CASE STUDY 1: Rwanda's High-Iron Beans

Better Nutrition from High-Iron Beans. Credit, HarvestPlus

In 2010, the Rwandan government introduced 4 high-iron biofortified varieties of bean. This was followed by a second wave in 2012, developed by the Rwanda Agriculture Board (RAB), the International Center for Tropical Agriculture (CIAT) and HarvestPlus.[1] In 2012, 38% of Rwandan children under five and 17% of adult women were iron deficient.[2] By 2014, more than 270,000 households or 15% of farmers were growing and eating the biofortified beans.[3] These beans contain 14% more iron than commonly grown varieties.[4] Given that Rwandans eat on average 200g/day of beans, the iron beans can provide 45% of their daily requirement of iron. HarvestPlus aims to continue to enrich their beans, with the goal of providing 60% of daily iron needs. The beans are also bred to be high yielding, virus resistant and heat tolerant.[5]

Preliminary evidence shows that consumption of iron fortified beans can increase iron status in iron-depleted Rwandan women. For example, iron-depleted female university students showed a significant increase in haemoglobin (by 3.5g/L) and total body iron (up by 0.45mg/Kg) after consuming biofortified beans for 4.5 months.[6] HarvestPlus also released iron beans in the Democratic Republic of Congo where they are being planted by 175,000 households[7] and in Uganda, where vitamin A enriched orange-fleshed sweet potato is already widely produced and consumed.[8]

CASE STUDY 2: Vitamin A Maize in Zambia

A lack of vitamin A causes blindness in 500,000 children annually and is linked to increased risk of death from disease.[9] In Zambia, although sugar has been fortified with vitamin A since the 1990's, a 2003 National Food and Nutrition Commission showed that 54% of children under the age of 5 remained vitamin A deficient, as well as 13% of women aged 15-49.[10]

Vitimin A maize. Credit, Hugo De Groote,CIMMYT-Nairobi

In 2012 pre-school children in the Nyimba District of Zambia were selected to partake in a study, primarily for their willingness to participate. Children were selected who were reasonably healthy, without infection, but who had not received any vitamin A supplements in the past 6 months. Children were either fed 200g/day of white maize, the same amount of orange vitamin A fortified maize (developed by the International Maize and Wheat Improvement Centre, CIMMYT and HarvestPlus) or a vitamin A supplement. The study demonstrated that orange maize is an effective vitamin A source; those who were fed orange maize showed significant increases in their vitamin A levels. In fact, there was no statistical difference

between the vitamin A levels in children who were fed the supplement and those who ate the orange maize.[11]

HarvestPlus released their first biofortified maize in 2012. By 2014, it reached 75,000 farming households, equivalent to more than 450,000 people. The maize currently provides 25% of the daily requirement of vitamin A in a typical 300g serving. However, HarvestPlus aims to provide more-fortified varieties, which can provide up to 60% of the daily requirement.[12] Emerson Banji is a HarvestPlus lead farmer in the Zambian village of Muyumbana.[13] Despite poor rainfall in 2013, Emerson was confident that his orange maize, which is high-yielding, disease and drought-tolerant,[14] would provide a better crop than the white maize he used to grow. He reports that 'he would prefer to always plant orange maize over white maize, because he believes it offers a better life for his family.'

CASE STUDY 3: Vitamin-A Biofortified Cassava in Kenya and Nigeria

Vitamin A Cassava, Nigeria. Credit, HarvestPlus

In 2011, the International Institute for Tropical Agriculture (IITA) and the National Root Crops Research Institute (NRCRI) announced the successful hybridisation and selective breeding for 3 new yellow varieties of cassava biofortified with vitamin A. Although by 2013, more than 25,000 households produced these biofortified varieties of yellow cassava, there is a long road between breeding and adoption, especially for crops that may look or taste different than local, more familiar, varieties. Improving and accelerating consumer acceptance of biofortified crops is therefore a major concern for breeders.

A study carried out in the Kibwezi district of Eastern Province in Kenya tested both children between the ages of 6-12 and their primary care-giver (who was usually the mother, but in some cases was the father, grandparent or other adult), to establish attitudes towards switching to vitamin-A biofortified yellow-fleshed cassava. Subjects reported a significant difference in taste between the local white variety and yellow cassava. However, both groups preferred the yellow cassava because of its soft texture, sweet taste and attractive colour. Indeed, more than 70% of subjects reported a preference for the yellow cassava. Knowledge about vitamin A-rich cassava and its relation to health was a strong predictor of 'health behaviour identity' or the notion that the new variety is good to eat. Worries related to bitter taste and colour, the care-givers' beliefs related to having control over preparing cassava. Information sessions about vitamin A enriched cassava and recommendations from health workers were the best predictors of intention to consume new varieties. Whilst the study concluded that vitamin A rich cassava is well accepted by school children, adoption rates could be improved by 1) reducing barriers such as worries about colour or taste; 2) increasing knowledge on the benefits of eating pro-vitamin A cassava; 3) empowering care-givers to control decisions on what they cook; and 4) involving health workers in the promotion of the new cassava varieties.[15]

Research into the efficacy of yellow cassava in Kenya to improve vitamin A levels is due to be published in 2015. However, a HarvestPlus study on yellow cassava in Nigeria showed

that the biofortified crop could provide up to 25% of the recommended amount of vitamin A for women and children. HarvestPlus aims to continue to improve the crop until it can provide more than 50% of the recommended daily intake of vitamin A.[16]

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[1] Johnson, N, Guedent, H & Saltzman, A 2015, 'What will it take for biofortification to have impact on the ground? Theories of change for three crop-country combinations', *International Food Policy Research Institute (IFPRI) Discussion Paper 01427*, Washington, DC.

[2] Harvest Plus 2013, *HarvestPlus Crop Strategies: It all starts with seed*, HarvestPlus, Washington, DC.

[3] *Iron Beans in East Africa*, 2014, Available from: <http://biofortconf.ifpri.info/2014/03/10/iron-beans-in-east-africa/> [6 July 2015].

[4] Harvest Plus 2013, *HarvestPlus Crop Strategies: It all starts with seed*, HarvestPlus, Washington, DC

[5]Harvest Plus 2013, *HarvestPlus Crop Strategies: It all starts with seed*, HarvestPlus, Washington, DC

[6] Haas, J ,Luna, S, Lung'aho, M, Ngabo, F, Wenger, M, Murray-Klob, L, Beebe, S, Gahutu, JB & Egli, I 2014, 'Iron biofortified beans improve iron status in Rwandan University women: results of a feeding trial' *The Journal of the Federation of American Societies for Experimental Biology,* vol. 28, no. 1: 646.1.

[7] Harvest Plus 2013, *HarvestPlus Crop Strategies: It all starts with seed*, HarvestPlus, Washington, DC.

[8] HarvestPlus (no date), *Rwanda*, Available from: <http://www.harvestplus.org/content/iron-beans-rwanda> [6 July 2015].

[9] World Health Organisation (WHO) (no date), *Nutrition: Micronutrient deficiencies – Vitamin A Deficiency*, Available from: <http://www.who.int/nutrition/topics/vad/en/> [6 July 2015].

[10] IRIN News (no date), *Zambia: Orange maize to curb vitamin A deficiency*, Available from: <http://www.irinnews.org/report/91049/zambia-orange-maize-to-curb-vitamin-a-deficiency> [6 July 2015].

[11] Gannon, B, Kaliwile, C, Arscott, SA, Schmaelzle, S, Chileshe, J, Kalungwana, N, Mosonda, M, Pixley, K, Masi, C & Tanumihardjo, SA 2014, 'Biofortified orange maize is as efficacious as a vitamin A supplement in Zambian children even in the presence of high liver reserves of vitamin A: a community-based, randomized placebo-controlled trial' *The American Journal of Clinical Nutrition*, vol. 100, no. 6, pp. 1541-1550.

[12] HarvestPlus (no date), *Vitamin A Maize*, Available from: <http://www.harvestplus.org/content/vitamin-maize> [6 July 2015].

[13] Feed the Future 2013, *Orange Maize Improves Yields and Nutrition for Families in Zambia*, Feed the Future Newsletter, Available from: <http://feedthefuture.gov/article/orange-maize-improves-yields-and-nutrition-families-zambia> [6 July 2015].

[14] HarvestPlus (no date), *Vitamin A Maize*, Available from: <http://www.harvestplus.org/content/vitamin-maize> [6 July 2015].

[15] Talsma, EF, Melse-Boonstra, A, de Kok, BPH, Mbera, GNK, Mwangi, AM & Brouwer, ID 2013, 'Biofortified Cassava with Pro-Vitamin A Is Sensory and Culturally Acceptable for Consumption by Primary School Children in Kenya' *PlosOne*, vol. 8, no. 9, e73433, Available from: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0073433> [6 July 2015].

[16] HarvestPlus (no date), *Nigeria*, Available from: <http://www.harvestplus.org/content/vitamin-a-cassava-nigeria> [6 July 2015].