Farmers in the ECA region need flexible seasonal decision making technologies for crop, soil and water management for maize production to respond to seasonal rainfall uncertainties. Paradoxically, dry land agronomy research has favored the more conservative concept of fixed "best bet" recommendations for farmer use in all seasons in any given rainfall zone. The fixed "best bet" recommendations for maize-based cropping systems include rigid procedures for soil preparation, blanket rates and types of fertilizers, and plant numbers regardless of rainfall behavior.

Owing to the lack of flexible recommendations, in unexpected dry years, variable inputs are not fully utilized by the crop and often exacerbate water deficits. In unexpected years of good water supply, opportunities for high returns are foregone. Without the ability to predict the nature of the pending season, economic benefits from maize yield-improving technologies in risky climates will always be less than in more reliable ones. - The response farming strategy is to ensure achievement of at least a subsistence crop, with little or no cash outlay in poor rainfall seasons while aiming at production for the family and market in better rainfall seasons.

In accordance with the strategies set by ECAMAW, the RF approach can offer opportunities to contribute a lot to food security goals and better market opportunities.

The hypothesis: Development and utilization of forecast based agronomic research findings are feasible, as compared to a non-forecast based strategy, for managing maize production risks, stabilizing and enhancing productivity. To test this hypothesis, the following activities will be carried out:

- Information on soils (depths, water holding capacities) and crop production packages (crop types, varieties, inputs, pre/early season practices, food and market preferences) will be gathered;
- Exploratory probability/risk assessment analysis on rainfall will be carried out;
- Initial response farming recommendations for discussion with farmers, extensionists and researchers will be formulated;
- Existing best-bet options for enhanced management of soil-water will be identified and improved to fit the different conditions existing within the region;
- Farmers will evaluate sets of integrated soil fertility management options Selection options will be evaluated on-farm at several sites with contrasting agro-ecologies and cropping systems;
- Decision guides will be developed and tested with farmers across ECA in similar AEZ.

In collaboration with SWMNET, scientists will investigate approaches for enhancing integrated management of soil-water for maize and wheat production. Selected options will be disseminated to other communities in collaboration with other partners (AHI, SWMNET, NARIs and NGOs).

Outputs:

1. Historical impacts of seasonal rainfall variability on maize production strategies currently adopted by farmers and those recommended in each country including input/output markets identified and quantified
2. Farm-level adaptive response farming maize production strategies to reduce the impacts of seasonal rainfall variability, combining indigenous knowledge and advanced response farming modelling tools developed and verified with stakeholders.
3. Capacity for application of response farming seasonal rainfall forecast information in maize production decision-by farmers and relevant stakeholders developed
4. Prototype seasonal response farming rainfall forecast information and training materials to support adaptive decision making by farmers and relevant stakeholders developed

Project 2: Development and dissemination of normal and nutritionally enhanced highland maize varieties

Project goal: To contribute to improvement of household income and nutrition in highland ecologies of ECA

Project Purpose: Productivity and nutritional status of highland maize varieties improved

Project Background/Rational

Maize is cultivated in all major agro-ecological zones in the region up to the altitudes of 2400 m.a.s.l. The highland zone of the region is among the favorable maize-growing environments as it ranks second in maize production. High rainfall, cool seasonal temperatures, high human population density and consequently high levels of poverty generally characterize it. Despite these potentials, maize production in the highland areas is characterized by low yields due to use of unimproved varieties and the long absence of infusion of new germplasm. Biotic stresses such as turcicum leaf blight, rust, grey leaf spot, stalk lodging and stalk borers are the major constraints. The abiotic stresses in the highland zone are frost, hail and water logging (on vertisols). Undulating terrain, low soil fertility and wide variations in climatic and other environmental conditions compounds these problems.

For the past 10 years, only few improved varieties have been released in the African highlands. Maize varieties generally grown beyond 2000 m.a.s.l. are local cultivars with many undesirable characteristics which contribute to low yield potential. In the recognition of these factors, the Highland Maize Gene Pools Project was initiated in 1997 with the objective to introduce, develop and improve the highland maize in six countries in the region (Ethiopia, Kenya, Tanzania, Uganda, Rwanda and Burundi). A regional nursery was established at Ambo, Ethiopia, in 1998. Local germplasm was collected in the six countries in 1998 and have been used together with CIMMYT germplasm to develop improved and well adapted varieties and inbred lines for the highland ecologies. This project will build on the previous successes where improved hybrids and OPVs identified will be widely tested in the highland ecologies and appropriate varieties selected for release.

Although maize is an important staple food for many communities in the region, maize protein is deficient in two essential amino acids, lysine and tryptophan. Quality protein maize (QPM), however, contains nearly twice the quantity of lysine and tryptophan, which are essential building blocks of protein in humans and mono-gastric animals like poultry and pigs (CIMMYT, 2000). QPM offers an additional potential benefit by indirectly increasing available protein for farm families that raise livestock as it increases weight gain of animals like poultry and swine. Hence, utilization of QPM in the highlands of ECA region in general will alleviate the malnutrition problem leading to a healthier population, increased productivity and higher incomes for better livelihoods. This project, therefore, aims at developing and releasing improved normal and QPM varieties giving higher yields with resistance to common foliar diseases and at the same time adapted to the highland ecology.

Participatory evaluation and selection through the widely used Mother/Baby technique will expose farmers to availability and potential of improved highland stress tolerant and high nutritional varieties. The farmers may request seed of the new varieties to plant in the target areas. Seed of selected already released OPVs will also be provided to those women groups interested in community seed production to avail improved seed in their villages. This strategy will increase dissemination and adoption of improved highland varieties

Outputs:

1. Improved highland maize germplasm made available for further use in the ECA region
2. Improved normal and nutritionally enhanced maize varieties developed/identified for highland ecologies
3. Increased availability of seeds of elite and released varieties
4. Increased knowledge and awareness of farm families and development agents towards newly released highland normal maize and QPM varieties

Project 3: Enhancing wheat production for food security and improved income in arid and semi-arid Areas of ECA

Project goal: Increased Food security and improved incomes in semi-arid areas of ECA
Project Purpose: Improved wheat, soil and water management technologies for semi arid areas identified and disseminated

Project Background/Rational

Semi arid areas (SAAs) in ECA constitute over 80% of total land area and are home to some of the poorest populations within the region who are frequently challenged with hunger and poverty. Studies indicate that the region holds potential for arable farming provided soil fertility and moisture constraints are addressed. The low productivity of agricultural systems in SAAs is mainly due to natural resource degradation and lack of appropriate natural resource management strategies.

Disease pathogens in the ECA region continuously threaten wheat productivity, reducing the lifetime of released wheat varieties. Moreover, the already released varieties do not fully meet the end users' need as a result of limited participation of the end users in variety development process. However, a number of promising materials have been selected for some constraints of the region and need further evaluation. In many cases, because diseases and pests (e.g., rusts in wheat) eventually overcome most crop resistance mechanisms, new resistance genes must be identified and deployed. "Hot spots" for diseases or other production constraints in particular countries will be used to develop disease tolerant varieties for the region.

Improper soil and water conservation practices are among the constraints of increased wheat productivity. Water conservation strategies such as contour farming and minimum tillage have been tested on-station and at the farm level and some positive results have been documented in Ethiopia and Kenya. Refining and further testing are required for the options to be confirmed in other ECA countries. Finally, there is need for integrated soil, water and crop management to fully exploit the genetic potential of cultivars, to benefit farmers by 1) exploiting the best combinations with high economic return, 2) scaling-up of proven technologies and approaches.

The hypothesis: Smallholder wheat productivity can be increased through application of integrated soil, crop and water management technology options.

To test this hypothesis:

- Existing best-bet options for enhanced management of soil-water will be identified and improved to fit the different conditions existing within the region;
- Integrated soil fertility management options will be evaluated by farmers and selected options will be evaluated on-farm at several sites in contrasting agro-ecologies and cropping systems.

Outputs:

1. Demand driven wheat technologies and innovations generated and made available for uptake
2. Regional and national capacity in wheat production and marketing in arid and semi-arid ecologies strengthened
3. Enhanced availability of wheat production and marketing information for research and development

Project 4: Quality Protein Maize Development and Dissemination For The Horn And East Africa

Project goal: To improve the food security, nutrition (and thus health), and farm income of resource-poor farming families by developing and facilitating adoption of stress-tolerant QPM cultivars adapted to the major ecologies of The Horn and Eastern Africa.

Project Purpose: To improve the availability, production and utilization of protein-quality enhanced, open-pollinated hybrid maize varieties and to facilitate transfer of the technology package to farmers in the four target countries of the region: Ethiopia, Kenya, Uganda and Tanzania

Project Background/Rational

The potential contribution of Quality Protein Maize (QPM) to improving human and animal nutritional status in ECA cannot be overemphasized. Suitable QPM germplasm that will be better than the existing varieties will be developed for the mid and low altitude agro-ecologies of ECA taking into consideration the farmer preferred traits like good storage characteristics and tolerance to stresses.

Improved nutrition and increased household incomes from QPM can positively affect women in the region. However, women and children generally suffer from poorer nutrition than men and may therefore benefit disproportionately from the improved protein quality of QPM. Furthermore, additional household income has the potential to put more resources into the hands of women. The QPM Project will thus serve women's basic needs by increasing household nutritional status and food security, empowering women farmers and by addressing women's strategic interests through the promotion of women in leadership roles in the participatory evaluation of QPM technologies. QPM project is committed to achieving gender-inclusive results, using gender-sensitive indicators, to the collection of gender-disaggregated data and to promoting women as agents of change.

ECAMAW and partners thus aim to improve availability; production and utilization of protein quality enhanced open pollinated and hybrid maize varieties to facilitate transfer of the technology package to farmers in ECA.

Outputs:

1. Increased involvement of stakeholders in the Development and dissemination of stress tolerant QPM cultivars adapted to the maize –producing ecologies of the Horn and Eastern Africa.
2. Increased releases of farmer preferred stress tolerant QPM cultivars adapted to the major agro-ecologies
3. Increased quantities of foundation and breeder seeds of elite QPM varieties available and accessible to seed producers
4. Increased knowledge of and skills in QPM development and Seed production
5. Increased knowledge and awareness of QPM technologies and nutritional benefits particularly amongst farm families

Project 5: African Maize Stress Project

Project goal: Increasing the food security and income generation of African farm families by increasing the productivity and sustainability of maize-based cropping systems subject to drought, low and declining soil fertility, and infestation by Striga spp and stem borers.

Project Purpose: To develop stress tolerant maize varieties accompanied with innovative and appropriate cultural practices for increased productivity in target areas of the region.

Project Background/Rational

Maize breeding programs in eastern and southern Africa, with CIMMYT's collaboration, have recently developed varieties and hybrids with high yield potential and tolerance to low soil fertility and drought, as well as to common biotic stresses such as *Striga*, borers, and streak virus. These are now being evaluated and distributed through farmer participatory research using ‘mother–baby’ trials on a large scale. To further improve maize yields and stability on resource-poor farmers’ fields, agronomic practices that complement stress-tolerant germplasm have been developed and are being evaluated and adapted with farmer participation in eastern and southern Africa.

Although the research and development activities have generated promising results, their adaptation to the ECA region and adoption are imperiled by the limited capacity of the national agricultural research organizations to bring these factors (stress-adapted germplasm, QPM) together, and by the inability of extension services, the private sector, and NGOs to disseminate the products. This project aims to combine these available technologies and, through a program of extensive participatory on-farm research and evaluation, to ensure proper adaptation, dissemination, and adoption.

Outputs:

1. Development of locally- adapted cultivars of maize with increased tolerance to drought, low soil nitrogen and Striga, and with resistance to stemborers, as well as with improved nutritional content.
2. Develop, test and promote the use of complementary crop management practices to ameliorate stress conditions.
3. Strengthen NARSs' ability to develop stress-tolerant maize.
4. Enhanced availability of stress tolerant maize systems information for research and development

Project 6: Improving the value of maize as livestock feed to enhance the livelihoods of maize-livestock farmers in East Africa

Project goal: *T*o enhance the livelihoods of resource poor crop-livestock farmers of East Africa where the concentration of mixed smallholders is highest and agricultural systems are undergoing further intensification.

Project Purpose: To improve smallholder food security and benefits from livestock through superior dual-purpose maize cultivars providing both food and feed.

Project Background/Rational

The project is a new multidimensional approach to maize improvement to provide maize genotypes that better match the needs of resource poor mixed-crop livestock farmers for food and fodder. It aims at producing cultivars for diverse and often marginal environments in Ethiopia, Kenya and Tanzania that produce higher grain yield under conditions of biotic (gray leaf spot, stem borer) and abiotic (drought, low fertility) stress than currently used cultivars while providing good stover quantity and quality for livestock fodder. *T*his project aims to enhance the livelihoods of resource poor crop-livestock farmers of East Africa where the concentration of mixed smallholders is highest and agricultural systems are undergoing further intensification. *The purpose* is therefore to improve smallholder food security and benefits from livestock through superior dual-purpose maize cultivars providing both food and feed.

This is a CIMMYT and ILRI joint project that is carried out in the lowlands, mid-altitudes (dry/moist) and highlands (transitional/true) agro-ecological zones of Ethiopia, Kenya and Tanzania. Investigation will be on landraces, released open pollinated varieties and hybrids, and initial and advanced breeding material under low (resource poor farmers practices) and recommended input levels. The on-station and on-farm maize improvement work will be linked through mother/baby trials involving farmers, NARES, NGO's and private entrepreneurs. Stover fodder value will be estimated through a validation chain starting with livestock productivity trials

accompanied by laboratory analysis (chemical, morphological/structural and *in vitro*) analysis and development of near infrared spectroscopy equations to predict pertinent laboratory traits in large number of germplasm
Relationships between stover fodder traits and primary traits and heritability and heterosis effects relating to food-feed maize will be investigated to identify cultivars that provide superior grain yield and stover fodder value, and to assess opportunities for further genetic enhancement

Outputs**::**

1. Influence of livestock related factors on farmers choice of maize genotypes assessed in Ethiopia, Kenya and Tanzania
2. Superior dual-purpose maize cultivars identified from existing maize germplasm for diverse agro-ecological zones:
3. Opportunities and strategies for further genetic enhancement towards dual-purpose maize assessed for diverse agro-ecological zones in East Africa defined:
4. New tools for quick and economical on-field assessments of stover fodder value in crop improvement work
5. Additional selection criteria for variety releasing agents and public and private seed industry

Project 7: Development and promotion of baby corn as part of value addition in maize in ECA region

Project goal: Improved market and trade opportunities for improved farm incomes

Project Purpose:
To improve smallholder incomes through superior baby corn maize cultivars for market and trade opportunities

Project Background/Rational
New products for maize and wheat in ASARECA countries are limited in number due to lack of innovative product development, continued use of old eating behaviors by consumers and lack of capital for entrepreneurs to venture into production of new products. However, maize genetic resources contain various benefits that include multiple uses of maize and maize products. This project explores new opportunities related to horticultural use of maize as baby-corn, which is an important source of cash for growers in ECA region. This trait incorporated into maize germplasm with tolerance to biotic and abiotic stresses will be usable by the communities especially in urban areas of ECA.

In collaboration with food technologists, nutritionists food processors and consumers, new baby corn varieties will be developed and promoted in two countries initially including Kenya where preliminary work started two years ago. Consumer preferences with regard to baby corn will be identified through market research. Strategic partners interested in processing and exporting in the counties will be identified. Consumers will be made aware of the new and existing baby corn varieties promotion campaigns.
Outputs:
1 Demand driven baby corn technologies and innovations generated and made available for uptake
2. Increased knowledge and awareness of stakeholders towards baby corn maize varieties
3. Enhanced availability of baby corn production and marketing information for research and development

Project 8: Strengthening Seed production and distribution systems for small-scale farmers in ECA

Project goal: Improved quality seed production and distribution for increased farm production and incomes

Project Purpose: Identify and facilitate the efficient seed production and distribution systems that provide small holder farmers in ECA with affordable, improved maize seed.

Project Background/Rational
One of the major limiting factors to maize and wheat production is unavailability of improved seed at the farm level. Seed is a very important and strategic input in production. Improved seed tend to give better yields because of special traits bred in them e.g. disease resistance, tolerance to certain abiotic stresses and adaptability itself.
While several seed companies have increased in number in ECA, availability of seed to farmers still stands out as a major constraint to adoption of improved varieties. Seed outlets are few and restricted to big trading centres requiring most farmers to travel long distances to buy seed. The multinational and regional seed companies show little or no interest in producing open pollinated varieties since their returns are very low and yet these are the varieties the resource poor farmers need most. For the benefits of improved varieties to reach small-scale, resource-constrained farmers, the farmers must have access to affordable seed of improved varieties. To this end, ECAMAW and its partners like CIMMYT will facilitate small national seed companies that do not have breeding capacity to benefit from multiplying and marketing the publicly developed improved varieties. This strategy will effectively reach the resource-constrained farmers in less potential areas of ECA. In addition, the different projects will support public as well as private breeding programs to ensure sufficient breeder and foundation seed of recently released varieties. ECAMAW and its partners will also facilitate community-based seed production by farmer groups where appropriate so that OPV seed readily reach more small-scale farmers at affordable prices.

Policies for production, supply and prices of seed and other inputs, germplasm exchange, credit, and variety release regulations need to be in place for competitive maize and wheat systems. ECAMAW will collaborate with partners in putting significant emphasis on determining factors that affect seed production and distribution

Outputs:
1. Demand driven quality seed technologies and innovations generated and made available for uptake
2. Enabling regional and national policy options for transformation of maize seed systems facilitated.
3. Regional and national capacity for IAR4D in quality seed production and distribution strengthened
4. Enhanced availability of seed production and distribution information for research and development

4.0 Partnerships and Linkages

The continuum of maize and wheat production to consumption involves a wide range of activities including input procurement and distribution, crop production, post-harvest handling, processing, and marketing. Thus, improved food security and livelihoods through maize and wheat requires a multidisciplinary approach and strong partnerships. Effective partnerships are important as a means of coping with declining resources in research for development to address problems in a systematic and sustainable manner.

The ECAMAW Network partners include national agricultural research institutes (NARIs), universities, extension divisions (usually in the Ministries of Agriculture), community based organizations (CBOs), non-governmental organizations (NGOs), scientific partners in the international agricultural research centers (especially, CIMMYT), public and private seed producers, traders, processors, other ASARECA networks (especially SWMNET, ECAPAPA, FOODNET and A-AARNET), exporters, and regulatory bodies especially for seed production. The network has also developed activities in partnership with other networks outside the region including the Southern Africa Drought and Low Fertility Project (SADLF) and Soil-Fert Net in the SADC region. Other research and non-research institutions, which have common interests with ECAMAW but have not been linked to the network research and development objectives but could participate effectively in implementing these objectives. ECAMAW must look for opportunities for developing joint activities with other institutions within and outside of the network for sourcing funds and capacity development where expertise is lacking. Opportunities Will be sought to collaborate with other institutions whose strengths complement those of ECAMAW, for example in value addition, soil and water management, policy analysis, market studies and training, and agro-forestry promotion.

Partnerships between national programs that serve as liaison with national collaborators need be strengthened to achieve the expected results of this MTP. Many technologies that have been developed in collaboration with network partners could not be scaled up due to lack of widespread committed development partners and limited resources in the member countries. ECAMAW thus aims to broaden partnerships to well-equipped institutions within the network member countries in all research and development areas for achieving wider impact in the region.

4.1 Roles of partners

Effective partnerships result in responsibilities being shared among partners, each respecting the other's roles. ECAMAW will coordinate and carry out consultations to reaffirm and enhance individual responsibilities.

NARI scientists: The land and facilities are owned by the NARs so the scientists will conduct field and laboratory studies for all projects activities described in this MTP. They will plan, manage, implement and report the collaborative activities to the special project coordinators and the network regional coordinator. They are expected to provide training and technical back stopping to NGOs, CBOs, farmer groups and other relevant stakeholders they will be working with. The NARs authorities will carry out the financial control of the funds disbursed by the network. The scientists spearhead all activities related to ECAMAW in their respective countries including establishing linkages with farmer groups, traders, processors, and exporters. The scientists also have a role of compiling and analyses of data in collaboration with CIMMYT and the coordination unit. NARs are accelerate variety releases or approval and dissemination of improved varieties with their accompanying technologies. They will ensure that breeder and/or basic seed are available to informal and formal seed producers depending on the regulations of the countries. The national coordinators nominated by the NARIs Director Generals will participate in the network's Steering Committee (SC) comprising of various stakeholders representatives involved in maize and wheat sectors. The SC representatives provide a key link with policy makers in their respective countries.

Universities. The role of universities includes both research and capacity building. Scientists in various disciplines, including genetics, plant breeding, food processing, crop protection, agronomy, marketing and agricultural economics, may participate in implementing the Network MTP. Some of the activities will be accomplished through student thesis research and consultancies in specific studies in collaboration with NARS and CIMMYT scientists. Universities may also assist in training of various stakeholder groups.

Extensionists. Extension services provide the link between researchers and farmers and play a crucial role in participatory technology development and evaluation, in addition to their traditional role in technology dissemination. Extension staff also provide feedback to researchers on disseminated technologies which researchers can use to fine-tune future research products.

Farmers and Farmer groups. Farmers are the ultimate users of many of the technologies developed and recommended. They will participate in selection, testing and validation of promising technologies. Farmer groups will be involved in community seed production of open pollinated varieties and distribution of seed in their areas. Farmers also play a key role in farmer-to-farmer dissemination activities.

Processors' and traders' major role is to promote the enhanced consumption and marketing of maize and wheat products by searching new market opportunities. They will also be involved in development and promotion of new products. They will participate in market studies in collaboration with other stakeholders.

CBOs and NGOs. Generally, these are involved in development activities within communities. Hence, they play a key role in scaling-up maize and wheat-based technologies/innovations. Specifically, this group will increase and disseminate seed of improved released varieties as well as promoting other technologies that go with the varieties. CBOs and NGOs will also be involved in participatory technology development and validation in collaboration with the scientists.

CIMMYT. CIMMYT is the scientific partner of the ECAMAW network. CIMMYT's breeding programs in Harare-Zimbabwe, Nairobi-Kenya and Addis Ababa-Ethiopia play a major role in providing elite maize and wheat germplasm to the regional and national breeding programs, technical backstopping network projects, and capacity building especially in crop improvement, biotechnology, seed production and distribution systems, integrated pest and disease management. CIMMYT provides visiting scientist programs that allow regional scientists to work closely with CIMMYT scientists to gain experience to improve their national programmes. CIMMYT scientists assist in sourcing funds and coordinating special projects in ECA through ECAMAW. CIMMYT scientists will continue to serve as resource persons in training in partnership with regional experts. CIMMYT therefore, plays a significant role in spearheading strategic research and new methodologies relevant to this MTP and globally.

Network Coordination. The network regional coordinator has the main role in developing proposals with network scientists, CIMMYT and other partner institutions for fundraising especially in value addition, marketing and post harvest technologies. Sourcing of funds will ensure all prioritized sub-themes are implemented, enhancing the sustainability of the network and national research institutions. She will assist in the formation of teams to respond to the ASARECA CGS. The regional coordinator will work with principal investigators in budget formulation and recommend adjustments in line with CGS rules and regulations.

Furthermore, it is the responsibility of the regional coordinator to ensure (i) the timely implementation of the activities in this MTP, (ii) the organization of workshops, seminars, training, steering committee meetings, (iii) the identification of resource persons, (iv) donor liaison and reporting, (v) promotion and dissemination of research results, (vi) management of project funds, (vii) public relations, (viii) technical backstopping of national programs, and (ix) continuous monitoring and evaluation of performance.

4.2 Expected beneficiaries (users)

The major beneficiaries of this MTP will be smallholder maize and wheat farmers as well as the urban population of ECA. Smallholder farmers will benefit from increased productivity and farm incomes resulting from increased utilization of new and existing maize and wheat-based technologies. Farmers and farmer groups will also benefit from improved production, business and organizational skills and higher demand of their products arising from new market opportunities and better quality. Urban populations will benefit from improved availability of the staple foods and better nutrition from quality protein maize products. Researchers, extensionists, NGOs, traders and processors will acquire knowledge and new skills, and establish strategic linkages to improve efficiency of their operations and, hence, increased productivity. Overall, this MTP will contribute to the national and regional economies through increased agricultural productivity, food security and incomes; strengthened organizations and human and physical resources in ASARECA region.

5.0 Financial Plans

The MTP framework is presented in Appendix 2.

The financial plan for the period 2006-2008 is derived from the ECAMAW 2005 annual work-plan budget. The coordination unit administration, stakeholder and steering committee meetings are funded by EU EDF 8. CIMMYT special projects continue to be the major source of funding for network activities. In general, a large part of the CIMMYT African Livelihoods Program in Eastern and Central Africa is implemented in partnership with NARS under the ECAMAW umbrella. Special projects in ECAMAW are funded by various donors including CIDA, Rockefeller Foundation, BMZ/GTZ, Nippon Foundation and IFAD. ECAMAW Stream B funds from the ASARECA CGS started funding the first three projects from 2005 and will terminate in June 2007.

The regional coordinator and ECAMAW collaborators will put emphasis on mobilizing resources to implement the identified and prioritized projects currently not implemented, in particular in post-harvest technologies, value addition, marketing and impact assessment. In addition, CIMMYT African Livelihood Program has a strong record of attracting special project funding that provides direct resources in support of priority areas in maize and wheat in ECA and globally. Hence, there is considerable potential to target donors with funding for our priority areas of work.

ECAMAW Finances summary			
<u>2006- 2007 Projects</u>	**2006**	**2007**	**2008**
Project.1 – Response Farming	41,226	33,774	0
Project.2 – Highland maize	58,482	.31,518	0
Project.3. - Wheat	25,000	25,000	25,000
Project.4 - QPM Development and Dissemination	226,087	280,000	310,000
Project.5 – African Maize Stress	130,435	140,000	150,000
Project.6 – Food/Feed maize	60,870	68,000	65,000
Project.7 Alternate uses of maize-Baby Corn	5,217	10,000	10,000
Project.8 – Strengthening Seed systems	37,391	25,000	30,000
Coordination Unit Administration	78,125	78,125	78,125
Review progress reports and annual planning meeting	39,148	39,148	39,148
Coordination Unit Training	11,799	11,799	11,799
Scientific Partnership	32,000	32,000	32,000
Stakeholder Meeting	25,213	25,213	0
Steering Committee Meeting	18,700	18,700	18,700
TOTAL	**789,693**	**818,277**	**769,772**

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