

CGIAR Research Program on Dryland Cereals

Draft Concept Note

for Discussion with Donors and Partners on Phase II (2015-2023)

4 June 2013

The **CGIAR Research Program on Dryland Cereals** (DrylandCereals) focuses on improving the productivity of barley, finger millet, pearl millet and sorghum, key cereals for smallholder farmers in Low-Income, Food-Deficit Countries of Africa and Asia. The targeted countries in these regions are home to the 'poorest of the poor' living in rural and marginal, often harsh, environments characterized by high temperatures, low and unreliable rainfall, poor soil fertility and limited market opportunities. Such smallholder agricultural systems are based primarily on dryland cereals highly linked to livestock enterprises where almost the entire crop production is consumed for subsistence as family food and animal feed and/or fodder. According to IFPRI models, demand for dryland cereals in the target regions is forecast to increase by about 40% by 2020 (over the 2000 baseline), driven mainly by population growth, but also by regional dynamics such as the growing demand for livestock feed and fodder, adverse effects of climate change, and trends toward urbanization of the population.

Proposed farm-level crop productivity improvement targets will not only address existing requirements for traditional food quantity and nutritional quality, but also take on a range of crop developments to address the emerging opportunities for animal feed and fodder and for diversified new products demanded by the emergent urban population. In this context, the proposed crop focus represents a balanced portfolio encompassing millets which are a mainstay traditional food, but with relatively low technical development; sorghum, also a traditional food and fodder, with moderate technical development; and barley with strong international technical development and potential upside as a cash food, feed and processed crop.

INTERMEDIATE DEVELOPMENT OUTCOMES

The successes of DrylandCereals will ultimately contribute to three CGIAR System Level Outcomes: SLO 1 on reduced rural poverty; SLO 2 on improved food security; and SLO 3 on improved nutrition and health. More directly, DrylandCereals is focused on producing the following five Intermediate Development Outcomes and draft specific targets within the nine-year period.

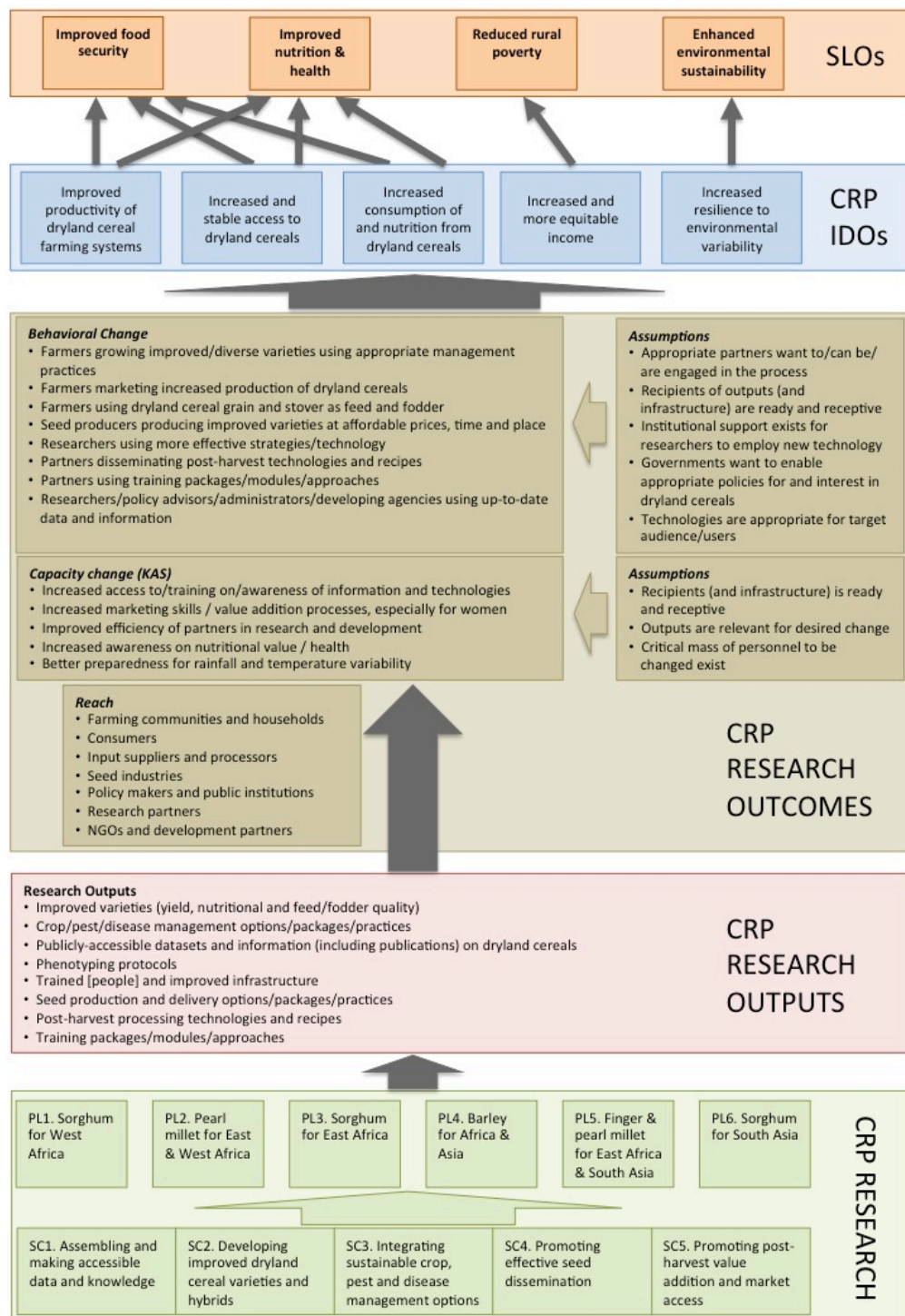
1. **Improved productivity** of dryland cereals in smallholder farming systems in Africa and Asia
 - 30-40% increase in sorghum grain yield in 600,000 farmer fields in WCA and ESA, of which 50% of the increase is in women farmers' fields
 - 20-30% increase in pearl millet grain yield in 800,000 farmer fields in WCA and ESA, of which 50% increase in women farmers' fields
 - 20-30% increase in barley yield in 300,000 farmer fields in Ethiopia, India, Iran, Kazakhstan, Morocco
 - 15-20% increase in pearl millet and sorghum grain and 5-10% stover yield in 3 million ha in India
 - 30-50% increase in finger millet grain yield in 300,000 farmer fields, and 20% increase in premium quality marketable grain in Ethiopia, Tanzania and Uganda
 - 10-20% increase in profitability of sorghum for industrial use in Nigeria, Kenya and Tanzania; 15-25% increase in profitability of barley for industrial use in Ethiopia, India, Iran and Morocco

2. **Increased and stable access to dryland cereal food, feed and fodder by the poor, especially rural women and children**
 - 50% decrease in the length of the hunger period for 500,000 rural poor households producing sorghum and pearl millet in Mali, Niger, Nigeria and Burkina Faso
 - 20% increase in the stock of finger millet prior to harvest period for 250,000 rural poor households producing finger millet in Ethiopia, Tanzania and Uganda
 - 20% increase in the availability of food barley (grain), feed barley (grain and straw) and industrial use at more stable market prices in CRP focal countries.
 - 15-20% reduction in price volatility (measured by CV in price) influenced by stable supply of pearl millet and sorghum in India
3. **Increased consumption of nutritious dryland cereals by the poor, especially among nutritionally vulnerable women and children**
 - 30-50% increase in iron and zinc intake levels from nutrient-dense pearl millet by women and children in WCA and ESA, and in areas where high iron hybrids were adopted in India
 - 30-50% increase in iron and zinc intake levels from nutrient-dense sorghum by women and children in WCA and ESA, and 15-20% increase in predominantly sorghum consuming population in India
 - 30-50% increase in iron, zinc and calcium intake levels from nutrient-dense finger millet by women and children in Ethiopia, Kenya, Tanzania and Uganda
 - 30% increase in consumption of finger millet, pearl millet and sorghum products in Ethiopia, Kenya, Sudan, Tanzania, Uganda and targeted areas in India, especially by women and children
 - 10% increase in the use of iron and zinc fortified barley grain as food by nutritionally vulnerable women and children in rural and urban areas and for individuals with special dietary requirements in India, Iran, Ethiopia and Morocco
4. **Increased and more equitable income from marketing dryland cereal grain, fodder and products by low income value chain actors, especially smallholder women farmers**
 - 20-30% increase in income for pearl millet and sorghum growers and processors in target regions of India, with 15-20% of the income by women growers and processors
 - 25% increase in income by finger millet, pearl millet and sorghum growers and processors in Burkina Faso, Mali, Nigeria, Ethiopia, Kenya, Tanzania and Uganda, with 35% of the income by women processors
 - 20% increase in income of barley growers from industrial uses in Ethiopia, India and Iran with 20% of the income by women processing barley for local food and other industrial uses in Ethiopia, India, Iran and Morocco
5. **Increased capacity to adapt to environmental variability and longer term changes in low income communities in Africa and Asia**
 - 20% decrease in acreage of dryland cereals fields requiring re-sowing in WCA, ESA and India
 - 25% reduction in acreage (and/or frequency) of failed dryland cereal crops in Africa and Asia
 - Increase by at least one the number of cultivars grown by 400,000 pearl millet and sorghum farmers in WCA, 25% of the pearl millet and sorghum farmers in Ethiopia, Sudan and Tanzania and 100,000 pearl millet farmers in India, 30% of the finger millet farmers in Ethiopia, Tanzania and Uganda
 - 150,000 households in India adopting improved sorghum cultivars and management practices to mitigate environmental variability
 - 5% of barley acreage is grown using enhanced water productivity technologies in rotation with legumes and with conservation agriculture practices in Ethiopia, Iran, India and Morocco.

IMPACT PATHWAY

DrylandCereals will achieve the above IDOs through numerous impact pathways and theories of change that will vary depending on the crop, technology innovation, value chain and region being targeted. Such

specificities are under draft. In this document, we present an overall picture of the impact pathway and theory of change that leads from the research outputs from each Flagship Project, to behavioral and capacity change among targeted immediate beneficiaries, ultimately leading to the desired set of Intermediate Development Outcomes and System Level Outcomes.



THEORY OF CHANGE

The theory of change for Dryland Cereals presented below in summary form captures the most important elements in the thinking behind the design of the program. It identifies the *preconditions* required to reach a long-term goal, explains the *hypotheses* that make it necessary for these preconditions to be met, and articulates the *assumptions* on which these hypotheses are based.

The ultimate outcome of DrylandCereals is a 16% increase in the productivity of four dryland cereals that will improve household food security and cash incomes for 5.8 million smallholder farm households.

Precondition 1: Smallholder farmers will adopt the outputs from the Flagship Projects.

Hypothesis: We hypothesize that raising the productivity of dryland cereals requires adoption of new technology. The expected increase in productivity cannot be achieved by genetic gains alone, but requires farmers to invest in improved crop management. Hence, productivity gains require adoption of *both* improved varieties and crop management practices.

Assumptions: We assume that Flagship Projects increase productivity under farmers' field conditions, which we will ensure by testing all outputs from the Flagship Projects on-farm, under farmers' management and low-management conditions. We also assume that they reduce unit costs of production, and therefore improve the profitability of dryland cereals, whether in terms of cash inputs or labor requirements.

Precondition 2: Smallholder farmers have access to the outputs from the Flagship Projects and information about them

Hypothesis: We hypothesize that many smallholders do not adopt new technology for dryland cereals because they are unaware of them or, if aware, do not have access to them. Improved access to the outputs of our Flagship Projects will allow more farmers to test them, adopt them, and benefit from them.

Assumptions: We assume the existence of effective development partners, which include farmer organizations that have the capacity to reach large numbers of smallholder farmers, provide them appropriate information about our Flagship Projects, access to the outputs from the Flagship Projects, and train farmers in how to use them efficiently. We have already identified the key development partners we will work with in each target country.

Precondition 3: There is an enabling environment for the dissemination and uptake of the outputs from the Flagship Projects

Hypothesis: We hypothesize that access to the outputs from the Flagship Projects can be improved by a more favorable enabling environment. Currently, markets and policies can have a disabling effect. The private sector has no incentive to promote seed of self-pollinated crops other than hybrids. Governments may subsidize competing food grains (rice and maize) that penalize growers of dryland cereals, and also enforce regulatory frameworks that prohibit the sale of quality-declared seed. Government policies may influence fertilizer availability and access, either via subsidies targeting specific crops, or via import tariffs, and distribution policies, that can lead to inflated prices, and delayed delivery. On the other hand, the development of hybrid dryland cereals will offer opportunities for the private sector to invest in seed supply, while governments have become more aware of the importance of dryland cereals for national food security, nutrition, and health. Technologies that increase profitability of fertilizer use can have a positive impact on government policies towards enhancing availability and access to fertilizers.

Assumptions: We assume the existence of private seed companies and that the market for seed is competitive; that seed regulations can be reformed to allow the sale of QDS; and that governments will not adopt economic policies that dis-advantage dryland cereals over other food grains.

Precondition 4: Sufficient seed is available to give many more farmers access to the outputs from the Flagship Projects

Hypothesis: We hypothesize that investment in seed production can make our Flagship Projects available to many more smallholders. Seed supply is a critical pre-condition since most Flagship Projects are seed-based. Increasing the supply of open-pollinated seed will require investment in public-sector organizations to increase the supply of breeder and foundation seed, and in informal seed suppliers that can multiply high-quality seed for sale. For hybrids, private companies will be encouraged to exploit the commercial opportunity to produce and market hybrids that meet industrial quality standards.

Assumptions: We assume that public-sector organizations can develop the capacity to supply the required volume of breeder and foundation seed at a competitive price; that the informal seed sector can access foundation seed, produce and market the required volume of quality seed; and that production of hybrids for dryland cereals is commercially profitable.

Precondition 5: Our Flagship Projects meet farmers' requirements for improved productivity, food security and income

Hypothesis: We hypothesize that our technology will be readily adopted because it meets farmers' prioritized needs. Smallholders are not homogeneous and vary according to production objectives, resource-base, and their degree of aversion to risk. Consequently, the Flagship Projects have been designed to suit different needs. Broadly, we distinguish two target groups: poorer farmers that require outputs from the Flagship Projects for household food security, and better-off farmers that require outputs to access markets.

Assumptions: We assume that the Flagship Projects identified meet the specific needs for each region; that we have identified the Strategic Components required to develop them efficiently; and that they can be delivered within the specified time-frame.

PARTNERSHIPS

Partners are critical for the CGIAR Research Program on Dryland Cereals to achieve its Intermediate Development Outcomes. These partners, beyond the CGIAR Centers, include national agricultural research institutes and their sub-regional coordination organizations (e.g., CORAF, ASARECA), advanced public and private research institutes, non-governmental organizations, civil society organizations, farmer unions, governments and their donor-funded agricultural development programs, and private enterprise. Partnerships will involve collaborative research projects, training, capacity building (including infrastructure), and projects linking research to development to achieve outcomes.

Beyond developing partnerships as part of the research and development activities, the CRP is seeking to directly involve partners in the management and oversight of the CRP. The Steering Committee of the CRP is composed of the Directors of the two CGIAR Centers plus Directors from two NARS (ICAR and AREEO), an advanced research institute (Agropolis) and a major donor (BMGF). In addition, the CRP is working to appoint two to three partners (one to two NARS and one advanced research institute) as Coordinators of Product Lines, which will become the Flagship Projects in Phase II. We also are considering the appointment to the Research Management Team of the Director of the Sorghum and Millet Innovation Lab, and possibly one sub-regional organization (e.g., CORAF or ASARECA). Such

involvement in the oversight and direct research management of the CRP is seen as vital to create the new partnership designed for the CRP.

In research, the development of improved varieties and hybrid parental lines rely on close collaboration with national breeding programs in each target country and international partners in the development and application of new genomic tools. In particular, the CRP is working hand in hand with the Indian Council of Agricultural Research (ICAR) particularly with Directorate of Sorghum Research, the All India Coordinated Sorghum Improvement Project, All India Pearl Millet Improvement Project, and State Agricultural Universities to meet the challenges in pearl millet and sorghum production.

The CRP already involves joint research with CIRAD, the University of Queensland, EMBRAPA, Cornell University, the University of Georgia and the University of Hohenheim. The newly USAID-supported Sorghum and Millets Innovation Lab will contribute breeding material, tools and support to national partners in sub-Saharan Africa. Similarly, breeding material from Australia, USA, Brazil and Indian programs will help widen the genetic base.

Overcoming adoption constraints will rely on collaboration with emerging seed companies and farmer-cooperative seed enterprises increasing information flow and capacity of seed production and marketing. The Pearl Millet and Sorghum Hybrid Parents Consortia established by ICRISAT in 2000 in India provides effective dissemination of improved research products to the farmers and will be used as a model for establishing similar entities in sub-Saharan Africa.

Close collaboration with agricultural development initiatives to facilitate farmers' access to fertilizer and more labour-efficient agricultural equipment will provide synergies for production increases. Also, linking producers with processing industries and large-scale grain market players will be essential for developing a growing demand for specific and uniform qualities – a specific advantage from hybrids. In finger millet, links with the key processing industries in the ESA region such as Nyirefami in Tanzania and Unga millers in Kenya are essential for creating market demands.

For barley, close collaboration with national and regional partners and specifically with national agricultural research systems, universities, governmental agencies (extension systems), NGOs and the private sector (seed companies, input companies, traders, and other actors of the value chain) would be key to success for improvement in Africa and Asia. Full involvement and integration of communities of small farmers into organized, interactive schemes (associations, cooperatives, and interest groups) would be another major asset to ensure success of the program.

Interventions in barley would be organized through strong partnership with NARES of focal countries. Each focal country would be having an interactive and collaborative agenda. Turkey, Morocco, Kazakhstan, Ethiopia and India would be organized to play a linkage and networking role within and between targeted regions. Focal countries would be implementing three major types of activities: a) specific lead activities that would benefit all partner countries while using efficiently resources and competencies and avoiding repeated implementation of the same research activities by several countries, b) country partnership activities, done in every focal country in relation to their priorities and needs and those of their partners in the same region, c) empowerment, interactions, capacity building and partnership activities which are key to mobilize farmers, all stakeholders and value chain actors to ensure success and impact.

In terms of partnership with international research institutions and universities, a strong partnership is operating with the University of California, Davis targeting drought tolerance, high productivity, disease resistance and malting quality. Another important collaboration is being developed with the USDA-ARS, North Dakota on barley genomic research. In the current phase of the CRP, links are being established

with a world leading brewing industry and USAID on the development of malt barley. The main objective of this initiative is to benefit small malt barley producers in Ethiopia, India and Morocco.

The monitoring and communications activities will rely on collaboration with farmers' organizations, development actors, and rural radio networks for successful and wide coverage. Evaluation of communication efficiency will require collaboration with ARI communication research specialists initially, e.g., Wageningen University and other partners via the McKnight Foundation CCRP Community of Practice for West Africa.

FLAGSHIP PROJECTS (= CURRENT PRODUCT LINES)

The October 2012 approved CGIAR Research Program on Dryland Cereals that is currently being implemented is structured around the development and delivery of the following seven innovative 'game changing' Product Lines. We consider these Product Lines as the 'Flagship Projects' that were proposed by the Consortium to be considered in the new CRP Phase. Each Flagship Project is developed based on a critical analysis of the major constraints in the targeted regions, including the specific needs of subsistence and market-oriented farmers growing the crop. Further details on each Flagship Project are available in the approved proposal on the Dryland Cereals website (www.drylandcereals.cgiar.org).

In considering the next phase of the CRP, we believe that essentially all of the Flagship Projects remain a high priority and provide the necessary geographic, commodity and research focus. Given the importance of sorghum in the targeted regions, we will continue to have three Flagship Projects focused on each major region – West Africa, East Africa and South Asia. The specific targeted products will vary by region, with varieties more important in West Africa, and hybrids more important in South Asia. Certain traits, such as drought and heat tolerance, will be important across all three regions, and provide opportunities for coordinated research across the CRP partners. Other traits, such as tolerance to Striga, are important in the African regions, but not in South Asia. The focus on post-rainy season sorghum hybrids in South Asia provides an opportunity for spillover of technology and research into Africa, especially East Africa.

Pearl millet will continue as two Flagship Projects, one focused on varieties for West and East Africa, and a second on hybrids for East Africa and South Asia. It is anticipated that hybrids will become more important in West Africa during the next phase and the CRP will continue to evaluate the development of hybrids in and for the region. In the current CRP phase, finger millet has been developed as a separate Flagship Project. Given its smaller area of coverage and potential opportunities for collaboration between India (where finger millet is a major focus of ICAR) and the CRP efforts in East and Southern Africa, we propose to merge the finger millet efforts into the pearl millet Flagship Project for East Africa and South Asia. This will create a single Flagship Project on pearl millet and finger millet for East and Southern Africa and South Asia.

Barley will remain a global Flagship Project with a geographical focus on North Africa, East Africa, West Asia, Central Asia and South and East Asia. Spillovers from highland barley research in East Africa and parts of West Asia would benefit highland countries of Latin America, not considered a focal region in the CRP. Each region would rely on a focal country as the driving force for lead activities useful to all countries in all regions, facilitation of interactions within and across regions and activities specific to each region in the appropriate specific sub-program(s). Morocco, Ethiopia, Turkey, Kazakhstan and India would be the main focal countries for the targeted regions indicated above.

Following are brief descriptions of the proposed six Flagship Projects in Phase II.

Flagship Project 1 – Sorghum for WCA: Supporting farmers’ transition from subsistence to market orientation with productive, nutritious, photoperiod-sensitive sorghum production tools for multiple uses in West Africa

Flagship Project 1 is focused on the Sudanian zone of West-Africa (Burkina Faso and Mali), where sorghum is a staple-crop, and the northern Guinean zone of Nigeria where grain processing and formal marketing options are taking off. These are zones where maize is also an important crop, thus the comparative advantages of sorghum – adaptation to low soil fertility conditions, resistance to Striga, adaptation to drought and heat, as well as good storability of grain of high nutritional value – will be emphasized in the breeding program. Adapted, and farmer preferred hybrids for the Sudanian are now available, and a priority for DrylandCereals will be to develop the partnerships and seed dissemination models for ensuring that hybrids can become a reality for West-African farmers, especially in areas where industrial sorghum processing is growing. Efforts in the Sahelian zone of West Africa (including Nigeria) will be dedicated to improve sorghum yield stability.

Flagship Project 2 – Pearl millet for WCA & ESA: Improving food security for subsistence smallholder farmers in East and West Africa with productive and nutritious pearl millet food and fodder production technologies

Flagship Project 2 will focus on Niger, Nigeria, Senegal, Mali and Burkina Faso, where more than 80% of the pearl millet in Africa is produced. Pearl millet is the dominant cereal and staple food for the Sahelian zone of West and East Africa. To ensure yield stability and grain quality, varieties for this region need to have the appropriate flowering time and plasticity of flowering behaviour, so that grain can be produced under the variable range of growing conditions in any specific target zone. While it will be crucial to continue to improve on these traits, and increase the range of varieties available to farmers, it also will be essential during this phase of the CRP to work with a wide range of partners to ensure that the maximum number of farmers can benefit from the improved varieties currently available. This will require support of the growing seed sector and engagement with development partners who invest in extension and enhancing farmers’ access to finance for inputs and small-scale machinery, as well as with key actors in grain marketing.

Flagship Project 3 – Sorghum for ESA: Drought tolerant, highly productive multi-use sorghum cultivars for food and processing uses in the dry lowlands of East Africa

Flagship Project 3 will target sorghum production in the dry lowlands in Sudan, South Sudan, Ethiopia, Tanzania and Mozambique where more than 60% of the sorghum is produced. A modest amount of work will focus on developing and testing sorghum hybrids for high yield and stable performance and quality attributes for multiple end uses. For varieties, collaboration will be strengthened with private seed companies for releasing hybrids and testing options for seed production and marketing. Grain processing industries of food and non-food products will be the main driver for sorghum market demands and the quality attributes will be established through collaborative analysis of the cultivars with the industries. In order to enhance productivity, intensified and profitable crop management options will be developed, and promoted. Efforts will be dedicated towards improving yield stability of sorghum cultivars cultivated in the large expanses of low rainfall, high-risk zones of sorghum cultivation of Sudan, Tanzania, Uganda and Ethiopia.

Flagship Project 4 – Barley in Africa & Asia: Multi-purpose barley production technologies to meet food, feed and fodder demands in the dry regions of Africa and Asia

Flagship Project 4 would target barley in the indicated focal countries for increased productivity and improved value in uses (nutritional, industrial and diversification of uses). Globally barley productivity is still low with averages during period 2001-2011 ranging from 1.1 tons/ha in North Africa to 1.4 tons/ha

in East Africa. Yield gaps have numerous and varied causes ranging from policy and socio-economical factors to agronomical ones. Although barley is more perceived as a feed crop, FP4 is focused on barley as an important food crop in many rural areas of the drylands of Africa and Asia where food shortages is still there. It is recognized as biofortified and functional food and can contribute to nutritional security in rural areas and increased health. In urban areas, its consumption is expected to increase because of its high content in beta glucans. Another area of research for PL4 is to explore and promote the potential of naked barley, for food uses. Malt is another product that FP4 would be monitoring because it is expected to bring higher demand for barley. Both uses represent economic assets to farmers of the drylands as they would surely influence added value, diversified uses, market security, emergence of industries and improved livelihoods.

Flagship Project 5 – Pearl millet and finger millet for ESA & SA: Improving food security and incomes with productive, nutritious multi-purpose pearl millet and finger millet in production technologies for East and Southern Africa and South Asia

Flagship Project 5 will target hybrid pearl millet production in the States of Gujarat, Haryana, Maharashtra, Rajasthan and Uttar Pradesh in India, and Sudan and Tanzania in East and Southern Africa. The decline in area trend as witnessed in case of all India has not been observed in the most arid regions of northwestern India, which receives less than 400 mm rainfall (accounts for 30% of the pearl millet area in India). Recently, there is increased interest from public and private sector to improve production in this region, hence the CRP will pay greater attention to increasing hybrid options in this ecology, and will develop early maturing hybrid materials with drought adaptation. Focus will be on moving these hybrids to Sudan and Tanzania. Finger millet production will focus on Ethiopia, Tanzania and Uganda. The importance of finger millet lies in its long storability without insect damage and superior nutritional value compared to other cereals. The grain is exceptionally high in calcium (358 mg/kg) and iron (46 mg/kg), which makes it an important food for expectant women, breastfeeding mothers, children, the sick and diabetics. Being gluten free, finger millet has a global potential in regions where demand for gluten free products is increasing. Finger millet is the only millet that has experienced a rise in the monthly per capita consumption, particularly in both low and medium income groups in urban areas.

Flagship Project 6 – Sorghum for SA: Multi-purpose post-rainy season sorghum hybrid production technologies for improving food and fodder availability in the driest regions of South Asia

Flagship Project 6 will target post-rainy season sorghum production in the States of Karnataka and Maharashtra in India. India has the largest sorghum area (8 million hectares) and third highest production in the world. While sorghum is grown in both the rainy and post-rainy seasons in India, post-rainy season sorghum occupies a larger area (4.5 million hectares). While there are a number of alternative crops like maize, soybean and cotton in the rainy season, there are no alternative crops for post-rainy season sorghum because the crop is grown on the residual soil moisture with limited rainfall and often affected by the terminal drought. The Indian states of Maharashtra and Karnataka are targeted by the CRP as these states together account for more than 70% of the total post-rainy sorghum area and production and over 60% consumption in India.

STRATEGIC COMPONENTS

These ‘game-changing’ Flagship Projects represent ‘the what’ that the CRP will produce over the nine-year period. Five Strategic Components (‘the how’) will effectively develop and deliver each Flagship Project, with a priority ranking firstly on the comparative advantage of the Centers and international

partners in modern breeding methods to address abiotic and biotic production stresses and output quality traits, followed by a range of systems management options for sustainable crop/livestock production. Integrated across all activities will be a focus on human capacity development of young scientists and local/regional institutions to ensure sustainable implementation.

- SC1. Assembling and making accessible data and knowledge for better targeting of dryland cereal technologies to enhance their adoption by smallholder farmers** for updated and more detailed data collection and analysis to stay abreast of the dynamics of population movements and potential climate change; and to provide a baseline and monitoring capacity for on-going governance of the program.
- SC2. Developing improved dryland cereal varieties and hybrids for increased grain and stover/straw yield, quality and adaptation in smallholder farmers’ fields** to rapidly improve cereal crop varieties for increased, sustainable yield and for a range of quality traits for food, feed and fodder applications, including emerging opportunities driven by population dynamics.
- SC3. Integrating sustainable crop, pest and disease management options, and enhancing crop-livestock integration, to capture genetic gains from improved varieties and hybrids** to capture and deliver genetic gains in farmers’ fields
- SC4. Promoting effective community-based seed production and delivery systems** to enable improved dissemination and adoption of new technology packages.
- SC5. Promoting post-harvest value addition and market access to enhance income of smallholder dryland cereal producers** to improve smallholder income beyond mere subsistence.

PROJECTED BUDGET

The budget for the next nine years (2015-2023) of Dryland Cereals is indicated in Table 1. It has been developed using the revised six Flagship Projects and is based on both current investments across the current Flagship Projects, and the projected investment required for success over the nine-year next phase. An estimated US\$ 265 million is projected across the six Phase II Flagship Projects.

Gender research and administration costs are estimated at US\$ 75 million, to give a total nine-year estimated budget of US\$ 340 million.

FLAGSHIP PROJECT	9-Year Total
PL1 Sorghum for West Africa	40
PL2 Pearl millet for East and West Africa	50
PL3 Sorghum for East Africa	40
PL4 Barley for Africa and Asia	45
PL5 Pearl millet and finger millet for East and Southern Africa and South Asia	55
PL6 Sorghum for South Asia	35
Sub-Total	265
Gender research	50
Management	25
Total	340