



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

*No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.*

## **Agricultural Biodiversity for Nutrition and Health**

**Emile Frison**

*Paper prepared for presentation at the “Biodiversity And World Food Security: Nourishing The Planet And Its People” conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, 30 August – 1 September, 2010*

*Copyright 2010 by Emile Frison. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.*



## Agricultural Biodiversity for Nutrition and Health

EMILE FRISON

Email: e.frison@cgiar.org

The number of chronically hungry people currently hovers just below the one billion mark, according to FAO. That figure, however, hides an even greater problem. Roughly two billion people, most of them women and young children, suffer malnutrition associated with a lack of micronutrients and vitamins. Furthermore, so-called diseases of affluence, such as type-2 diabetes, cardiovascular disease, obesity and cancers are increasing most rapidly in developing countries. The underlying reason for both of these observations is that diets have become simpler. The prevailing highly medicalised view of micronutrient deficiency sees only supplements and biofortification as effective treatments. Neither approach, however, often does not reach the poorest sectors of society where they are most needed. Similarly, while developed country governments exhort citizens to eat a greater diversity of fruit and vegetables for their health, such policies do not appear to be common in developing countries. Agricultural biodiversity offers an alternative approach to

malnutrition and health, with additional important benefits for productivity, environmental sustainability and human and economic development. Examples will be presented of research to make greater use of agricultural biodiversity to increase dietary diversity, often using local diversity and addressing agronomic, social, marketing and other constraints. Much current agricultural research for development is focused on increasing major nutrients, such as protein and carbohydrate, at the expense of micronutrients. It will be argued that better nutrition and health would be just one outcome of more research into the wider use of agricultural biodiversity.

### Introduction

True food security is more than just calories and protein, the *quantity* of food produced. It is also about *quality*. People must have access to a diverse, balanced and preferred diet that includes adequate micronutrients and other essential components if they are to be considered food and nutrition secure.

These missing micronutrients constitute the problem of hidden hunger, which is still not sufficiently on the radar when talking about food security, and which affects roughly one person out of three. More than two billion people, mostly women and young children, suffer from various micronutrient deficiencies, which is not only directly debilitating but which also undermines the full development of the next generation. About 60% of child deaths worldwide are linked to poor nutrition, and the impact of poor childhood nutrition is felt throughout peoples' lives and in the offspring of undernourished mothers.

There is another side to malnutrition, which results in a situation that is often described as the double burden of malnutrition. This is the rapid

EMILE FRISON is Director General of Bioversity International, the world's largest international research organisation dedicated solely to the conservation and use of agricultural biodiversity. He has spent most of his career in international agricultural research for development, starting at the International Institute for Tropical Agriculture (IITA) in Nigeria in 1979. A plant pathologist by training, Dr Frison recently lead Bioversity, its stakeholders and partners in the formulation of a new strategic vision in which nutrition and agricultural biodiversity will play an important role in the overall goal of reducing hunger and poverty in a sustainable manner. He also leads the CGIAR system-wide Genetic Resources Programme and is a member of the CGIAR Genetic Resources Policy Committee, and of the Board of Directors of Ecoagriculture Partners.

growth in non-communicable diseases such as type-2 diabetes, obesity, cancers and cardiovascular diseases. These used to be referred to as diseases of affluence but increasingly they are affecting mostly poor people in developing countries; 80% of deaths associated with chronic ill-health and disease occur today in low- or middle-income countries and not in the industrialised countries. In the western Pacific, 70% of deaths are now caused by non-communicable diseases, which have overtaken by far all the infectious diseases combined. In Kiribati, for example, the rate of obesity in the population increased four-fold between 1981 and 2006, the latest date for which data are available.<sup>1</sup> More than four out of five adults in the population are overweight. The problems are not restricted to the present generation, as both underweight and overweight mothers have children that are themselves predisposed to nutritional and health of various kinds. Underweight children, for example, not only have problems in development; they may in turn, given access to sufficient food, tend to become overweight when they themselves are adults. (See, for example, Delisle 2008) The effect of poor nutrition thus transcends the generations.

Overall, the root causes of malnutrition—manifested both as underweight and overweight—are linked to what has been called the nutrition transition, a shift from diverse and nutritionally-complex diets to simplified diets based on a narrow range of foods that have often been treated to some sort of industrial processing. Almost everywhere around the world, the number of different food species that are used in diets, especially of the poorest people, has been greatly reduced: they eat the cheapest food available (Hawkes 2006).

## **Biodiversity provides options**

How can we address this issue? In the original strategies for tackling micronutrient deficiencies the World Health Organization and other actors in the nutrition community stressed that a food-based approach using more diverse diets was the long-term sustainable solution. More recently the dominant approaches have been more medically oriented, based on delivering specific nutrients through supplements or biofortified staples, but it

---

<sup>1</sup> These and other statistics are derived from the World Health Organization's Global InfoBase, [http://www.who.int/ncd\\_surveillance/infobase/en/](http://www.who.int/ncd_surveillance/infobase/en/)

is becoming clear that the pendulum is now starting to swing back to diversity in the diet (Mozaffarian and Ludwig 2010). The use of diversified agriculture to deliver those diverse diets also has other benefits and it is important to keep in mind that besides providing opportunities for better nutrition and health, agriculture based on greater diversity can provide greater resilience, adaptability and stability in production. In addition, of course, it provides opportunities for income generation (Frison *et al.* 2006; Johns and Eyzaguirre 2006).

Agricultural biodiversity refers to various levels that matter to farmers. Farmers use different ecosystems and different species of plants, animals and fish. In addition to these two levels of diversity, the organisms themselves have genetic diversity that is reflected in different varieties and breeds and in the differences among individuals within populations. Furthermore, agricultural biodiversity refers not only to species that are directly used for production but also to those species that support production in the agro-ecosystem, like soil microbes and pollinating insects.

## **Poor food, good food, successful projects**

There are many examples of the increased consumption of oils, fats and refined sugars over the past few decades (Beare-Rogers *et al.* 1998). In Senegal, for instance, the energy derived from fats and oils in the diet increased 2.5 times over a period of 25 years. Worldwide there has been a reduction in use of and access to traditional and indigenous food. Many poor people, for example in Africa, used to rely to a large extent for their micronutrients and vitamins on small quantities of food harvested from the wild. This contribution has become less significant especially as people move into the cities. The cheapest food available in urban areas is usually a form of processed major cereal, sometimes brought into countries as food aid, and often fried with sugar or salt; this food is energy rich but nutrient poor. It satisfies immediate hunger, while the impact of poor nutrition is delayed. In addition social pressures, including images of backwardness associated with traditional food, have been significant. All these various factors and others have to be tackled simultaneously in efforts to use dietary diversity to tackle malnutrition.

Bioversity implemented a project in Kenya, in cooperation with Family Concern (an NGO) and Uchumi Supermarkets, to reintroduce traditional African green leafy vegetables (Gotor and Irungu 2010). Traditionally, Kenyans ate more than 200 different species of traditional leafy vegetables, and these may have 10 or even 100 times more micronutrients, such as iron, calcium and beta-carotene, than the cabbage and kale available in Nairobi markets. By improving seed supply (training farmers to specialise in seed production) and agronomy, training producers to present cleaner, high-quality produce, and consumer education (with leaflets and public events), sales increased from 30 to 400 tons per month over three years and incomes of producers rose 2–20-fold. Demand in the city now far exceeds supply and further opportunities remain.

Small-holder farmers in Africa cannot live on the produce of half a hectare if they focus on a staple crop like rice or maize or even a root crop. Bioversity is now following up the impact of the Kenyan project by comparing data from villages where production and consumption have been promoted by several different kinds of intervention with those from similar villages where there have been no interventions. An obvious early observation was that during the serious Kenyan drought of 2008 and 2009, when the maize crop failed almost completely in that part of the country, farmers growing these vegetables were better off than those that were not (P. Maundu, *pers. comm.* 2010). The study also includes assessments of peoples' health, and there are preliminary indications of lower levels of anaemia in the populations that are producing and consuming traditional African leafy vegetables.

To further popularise these traditional foods, the project has been working with chefs of the most famous restaurants in Nairobi to prepare new recipes, and the vegetables have been served in the canteen of Kenya's parliament. In a clear indication that changes in attitude and behaviour can be achieved, people have begun to take pride in their traditional food systems, instead of shunning them as backward and primitive. We should not accept that we cannot do anything about food preferences: education and improved choice make it possible to really change food habits.

Of course African leafy vegetables are not transposable everywhere in the world, and that is not the intention of such research. However, the approaches and methodology are transposable,

and these are a global public good. Bioversity has undertaken similar research with small millets in southern India with the M.S. Swaminathan Research Foundation (Bala Ravi *et al.* 2010; Shanthakumar *et al.* 2010; Vijayalakshmi *et al.* 2010; Yenagi *et al.* 2010) and with Andean grains such as amaranth and quinoa in Bolivia, with the farmers' group called PROINPA (Rojas *et al.* 2009.) In both, as in Africa, the projects work along the whole chain from production to transformation to consumption, involving local entrepreneurs to add value and making use of species that are well adapted to the environment in which they are grown.

## Action in the Pacific

The Pacific is a high priority for the donor agencies in Australia. Some projects in this region have already started to look at local diversity and the contribution it can make to addressing vitamin deficiencies. (See, for example, Englberger *et al.* 2005). Vitamin A is particularly important, and in Pohnpei (one of the four states in the Federated States of Micronesia) the use of some varieties of pandanus, which are rich in beta-carotene, has been encouraged in order to provide necessary supplies of pro-vitamin A (Fig. 1). Several Pacific varieties of banana also have very high levels of this compound—a variety called Karat has a higher level of beta-carotene than the yellow-fleshed sweet potato that is often advertised (Englberger *et al.* 2006). This research, too, has global implications. For example plantains, or cooking bananas, are a major staple in Cameroon and elsewhere in West Africa. Bioversity and partners have been scouring collections of plantain diversity in search of high beta-carotene varieties in the preliminary steps of a project that will work to lessen vitamin A deficiency there (Davey *et al.* 2009).

## Action in Russia

Bioversity is also working with colleagues in Russia and Luxembourg on the Pavlovsk collection of more than 5700 different fruit varieties. The collection dates back to 1926, when the great Russian plant explorer and scientist Nikolai Vavilov was one of the most important and influential scientists in the Soviet Union. Recently, the collection at Pavlovsk has been threatened by housing developers who would like to send in the bulldozers to take out the entire collection. Our



Children need about 600 µg β-carotene per day; adults need about 800 µg per day; more if breastfeeding  
 Pandanus fruit:  
 – four species; more than 180 varieties  
 – 14–1000 µg β-carotene per 100 g fruit

**Figure 1.** Some pandanus are a rich source of provitamin A

collaborative project is analysing the nutritional properties of some of the fruits and vegetables in the Vavilov Research Institute’s collection. The research is intended to inform a food-based approach to problems of malnutrition, taking a broad approach while at the same time focussing on local biodiversity so that when appropriate species or varieties may be introduced from other areas. This holds most promise for sustainably addressing the problem. And while the project began before the current threat to the collection materialised, the preliminary results, showing very high levels of anti-oxidants in some varieties, underscore the need to preserve such collections for their long-term value.

## Conclusion

As mentioned earlier, the first strategies proposed by global advocates to respond to malnutrition focused on the dietary diversity encompassed in food-based approaches, although these were

subsequently overtaken by more simplistic and inherently unsustainable solutions that focused on supplying individual specific micronutrients that were lacking. Increasingly of late the nutrition community is once again recognising the need to move back to a food-based approach. Bioversity’s key objectives and contribution to this effort are to enhance food and nutrition security and thereby the health and livelihoods of poor people, ensuring traditional resiliency of food and ecosystems by using a broader range of diversity.

There is plenty of evidence, much of it anecdotal in nature, that this is the right approach. At Bioversity we have been building a broad range of partnerships that include researchers at national and international levels, and governments and government agencies, bringing agricultural and health departments together. We are building a solid base of evidence, and demonstrations of what really works on the ground, to inform policy-makers and convince large investors like the World Bank to support this food-based approach to malnutrition. In the end it is as important to obtain policy changes at the national level as it is to create the conditions and knowledge that will permit farmers and their customers to enjoy all the many benefits of the more diverse diets that agricultural diversity can deliver.

## References

- Bala Ravi, S., *et al.* 2010. Mobilizing neglected and underutilized crops to strengthen food security and alleviate poverty in India. *Indian Journal of Plant Genetic Resources* **23**, 110–116.
- Beare-Rogers, J. *et al.* 1998. Dietary fat in developing countries. *Food and Nutrition Bulletin* **19**, 251–267.
- Davey, M.W. *et al.* 2009. Genetic variability in *Musa* fruit provitamin A carotenoids, lutein and mineral micronutrient contents. *Food Chemistry* **115**, 806–813.
- Delisle, H.F. 2008. Poverty: the double burden of malnutrition in mothers and the intergenerational impact. *Annals of the New York Academy of Sciences* **1136**, 172–184.
- Englberger, L. *et al.* 2005. An NGO approach for addressing the nutrition dilemma: Pohnpei focuses on awareness, food analysis, conservation, and food processing. *Pacific Health Dialog* **12**, 79–84.
- Englberger, L. *et al.* 2006. Carotenoid and vitamin content of Karat and other Micronesian banana

- cultivars. *International Journal of Food Sciences and Nutrition* **57**, 399–418.
- Frison, E.A. *et al.* 2006. Agricultural biodiversity, nutrition, and health: making a difference to hunger and nutrition in the developing world. *Food and Nutrition Bulletin* **27**, 167–179.
- Gotor, E. and Irungu, C. 2010. The impact of Bioversity International's African Leafy Vegetables programme in Kenya. *Impact Assessment and Project Appraisal* **28**, 41–55.
- Hawkes, C. 2006. Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Globalization and Health* **2**, 4.
- Johns, T. and Eyzaguirre, P.B. 2006. Linking biodiversity, diet and health in policy and practice. *Proceedings of the Nutrition Society* **65**, 182–189.
- Mozaffarian, D. and Ludwig, D.S. 2010. Dietary guidelines in the 21st century—a time for food. *JAMA (The Journal of the American Medical Association)* **304**, 681–682.
- Rojas, W. *et al.* 2009. From neglect to limelight: issues, methods and approaches in enhancing sustainable conservation and use of Andean grains in Bolivia and Peru. *Agrobiodiversity and Genetic Erosion, Contributions in Honor of Prof. Dr Karl Hammer. Supplement* **92**, 87–117.
- Shanthakumar, G. *et al.* 2010. Participatory varietal selection: a case study on small millets in Karnataka. *Indian Journal of Plant Genetic Resources* **23**, 117–121.
- Vijayalakshmi, D. *et al.* 2010. Empowerment of women farmers through value addition on minor millets genetic resources: a case study in Karnataka. *Indian Journal of Plant Genetic Resources* **23**, 132–135.
- Yenagi, N.B. *et al.* 2010. Nutritional and technological advancements in the promotion of ethnic and novel foods using the genetic diversity of minor millets in India. *Indian Journal of Plant Genetic Resources* **23**, 82–86.