Consortium

Full commitments to mainstreaming breeding for mineral and vitamin traits into conventional food crop development programs by the CGIAR Consortium and its members

March 31 2014, Kigali, Rwanda

An essential role of agriculture and food systems is to provide the minerals, vitamins and other compounds that are essential for good health. As one way to contribute to this objective of agriculture, the CGIAR Consortium and its members agree to develop a plan for mainstreaming breeding for mineral and vitamin traits into conventional food crop development programs.

The following are relevant considerations underpinning these discussions:

- HarvestPlus-sponsored research has shown that iron, zinc, and provitamin A traits can be combined with high yields and the best agronomic and end-use quality traits. Biofortified varieties for sweetpotato, beans, cassava, maize, pearl millet, rice, wheat and other crops have been officially released. Approximately 1.5 million farming households are already growing these crops.

- Under HarvestPlus sponsored research, techniques have been developed to lower the costs of breeding for these traits; more advances can be made here through marker-assisted selection which has been already implemented for provitamin A maize.

- Mineral and vitamin content are traits which are not subject to genetic erosion (for example, as the dwarfing genes which catalyzed the green revolution), making this relatively simple and low cost to sustain in the long-run.

- Once the genes that confer high mineral and vitamin density are in all elite breeding lines used as parents in constituting new crosses, the progeny from all crosses should have the required traits.

- Iron and zinc are invisible and tasteless at the levels being bred into the edible portions of staple food crops, and will not directly influence demand; high provitamin A content confers a yellow or orange color, so that developing demand for yellow or orange varieties is an important step in the mainstreaming process.

- Private sector engagement is part of the mainstreaming strategy; seed companies have started to establish biofortified product lines.

- Ex ante benefit-cost analysis, endorsed by the Copenhagen Consensus, has shown that the public health benefits of incorporating mineral and vitamin traits far exceed the extra crop development costs.

International Center for Tropical Agriculture (CIAT)

The CIAT Bean Program commits to:

- Mainstream the development of high iron beans by combining this trait with major agronomic traits of importance for productivity.
- Offer services of mineral analysis to national partners involved in selection of the high mineral trait in beans, using the X-ray Flourescence (XRF) technology.
- Test the agronomic viability of low phytate, high iron beans as an option to improve bioavailabilty.
- Contribute to the development of easy-to-use, bean-based complementary foods for infants and children under-5.
- Publicize the benefits to be derived from biofortified crops.
- Promote the adoption of nutritional enhancement of crops as a standard objective of crop improvement.

During 2014 to 2018, the CIAT Cassava Program commits to:

- Collect and conserve the full range of genetic diversity for Vitamin A precursors (carotenoids) from cassava's center of origin in the Americas.
- Fully characterize that genetic diversity and related biosynthetic pathways through biophysical and molecular diagnostic tools.
- Develop and share high throughput, cost-effective screening methodologies to accelerate genetic gain for carotenoid content, including use of molecular markers.
- Combine high carotenoid content with resistance to cassava mosaic disease in breeding populations targeted toward sub-Saharan Africa.
- Distribute high carotenoid-content, CMD-resistant breeding materials with IITA in order to increase carotenoid levels in varieties for sub-Saharan Africa.
- Mainstream the development of high carotenoid cassava in breeding populations targeted toward vulnerable populations in the Americas and Asia, especially Colombia and Haiti, by combining this trait with major agronomic traits for productivity and consumer acceptance.
- Partner with public and private sectors to develop processes and products that extend the access to affordable biofortified food for vulnerable urban populations.
- Build capacity among partners for accessing and exploiting the genes for high carotenoids.
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- Promote the use of biofortified cassava, and facilitate diet diversification through higher incomes from value-added cassava, as a holistic approach to resolving Vitamin A deficiency.
- Develop and implement effective monitoring and evaluation systems to optimize design of the impact pathways.

International Maize and Wheat Improvement Center (CIMMYT)

Maize

With support from A4HN including HarvestPlus and other donors, CIMMYT will:

- Mainstream breeding for mineral, vitamins and other beneficial health compounds in maize germplasm adapted to the tropics.
- Expand and maintain breeding pipelines for developing and deploying stress resilient and nutritious maize varieties with increased mineral, vitamin, and other beneficial health compounds.
- Continue to invest in further R&D for developing improved biofortified products, trait analysis, as well as for improving the efficiency of breeding for nutritious maize.
- Undertake seed production research of improved maize hybrids, and catalyse deployment of nutritious maize varieties (with other relevant adaptive traits) derived out of CIMMYT breeding pipelines in sub-Saharan Africa, Latin America and Asia.
- Train scientists, especially women from public and private institutions, in novel tools and technologies in phenotyping and breeding for nutritious maize.

Wheat

With support from A4HN including HarvestPlus and other donors, CIMMYT will:

- Expand and maintain breeding pipelines for increased Zn and Fe enriched wheat germplasm adapted to the target regions (South Asia, East Africa and beyond).
- Identify and integrate molecular markers and genome-wide selection strategies to breed Zn and Fe enriched wheat germplasm.
- Catalyse deployment and adoption of CIMMYT derived nutritious wheat varieties (with essential core traits) through public-public and public-private partnerships in the target regions (South Asia, East Africa).
- Train the trainers (especially women scientists) from public and private institutions, which would facilitate the education of women farmers and help them advocate for biofortified crops and its health benefits.

INTERNATIONAL POTATO CENTER (CIP)

Biofortified Orange-fleshed Sweetpotato

In its new Corporate Strategy for 2014 through 2018, CIP has highlighted Combating Vitamin A Deficiency with Resilient, Nutritious Orange-fleshed Sweetpotato as its first strategic objective to make a difference in the lives of 15 million

households in Sub-Saharan Africa, India, Bangladesh, Indonesia, and Haiti over the next 10 years. Responding to strong regional and national demand for more nutritious foods, we will generate new, locally adapted and nutritious OFSP varieties. We will help our partners to scale-up use of these varieties through accelerated breeding, improved multiplication techniques, diversified value chain development, and evidence-based policies. We will establish strategic partnerships for going to scale and accompany this process with strategic research to assess cost-effectiveness, pro-poor focus, and gender inclusiveness.

With continued support from our donors, we will continue to:

1) Develop OFSP populations with key traits, such as drought tolerance, virus resistance, and low sugar, that will serve as parents in breeding programs of at least 20 national partner institutions.

2) Continue to build a community of practice among breeders, so that our research advances in accelerated breeding (getting varieties out in 4 years) and heterosis are broadly used and breeders are using common protocols and analytic tools.

3) Continue to increase the iron and zinc contents in OFSP varieties, undertaking bioavailability studies as levels reached warrant.

4) Continue to conduct research that will enable us to address remaining bottlenecks in the seed system, so that the goal of farmers having sustainable access to adequate quantities of quality planting material is attained. Within the next ten years, we will widely adapt and promote our new technologies of net protection tunnels in high virus pressure areas and the Triple S system in drought prone areas.

5) Continue to test new delivery systems and improve on existing delivery systems that integrate strong nutritional components that assure improved vitamin A and other key micronutrient intakes, especially in young children and their mothers.

6) Continue to explore the diversified use of OFSP as a food for human and a feed for animals. Of particular interest is having an integrated crop-dairy system, with protein-rich vines feeding dairy cows and vitamin A roots feeding the family.

7) Continue to develop and test improved fresh root storage systems for OFSP to expand its availability in the rural diet.

8) Continue to develop and test new OFSP-based processed products in close collaboration with the private sector, which will expand the urban demand for OFSP in particular and provide better markets for farmers.

9) Collaborate with our partners in going-to-scale with OFSP and building the evidence base for how this can be accomplished cost-effectively and with gender-sensitivity.

10) Build a global community of practice, with information and technical exchange enhanced between China (the world's largest sweetpotato producer), the USA, other parts of Asia, and SSA in particular.

11) Collaborate with the Roots, Tubers, and Bananas CRP and HarvestPlus so that lessons learned from the development and dissemination of biofortified OFSP are shared with other crop efforts.

12) Actively engage with policy makers to ensure that the benefits of nutritious crops like sweetpotato are recognized and integrated into food security, nutrition, and poverty reduction policies.

Biofortified Potato

CIP's strategic objectives for the next ten years include one oriented to enhance food security in Asia through the diversification of cereal-based systems with early-maturing, agile potato, and another aimed at improving livelihoods of potato farmers in Africa by tackling deteriorated seed quality. For these two objectives, the development and delivery of varieties with desirable traits such as high yield, earliness, drought tolerance, resistance to key diseases, and processing quality are a priority. The objectives make up two of the Roots, Tubers and Banana flagships. Complementing these main traits with higher contents of micronutrients and vitamins will have an additional impact in target populations, which is in line with Agriculture for Health and Nutrition.

Therefore, towards its Strategic Objectives CIP commits to:

- Mainstream high iron and zinc density into potatoes by combining these traits with major disease resistance and agronomic characteristics important for productivity and diversification.
- Improve access and supply of quality seed through decentralized seed production and innovative partnerships including PPP.
- Build capacity for sample preparation and mineral analysis among national partners involved in selection of high mineral traits in potato, using XRF technology.
- Combine high vitamin C concentration with high iron and zinc traits of potato varieties to promote bioavailability.
- Contribute to research to determine the in vitro and human bioavailability of iron and zinc from potato.
- Contribute to the validation of the role of potato in enhancing bioavailability of iron from other sources in the diet.
- Contribute to consumption studies to obtain disaggregated data for setting potato biofortification targets.
- Develop evidence and communicate that potato can make a positive difference to food security and human health.
- Investigate means to verify and assure the biofortified nature of products.

During 2014 to 2018, the CIP Science Programs commit to:

- Evaluate potato genetic diversity for iron, zinc, vitamin C, carotenoid and phenolic compounds and selected related biosynthetic pathways.
- Develop and share high throughput, cost-effective screening methodologies to accelerate genetic gain for iron and zinc content of potato, including molecular markers.
- Identify varieties and practices to optimize retention of vitamin C during storage and cooking to promote bioavailability of iron and zinc in potato.
- Mainstream high iron and zinc concentrations into late blight and virus resistant potato populations targeted toward Sub-Saharan Africa and South Asia.
- Create demand for and capture user preferences to new iron and zinc-dense potatoes through participatory research (in Rwanda and Ethiopia).

- Improve understanding of genotype by environment by management (GxExM) interaction to optimize the uptake of iron and zinc by biofortified potatoes.
- Build capacity among NARS partners for accessing and using genetic sources of high iron and zinc in potato improvement.

International Center for Agricultural Research in Dry Areas (ICARDA)

With support from HarvestPlus, CRP-GL, CRP-A4NH and other donors, ICARDA will be:

- Mainstreaming breeding program for bio-fortification of lentil germplasm with micro-nutrients (Fe, Zn, Selenium), and other beneficial health compounds adapted to South Asia, sub-Saharan Africa and WANA regions.
- Discovering and deploying traits associated with enhanced nutrition and market values through better phenotyping and genotyping.
- Managing productivity of nutritious lentils through integrated crop management, post-harvest processing, and market opportunities.
- Facilitating seed production and variety delivery systems of biofortified lentils for widespread deployment of nutritious varieties.
- Capacity building and training of NARS partners, especially women, in novel tools and technologies in phenotyping and breeding for nutritious lentil.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

During 2014-18, with support from HarvestPlus and other donors, ICRISAT will:

- Continue to mainstream breeding for iron and zinc in pearl millet and sorghum germplasm adapted to the semi-arid Tropics of Africa and Asia. Starting in 2014, almost all crosses in the India based pearl millet breeding program will include at least one parent having high iron content. By 2018, 90-100 % of the total area planted by the pearl millet breeding program will include biofortified material.
- Expand and maintain breeding pipelines for developing and deploying nutritious pearl millet and sorghum varieties with increased mineral, and other beneficial health compounds and with superior agronomic performance and adaptation to changing climatic conditions.
- Share nutrient-rich pearl millet and sorghum varieties with partners in Asia and Africa.
- Partner with private sector to promote and upscale the seed production of biofortified pearl millet and sorghum hybrids derived from ICRISAT breeding pipelines in sub-Saharan Africa and Asia, and catalyse their deployment.
- Continue to invest in R4D to further developing improved biofortified products and their marketing.

- Train scientists, especially women from public and private institutions, in novel tools and technologies to enhance the efficiency and effectiveness of breeding nutritious pearl millet and sorghum.

International Institute of Tropical Agriculture (IITA)

During 2014-18, IITA will:

Breeding

- Continue to mainstream biofortification breeding for maize and cassava varieties targeted for food uses by consumers who are vulnerable to micronutrient deficiencies in sub-Saharan Africa. For cassava this will include about 50% of genotypes evaluated on an annual basis with additional genotypes targeting critical supporting traits such as virus resistance, root mealiness and high starch yield.

- Develop nutrient-rich maize varieties and hybrids and cassava varieties with superior agronomic performance and adaptation to changing climatic conditions.

- Share nutrient-rich maize varieties with partners in Africa.

- Provide support to the NARS in Nigeria, Ghana, and the DRC for developing, testing, registration and release of nutrient-rich maize and cassava varieties.

- Disseminate disease free elite germplasm among partner countries in Africa.

- Support capacity development for biofortification research in student training and national programs of IITA partner countries in SSA.

Supply of Breeder Seeds:

- Produce breeder seed of maize parents of hybrids for private seed companies.

- Supply seeds of OPVs to community-based seed producers to promote commercialization of nutrient-rich maize.

- Produce high quality breeders seed to support delivery of biofortified cassava varieties in Nigeria and the DRC though HarvestPlus, NGOs, youth agribusiness and private seed producers.

Testing for Use as Ingredients in Processed Foods:

- Supply nutrient-rich maize varieties to producers and suppliers of food processing companies.

- Support researchers and companies with elite Vitamin A cassava genotypes for inclusion of biofortified cassava in processed products and composite foods.

IRRI

Commitment on Healthier Rice Varieties
1 April 2014

The International Rice Research Institute (IRRI) continues its research to evaluate and develop varieties of rice with more micronutrients - iron, zinc, and beta-carotene (a source of vitamin A) to help people, especially the very poor, benefit from these important micronutrients and help address global malnutrition and public health issues.

IRRI's research on developing healthier rice varieties aims to achieve not only enhanced nutrient content, but also desirable agronomic traits such as high yield, pest and disease resistance, and good grain quality to help ensure its acceptability among both farmers and consumers.

The research to develop healthier rice varieties is supported by the Bill and Melinda Gates Foundation (BMGF), Rockefeller Foundation (RF), US Agency for International Development (USAID), HarvestPlus, and the Governments of Bangladesh, Indonesia, and the Philippines.

Vitamin A

To help address the devastating effects of vitamin A deficiency, IRRI and its partners internationally and also the Philippines, Bangladesh and Indonesia are further developing Golden Rice, a new type of rice that contains beta carotene, a source of vitamin A. HarvestPlus has provided equipment to support this research. Breeding and field evaluations of Golden Rice varieties will continue from 2014 into the future, followed by regulatory review and, if deemed safe for human consumption, an independent community nutrition evaluation.

Iron

Using advanced biotechnology tools, IRRI is breeding iron-enriched rice. Already rice lines with iron concentration of 15 parts per million (ppm) in the polished grain as measured from confined field trial have been achieved. As an added benefit, there was a boost in zinc levels in the rice grain up to 50 ppm, well over the target of 28 ppm of zinc in milled rice grains — the level required to make a significant impact in reducing global zinc deficiency per agreed targets under HarvestPlus.

Zinc

IRRI is pursuing its commitment to mainstream zinc biofortification in rice breeding, particularly using advanced non-GM approaches. Within the wide genetic diversity of rice is germplasm that have comparatively higher zinc in the rice grain. This germplasm can be used to breed high-zinc high-yielding rice varieties. Under a HarvestPlus project and with the support of IRRI, the Bangladesh Rice Research Institute (BRRI) was able to develop and release high-zinc rice in Bangladesh. IRRI is also investigating the bioavailability of zinc in high-zinc rice in collaboration with institutions from Bangladesh, the University of California-Davis, HarvestPlus, and other international organizations. IRRI is leading a collaborative project to develop high-zinc rice for release in India, Indonesia, and the Philippines.

Impact research

HarvestPlus and IRRI are evaluating the potential impact of biofortification of rice with vitamin A, iron, and zinc on the adequacy of intake of vitamin A, iron and zinc among populations in Bangladesh, Indonesia, and the Philippines. The main objectives of this assessment are:

1. To estimate the dietary intake of rice among women and children in target countries.

2. To estimate usual daily intakes of vitamin A, iron, and zinc before and after biofortification of rice at different target levels with different consumption scenarios.

3. To estimate the percentage of women and children at risk of inadequate intakes of vitamin A, iron, and zinc before and after biofortification of rice.

The results of the research conducted by IRRI and its partners will be subjected to international peer evaluation and publication within 2014-2015, with the goal of informing policymakers on decisions with on the role of biofortified rice in national public health programs.