

Industry note: The World Vegetable Center

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Biographical notes: Marco Wopereis joined the World Vegetable Center as Director General in April 2016 and is based in Taiwan. He is an agronomist with a Doctorate in Tropical Agronomy from Wageningen University, The Netherlands. Since October 2020 he is Chair of the Association of International Research and Development Centers for Agriculture (AIRCA).

1 Quick facts

The World Vegetable Center (WorldVeg), formerly known as the Asian Vegetable Research and Development Center (AVRDC), was founded in 1971 by the Asian Development Bank, Japan, Korea, the Philippines, Thailand, the USA, Vietnam and the Republic of China (Taiwan). WorldVeg is an international, inter-governmental, non-profit institute for vegetable research and development. The centre mobilises resources from the public and private sector, operates with an annual budget of about US\$23M (2019), and employs about 400 staff.

WorldVeg is the only international research centre with an exclusive focus on vegetables. It holds the world's largest public-sector collection of vegetable seed, an international public good, with more than 61,000 accessions and 440 species represented. It also holds Africa's largest collection of traditional vegetable seed. WorldVeg runs a global research network from its headquarters in Taiwan with five regional offices:

- Headquarters (Shanhua, Taiwan – established in 1971)
- East and Southeast Asia (Bangkok, Thailand – 1992)
- Eastern and Southern Africa (Arusha, Tanzania – 1992)
- South Asia (Hyderabad, India – 2006)
- West and Central Africa – Dry Regions (Bamako, Mali – 2014)
- West and Central Africa – Coastal and Humid Regions (Cotonou, Benin – 2017).

WorldVeg is a founding member of the Association of International Research and Development Centers for Agriculture (AIRCA) and is committed to achieving the UN Sustainable Development Goals.

2 Mission

WorldVeg builds quality partnerships in research and development to increase the production and consumption of safe, nutritious and health-promoting vegetables for faster, greater and lasting positive impact on the nutritional status, incomes, and well-being of people, particularly youth and women in Africa and Asia. Its mission is ‘Research and development to realise the potential of vegetables for healthier lives and more resilient livelihoods’.

3 Why vegetables?

High rates of malnutrition challenge the health of people worldwide. Undernutrition and micronutrient deficiencies often coexist with overweight, obesity or diet-related non-communicable diseases within the same country or even within the same household, particularly in urban settings. Vegetables can contribute to alleviate malnutrition problems. They are essential sources for the micronutrients needed for healthier diets. The World Health Organization (WHO) recommends a minimum intake of 400 g of fruits and vegetables per day to prevent chronic diseases and to supply needed micronutrients.

Vegetables also provide an important economic opportunity to reduce rural poverty and unemployment, particularly if rural and peri-urban farming can be linked to rising urban demand for quality vegetables. The vegetable sector generates more income and jobs per hectare, on-farm and off-farm, than most other agricultural enterprises.

However, neither the nutritional nor the economic potential of vegetables is sufficiently realised because of the prevailing and longstanding bias among governments and donors towards staple food crops (Schreinemachers et al., 2018). Rapid population growth, in particular in Sub-Saharan Africa and South Asia, combined with urbanisation is making it even more urgent to focus attention on the vegetable sector. For example, Africa’s 1.1 billion citizens will likely double in number by 2050, and more than 80% of that increase will occur in cities, adding many more mouths to feed with nutritious, safe and affordable food. Climate change is complicating matters further as vegetables are highly sensitive to environmental extremes. Among the various stress factors caused by climate change, high temperature, drought, waterlogging, salinity and emerging infectious diseases and pests are the major ones that reduce the productivity and quality of vegetables.

4 Strategy and flagship programs

In 2016–2017, WorldVeg staff, board members, and partners based in Africa and Asia embarked on a series of meetings and discussions to develop a new strategy that better orients the centre to realise the immense potential of vegetables to improve nutrition and incomes. This work resulted in a new strategy for 2017–2025 entitled ‘Healthier lives, more resilient livelihoods’ (World Vegetable Center, 2017).

The strategy introduces a new structure in which discovery research, piloting innovations, and scaling best technologies and practices continuously inform and improve the centre's work and impact. The centre implements its science for development agenda through three outcome-oriented flagship programs: 'safe and sustainable value chains', 'healthy diets' and 'vegetable diversity and improvement' and one cross-cutting flagship program: 'enabling impact'. These flagship programs are based on relative strengths, identified trends, and potential for impact. They bring together WorldVeg staff and partners from the public and private sector, from research and development organisations, and from farmer organisations and civil society. The flagships are gateways to achieving outcomes and impact and each is operationalised through two to four 'innovation clusters'. Innovation clusters are teams of WorldVeg staff and partners working towards a clear and measurable set of outcome targets through discovery, piloting, and scaling activities and continuous improvement of a coherent set of products and services. This is not a linear, predictable process moving from ideas to application to impact, but rather an iterative pathway to impact with numerous feedback and feedforward loops allowing for unexpected outcomes and trajectories.

5 What we do

The WorldVeg is working with public and private sector partners on both demand (nudging consumers towards healthier diets) and supply (enhancing availability and affordability of safe, locally produced vegetables). This requires a thorough understanding of dietary gaps and consumer behavior, food environments, food supply chains and external drivers, such as climate change, urbanisation, youth unemployment and migration.

WorldVeg research provides small-scale farmers with the knowledge, skills, technologies, and opportunities to boost their vegetable yields and increase their incomes whilst respecting the environment and promoting food safety. Our activities aim to strengthen the entire vegetable value chain to unleash the economic and nutritional power of vegetables, from breeding and vegetable seed systems to market access and awareness of the need for a healthy diet. WorldVeg has a long history of conservation of vegetable germplasm, successful breeding of both global and traditional vegetables, and development of production technologies that support the growth of vegetables on a rural to urban gradient, from home gardens aimed at family nutrition to intensive market-oriented vegetable farming (Schreinemachers et al., 2018).

6 Improving on-farm productivity

WorldVeg and partners pilot and scale safe and climate-smart production practices, such as low-cost irrigation scheduling tools, soil moisture retention (e.g., net shading, mulching), crop rotation, integrated pest and disease management (IPM) and protected cultivation techniques, particularly for seedling nurseries. Digital traceability and decision-support systems and sensors are used to track and enhance the efficiency of water, fertiliser and bio-pesticide use, including rapid recognition of pests and diseases and nutrient deficiency symptoms through mobile phone applications. IPM practices include resistant varieties, soil solarisation (sterilisation), biological control agents

(including microbial pesticides), botanical pesticides, pheromones and sticky traps. Vegetable grafting is promoted, in particular for tomato using eggplant rootstocks resistant to soil-borne diseases, nematodes and flooding. Best-bet knowledge and technologies are combined into baskets of good agricultural and water management practices ('GAP baskets') per major group of vegetables with farmers and communicated widely through ICT-based knowledge exchange, field demonstrations, group training and use of multimedia. GAP baskets raise productivity levels, reduce reliance on chemical pesticides and fertilisers, improve food safety, and extend the vegetable growing season.

7 Reducing postharvest losses

WorldVeg and partners pilot and scale postharvest and processing technology to reduce loss, add value, enhance nutrition, and promote food safety. Particular attention is paid to ensure women and youth have access to these innovations. Examples include monitoring pesticide residue and microbial contamination along the vegetable value chain; improved storage facilities; evaporative cooling technologies; cold rooms equipped with solar panels; hermetic storage bags and edible coating technologies to extend the shelf-life of fruit and vegetables. Improved crates and containers are also introduced to reduce losses during handling and transportation. Low-cost equipment for fruit and vegetable processing add value and reduce postharvest losses. Establishment of collectively managed packhouse space to sort, clean, label, pack and store vegetable produce helps to harmonise production and marketing, substantially decreasing postharvest losses.

8 Seed systems development

In Asia, WorldVeg has built strong public and private partnerships to advance characterisation and use of its unique vegetable germplasm collection in vegetable breeding and seed systems development. WorldVeg products that are developed, piloted and scaled include: pre-breeding lines and populations, markers for marker-assisted selection, improved inbred lines and hybrids, protocols for phenotyping targeted at disease and insect resistance screening, quality and nutrient content analyses, and scientific information targeted to different audiences, all of which are valued by end-users in the formal seed sector. The focus is on tomatoes, peppers, cucurbits, vegetable legumes, onions, and rootstocks for grafting.

WorldVeg breeding teams at WorldVeg headquarters and the regional centres in Asia work closely with farmers, vegetable seed companies, national agricultural research and extension systems and advanced research institutions to develop improved vegetable varieties (e.g. in terms of abiotic or biotic stress tolerance/resistance, enhanced shelf life) and facilitate their uptake by farmers through formal and informal seed sectors and in some situations through emergency seed programs. A consortium of seed companies of the Asia-Pacific Seed Association (APSA) and WorldVeg (as of January 2020, 43 seed companies have joined) is an important research and scaling partner in Asia, especially for solanaceous and cucurbit crops. In 2019, companies reported to have incorporated WorldVeg germplasm in 45 varieties and 9.5 tons of seed (mostly chili and tomato). Public and private sector partners are also collaborating with WorldVeg to develop

sustainable seed systems for mungbean in Asia and Africa through the International Mungbean Improvement Network (IMIN) convened by WorldVeg.

In Africa, virtually all of the vegetable seed is of local landraces or cultivars that were introduced decades ago. Little has been done to improve and adapt vegetable varieties to the continent's diverse and changing climates. Seed mostly originates from informal non-certified sources and is often of poor quality. Poor seed germination and non-uniformity of seed are often reported as major constraints. Certified seed, if available, is mostly imported from Europe and may not have been tested for local growing and market conditions. For example, most tomato varieties used in Nigeria are not well suited for industrial processing. WorldVeg is taking an active role to build R&D capacity in vegetable breeding and allied disciplines, joint development of hybrids and inbred line cultivars, and strengthening the large-scale seed production capability of selected companies with technical staff, capital, land and infrastructure that are willing to invest in breeding R&D. WorldVeg has established a consortium with seed companies active in Sub-Saharan Africa in collaboration with the African Seed Trade Association (AFSTA), similar to the one established in 2016 with APSA. As of January 2020, nine seed companies have joined the African Vegetable Breeding Consortium (AVBC). WorldVeg is co-organising the first all-Africa summit on traditional African vegetables in May 2020 in Tanzania. This is seen as the start of an important multi-partner effort to get traditional, sturdy and nutrient-dense African vegetables back in farmers' fields and on people's plates.

9 Impact highlights

In India, impact studies show that nearly 15% of tomato and chili pepper seed of commercial hybrids contain WorldVeg material, benefiting an estimated 500,000 farmers.

Two-thirds of Myanmar's mungbean farmers plant Yezin 11 and Yezin 14, two virus-resistant varieties developed by WorldVeg. Together, these two varieties benefit about 425,000 farm households in the country. An estimated 1.5M farmers have adopted WorldVeg mungbean varieties in Asia, on about 60% of the total area planted to mungbean (2M ha).

In Tanzania, WorldVeg introduced improved varieties of tomato (in the 1990s) and African eggplant (early 2000s). Both have gained large shares of the domestic market, leading to sizeable returns on investment of 26% for tomato and 12% for eggplant and economic gains of US\$255M for tomato and US\$5M for African eggplant (as of 2014).

WorldVeg's improved amaranth varieties have reached 231,000 farm households in Kenya and Tanzania.

10 Conclusions

The world is facing high rates of malnutrition within the same country or even within the same household, particularly in urban settings. Important income and employment opportunities exist for vegetable farmers near urban centres if they can link with urban demand for quality and nutritious food. There is an urgent need for increased attention to

the vegetable sector to achieve favorable and lasting dietary, economic and environmental outcomes at scale.

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