International Journal of Nutritional Sciences

Open Access

Austin Publishing Group

Opinion

Whither the Marriage of Agriculture and Nutrition?

Beebe S*
Alliance Bioversity International and CIAT, Cali, Colombia

***Corresponding author:** Beebe S, Bean Program, Alliance Bioversity International and CIAT, A.A. 67-13, Cali, Colombia

Received: April 08, 2021; **Accepted:** May 03, 2021; **Published:** May 10, 2021

Opinion

In many circles today, there is enthusiasm to join nutritional sciences to agriculture, whereby the supply of a healthy diet to the populations of the world starts with agricultural production. However, bridging disciplines has always been a challenge, as each discipline has its own multiple centers of gravity: intellectual, methodological, institutional, administrative, and budgetary. HarvestPlus is a program within the international agricultural research centers of the CGIAR system, and has been one of the most structured attempts to bridge agriculture and nutrition. This effort initiated in 1994 with an exploratory workshop to test the possible interest of crop researchers in addressing nutritional problems. This writer signed up "for the ride" given that it was a funded activity, and agreed to test the potential to improve common bean (*Phaseolus vulgaris*) as a dietary source of iron and zinc. He only gradually incorporated nutritional impact into his worldview of the role of agriculture in what is now widely known as "biofortification" – a term that he is credited with coining. These lines are a reflection on that experience.

Over the past quarter of a century, breeders and agronomists of common bean have broadened their scope beyond yield-related traits, and learned something of nutrition. Agronomists have learned to refine their vocabulary. What is bioefficacy? What is the difference between anemia and iron deficiency, and what is their relationship? What is the optimal variety, if not one that serves the nutritional needs of consumers? But this transition has been received with enthusiasm as it has given a new dimension and social role to the work of crop development. Perhaps what has most motivated breeders and agronomists is the possibility of rescuing young children in their developmental years from the life-long effects of iron deficiency on their cognitive ability.

On the other hand, nutritionists contributed to the breeding program from the start, in choosing target nutrients and setting goal levels of these. Within HarvestPlus, micronutrients were highlighted and iron, zinc and pro-vitamin A were prioritized. Meanwhile, perhaps nutritionists have learned something of plant breeding: what is genetic variability? What is heritability? Perhaps they have learned to think in terms of hundreds or thousands of breeding lines, instead of two or three that enter bioefficacy trials. Perhaps they have found a new channel whereby their own science can impact on society.

While donor expectations often overshot the outputs of the breeding program, and results were a long time coming, the foray into a very new area of breeding proved to be a productive learning experience. Biofortification joined cutting edge research on genetic resources and a core collection [1], with standard genetic studies on genotype by environment interaction, and conventional breeding methods. A long-term learning process eventually led to an appreciation of the evolution of different species and the potential contribution of genes from those that originated in semi-arid environments [2]. Breeders were supported for evaluation of mineral concentration with efficient methodologies of atomic absorption spectrophotometry, and later with a novel method of X-ray Fluorescence (XRF) [3], which greatly facilitated the breeding process. In retrospect, iron homeostasis was an obstacle to altering the iron concentration in the crop; interestingly, this is a biological phenomenon shared by plants and humans, and we might have appreciated this much sooner with a more intense dialogue with nutritionists.

Early efforts in the nutritional sciences were marked by naivety about the demands of properly run bioefficacy trials, including among nutritionists whose specialty was not iron. Just as breeders and agronomists specialize on their crop, so do nutritionists specialize on their nutrient - a fact those breeders needed to appreciate. Eventually success emerged in a bioefficacy trial in Rwanda comparing high and low iron beans. Publications document the successful partnership of breeders and nutritionists. Not only did high iron beans increase hemoglobin levels in college age women [4], but they also improved cognitive ability [5], neuron function [6], and work capacity [7]. In a separate trial, a strong tendency toward improvement of transferrin receptor (P=0.054) was observed among Mexican school children consuming biofortified beans [8], especially among the most iron deficient [9]. At the end of the day, our faith in a diet-based approach and the potential contribution of biofortification was vindicated.

Breeding itself is being restructured within the international agricultural research centers, whereby the stages of developing and delivering improved varieties are defined more explicitly, from product design, to breeding and testing, to final dissemination to farmers and consumers. Just as nutritionists participated in the definition of breeding goals at the outset of HarvestPlus, so will they likely do so in the future as new frontiers emerge? However, as illustrated in the case of biofortification of common bean, this long-term interdisciplinary interaction extended far beyond the definition of expected products, and has been a partnership that facilitated genetic improvement, and that led to validating those products in trials with human beings.

Indeed, an even more pernicious scenario is emerging in both the developed world and in so-called developing countries, as obesity and its accompanying syndrome of diabetes loom large. With continuing prevalence of micronutrient deficiencies in many countries and environments, under-nutrition increasingly co-occurs with "over-nutrition". The current pandemic has thrown millions more into poverty and will aggravate malnutrition. Other questions

Citation: Beebe S. Whither the Marriage of Agriculture and Nutrition?. Int J Nutr Sci. 2021; 6(2): 1051.

have been raised about the effects of climate change on the nutritional quality of crops. Where will the institutional leadership come from to confront these challenges and to coordinate across disciplines? Some issues may be addressed by joint short-term projects, but these challenges will require an even more coordinated cross-disciplinary programmatic effort.

Within the United States, the USDA is the institution best positioned to address the linkages between nutrition and agriculture, and this has become an explicit part of its mandate. On the international scene, the CGIAR maintains a stated commitment to both nutrition and agricultural production, but the necessary institutional structure to facilitate cross-disciplinary cooperation has not been defined. Any reorganization has implications of re-positioning relationships, but cross-disciplinary relationships present their own tests. While technical challenges may appear daunting, the greater challenge may be to find a coherent institutional programmatic framework whereby well-meaning scientists can cooperate on solving the nutritional problems of society.

References

1. Tohme J, Jones P, Beebe S, Iwanaga M. The combined use of agroecological and characterization data to establish the CIAT *Phaseolus vulgaris* core collection. Hodgkin T, Brown AHD, van Hintum TJL, Morales EAV, editors. In: Core Collections of Plant Genetic Resources. John Wiley and Sons, Chichester, U.K. 1995: 95-107.
2. Beebe S. Biofortification of common bean for higher iron concentration. Front. Sustain. Food Syst. 2020.
3. Guild GE, Paltridge NG, Andersson MS, Stangoulis CR. An energy-dispersive X-ray fluorescence method for analyzing Fe and Zn in common bean, maize and cowpea biofortification programs. Plant and Soil. 2017; 419: 457-466.
4. Haas JD, Luna SV, Lung'aho MG, Wenger MJ, Murray-Kolb LE, Beebe S, et al. Consuming iron biofortified beans increases iron status in Rwandan women after 128 days in a randomized controlled feeding trial. J Nutr. 2016; 146: 1586-1592.
5. Murray-Kolb LE, Wenger MJ, Scott SP, Rhoten SE, Lung'aho MG, Haas JD. Consumption of iron-biofortified beans positively affects cognitive performance in 18- to 27-year-old Rwandan female college students in an 18-week randomized controlled efficacy trial. J Nutr. 2017; 147: 2109-2117.
6. Wenger MJ, Rhoten SE, Murray-Kolb LE, Scott SP, Boy E, Gahutu JB, Haas JD. Changes in iron status are related to changes in brain activity and behavior in Rwandan female university students: results from a randomized controlled efficacy trial Involving iron-biofortified beans. J. Nutrition. 2019; 149: 687-697.
7. Luna SV, Pompano LM, Lung'aho M, Gahutu JB, Haas JD. Increased iron status during a feeding trial of iron-biofortified beans increases physical work efficiency in Rwandan women. J. Nutr. 2020; 150: 1093-1099.
8. Finkelstein JL, Mehta S, Villalpando S, Mundo-Rosas V, Luna S, Rahn M, et al. A randomized feeding trial of iron-biofortified beans in school children in Mexico. Nutrients. 2019; 11: 381.
9. Haas JD, Villalpando S, Beebe S, Glahn R, Shamah T, Boy E. The effect of consuming biofortified beans on the iron status of Mexican school children. FASEB journal. 2011; 25: 96.6.