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# Tapping the nutritional power of vegetables

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## Abstract



Vegetables add diversity, flavour and nutritional quality to diets and provide greater profits and employment per hectare than cereals. On-farm productivity of vegetables in low-income tropical and subtropical countries is generally low and highly variable. Public-private sector networks are crucial for piloting and scaling-up innovations to raise productivity in a safe and sustainable manner – including varietal improvement, pest and disease management, and protected cultivation – and to reduce postharvest losses. The nutritional power of vegetables can be tapped on an intensification gradient, from home gardens aimed at family nutrition to intensive market-oriented vegetable farming to address the growing demand for vegetables at affordable prices. Home garden interventions in Africa and Asia that combined training in vegetable production with communication activities targeting nutrition and health behaviours increased vegetable consumption among rural households vulnerable to micronutrient deficiencies. Less is known about the effectiveness of sack and vertical gardens in urban slums. Training and linking youth with markets for quality vegetables in East Africa showed promise in creating income and employment. Training farmers in off-season tomato production in Bangladesh led to dramatic income improvements but also increased pesticide use. Evidence from Tanzania highlights the market potential of often neglected nutrient-dense indigenous vegetables, such as amaranth and African eggplant. The effect of farm diversification on dietary diversity of farming households seems small, with market access being more important. To tap the nutritional power of vegetables, governments and donors must give greater priority to the vegetable sector through a combination of supply and demand (behaviour change) interventions.

This presentation about vegetables and nutrition first outlines some of the diversity in vegetables, because they do not all have the same nutritional power. Then it discusses how to mobilise that power for rural and urban consumers.

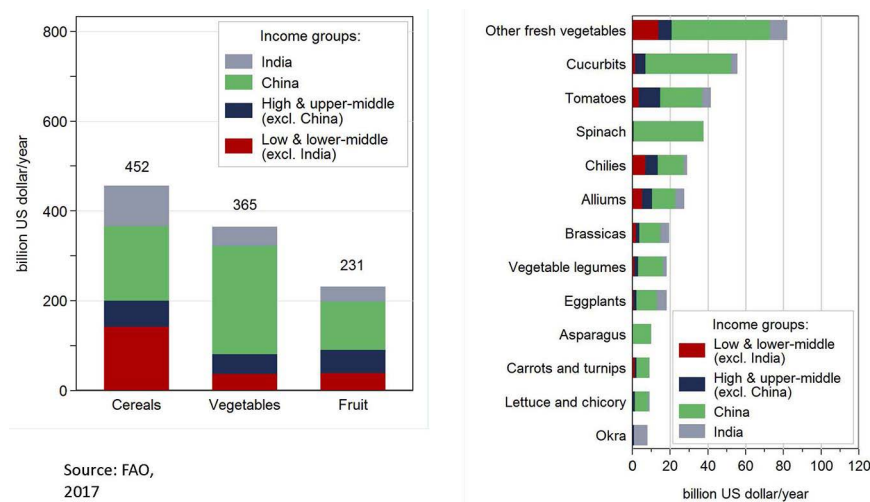
## Vegetable production and nutritional power

Vegetable production in Asia is big business. The farm-gate value of vegetable production is about US\$365 billion – not far below the value of cereal production (Figure 1). The biggest contributors (grey and green in the chart) are India and China.

These statistics, collected by FAO, deal mainly with global vegetables, listed in the right-hand chart: tomatoes, cucurbits, chillies, alliums, ..., lettuce, okra.

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This paper has been prepared from a transcript and the illustrated slides of the presentation.



**Figure 1.** Vegetable production in Asia – big business.


There are also many traditional vegetables. Figure 2 shows seven vegetables that are traditional in East Africa: for example, amaranth, African nightshade, Ethiopian mustard. These are very important in rural areas, where they provide a lot of flavour and diversity to people's plates.

The traditional vegetables are important because they are very rich in nutrients. For comparison, Figure 3 shows the nutritional value of cabbage (grey column) compared to the nutritional values of some of these traditional vegetables. The micronutrient content of these four traditional vegetables is clearly much higher



**Figure 2.** Traditional vegetables in East Africa.

Micronutrient content of common and traditional vegetables



	Ranges	Cabbage	Moringa	Amaranth	Aibika	Sweet potato leaf
$\beta$ -Carotene, mg	0.0 - 22	0.00	15.28	9.23	5.11	6.82
Vit C, mg	1.1 - 353	22	459	113	82	81
Vit E, mg	0.0 - 71	0.05	25.25	3.44	4.51	4.69
Iron, mg	0.2 - 26	0.30	10.09	5.54	1.40	1.88
Folates, $\mu$ g	2.8 - 175	ND	93	78	177	39
Antioxidant activity, TE	0.6 - 82,000	496	2858	394	560	870

Source: WorldVeg Nutrition Lab

Figure 3. Traditional vegetables: robust and rich in nutrients.

than that of cabbage. Growers can also make money out of these traditional vegetables, with urban consumers rediscovering them.

Figure 4 presents data from 250 farmers WorldVeg worked with in Tanzania. Traditional vegetables are as profitable as tomato, and vegetables in general are much more profitable than maize. This result illustrates the market potential of

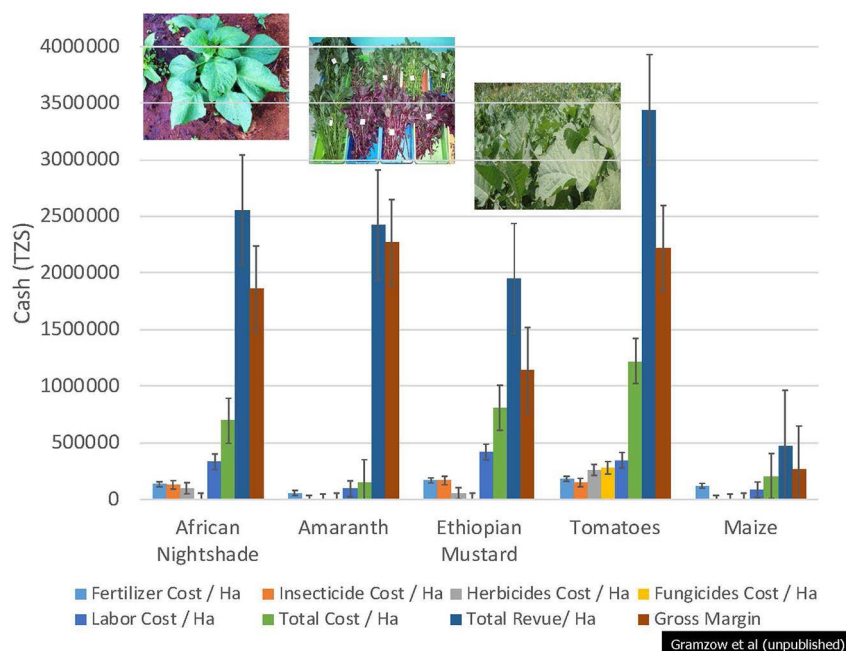


Figure 4. Costs and returns to growers for four vegetables compared to maize.

these often forgotten crops. Moreover, growing traditional vegetables requires less herbicide and fungicide than growing tomatoes (Figure 4).

The World Vegetable Center’s public collection of vegetables comprises about 60,000 accessions from 150 countries, covering 400 species, but sadly only about 5% of that collection covers traditional vegetables, at present.

### Mobilising the nutritional power of vegetables for rural consumers

Figure 5, by the Global Panel on Agriculture and Food Systems for Nutrition (2016), presents consumption patterns of different income groups along a rural-to-urban gradient in Africa. Rural consumers mostly derive food from their own production, with an increasing share from purchased food as income grows.

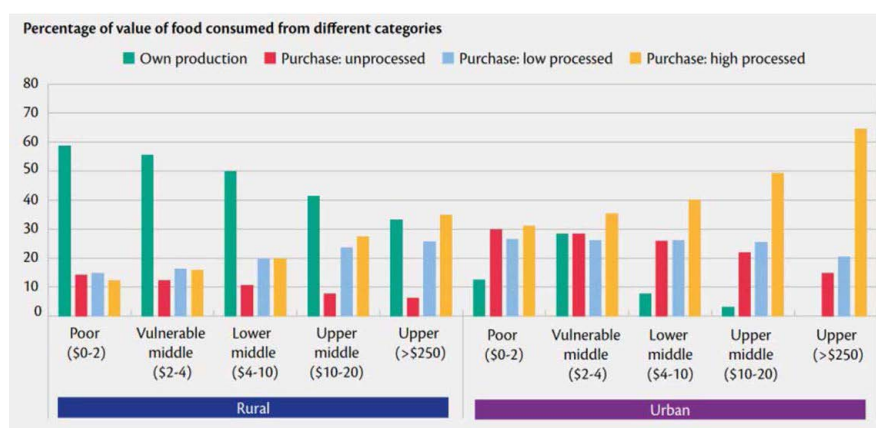
The World Vegetable Center, mainly through USAID funding, has been working with vulnerable households in rural areas in Africa and Asia to help them to grow their own vegetables throughout the year. We work mainly with women (Figure 6), teaching them how to grow vegetables near their homes. These areas (‘household gardens’) usually measure about 35–40 m<sup>2</sup>, enough to feed a family of four.

The impact pathway of our household garden work is indicated in Figure 7.

We link women with seed suppliers, to ensure continued supply of good quality vegetable seed. To motivate them to produce and consume vegetables we provide them with nutrition and health messages, emphasising the importance of sanitation and hygiene and the significance of different vegetables for their families’ nutrition status, and we teach them how to prepare and cook the vegetables in a way that retains nutrients.

### Evidence of rural successes

In north-west Cambodia (Figure 8) 45% of children under five are stunted. We have worked with USAID funding (‘Feed the Future’) in this region since 2016, with about 3000–4000 households. Figure 9 shows that about 80% of the

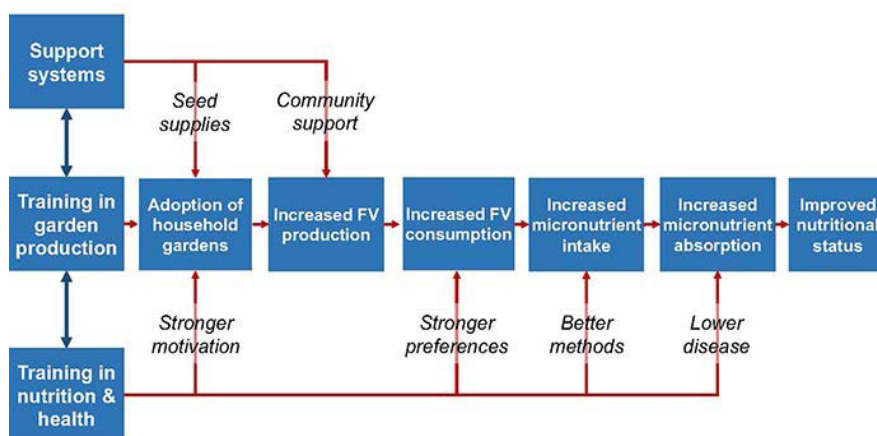


**Figure 5.** Consumption patterns of different income groups in rural & urban areas of Africa (Global Dietary Database; Global Panel on Agriculture and Food Systems for Nutrition 2016).





**Figure 6.** Some of the women being trained by the World Vegetable Center, in their household gardens around the world.



**Figure 7.** The impact pathway of World Vegetable Center's integrated household gardens approach.

produce of these gardens is consumed by the families, and about 20% is sold. In monetary terms, this represents a gain of \$18 per month from not needing to buy vegetables in the market, and \$5 from selling produce: in total a benefit of about \$23 per month.

We are currently conducting randomised controlled trials in Africa and Asia in similar projects. This should enable us to have a good idea of what this type of intervention means for diet diversity in these different families, in particular for children under five.

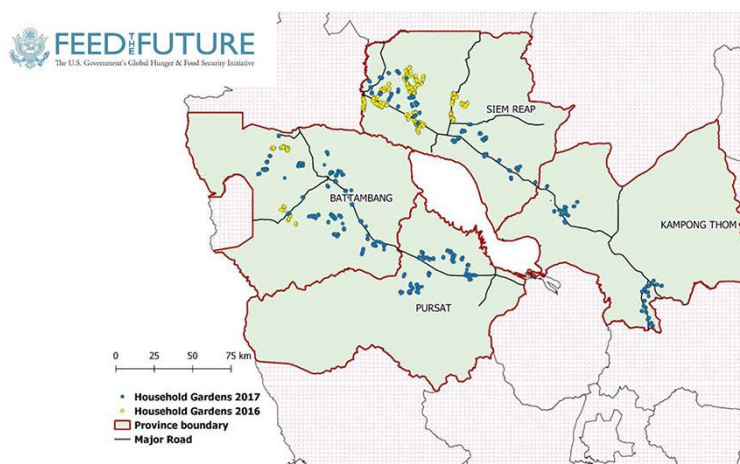


Figure 8. The spread of household gardens in NW Cambodia between 2016 and 2017.

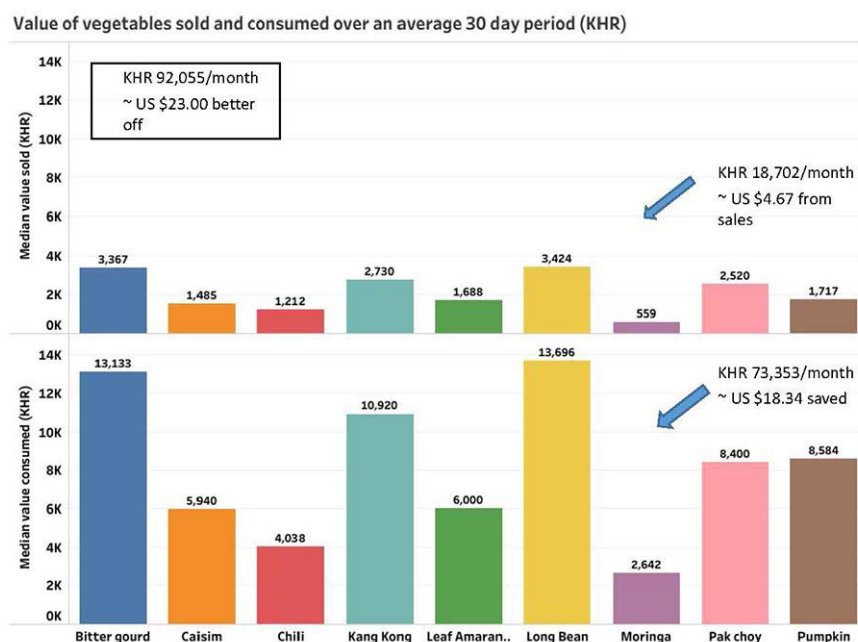


Figure 9. Exploratory analysis – income calculation comparing nine vegetables grown in household gardens, sold and consumed in NW Cambodia.

### Mobilising the nutritional power of vegetables for urban consumers

In urban settings in Africa, only the two lowest income groups still produce some of the food they consume (Figure 5). For these families it may be possible to tackle malnutrition through urban gardens.



**Figure 10.** Potential vegetable garden methods for slums.

There are challenges in growing vegetables in slums: lack of space; poor quality water and lack of water in general. The World Vegetable Center is considering taking on this challenge in the future. Some proven household garden technologies in rural areas could be adapted to urban slum settings (Figure 10): such as sack gardens or container gardens, which need relatively little land and water per unit yield; raised bed gardens and community (group) gardens, rotating scarce labour and potentially using low cost drip irrigation (US\$20/set).

However, most urban consumers buy their vegetables in informal and formal markets, and that situation offers good opportunities for peri-urban farmers to sell their produce. With Australian funding, WorldVeg has trained young farmers in East Africa to produce vegetables for specific markets, such as restaurants, hotels, supermarkets and even for export to Europe. Training (one day a week for a period of six months) involves improving agronomic skills, but also strengthening collaboration among young farmers and enhancing their access to finance and other inputs, in particular seeds.

In Tanzania, WorldVeg and Catholic Relief Services (CRS) have trained six groups of between 30 and 40 young people, two of which have contracts to supply fresh vegetables to export markets. These 'youth vegetable business hubs' are supplying to relatively high-end markets.

To link farmers to urban consumers who use informal and semi-formal markets, WorldVeg has developed the 'pack house model'. The pack house is a simple roofed facility, equipped with a coolbot\* where the farmers' produce is delivered, washed, sorted, weighed, labelled, and can be stored under cool conditions. Using this space, farmers are able to harmonise production and marketing and reduce post-harvest losses substantially.


Food safety issues when producing vegetables for urban markets are of great importance. This is illustrated with an example from Bangladesh (Table 1). In

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\* see <https://horticulture.ucdavis.edu/coolbot>



**Table 1.** Impact of training in off-season tomato production on income and pesticide use, Bangladesh, 2014.

Outcome indicator	Average treatment effect	Significance	% increase	
Total income (USD/capita)	85.9	p<0.05	50.5	
Pesticide use (kg/ha)	2.0	p<0.05	58.4	

Notes: Based on propensity score matching, n=245 (94 trained, 151 control).  
Evaluation conducted 2 years after the training.

2014, WorldVeg worked with Bangladeshi farmers to help them capture very good tomato prices by growing tomatoes in the off-season. We introduced disease-resistant varieties, integrated pest management (IPM) methods (including sticky traps and pheromones) and rain-out shelters and nets (image above). The project was successful in raising farmers' income by 51% but, controversially, pesticide use went up by 58%. IPM methods were not being adopted by the farmers because pesticides are cheap in Bangladesh and easy to get, contrary to IPM technology. Farmers increased pesticide use substantially because they did not want to lose any of their harvest. In fact, they used pesticides as an insurance policy, having put so much effort into the operation.

## Conclusion

Vegetables have tremendous nutritional power. To tap that power for both rural and urban consumers, governments and donors must give greater priority to the vegetable sector through a combination of supply and demand (behaviour change) interventions.

## References

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- Global Panel on Agriculture and Food Systems for Nutrition. 2016. *Food systems and diets: Facing the challenges of the 21st century*. London, UK.  
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Marco is a Dutch national and holds a PhD degree in tropical agronomy from the Wageningen University, Netherlands. He is the Director General of the World Vegetable Center and based in Taiwan. Prior to his current position he served as the deputy director general of the Africa Rice Center (AfricaRice, Benin). He also worked for the French Agricultural Research Centre for International Development (CIRAD, France), the International Fertilizer Development Center (IFDC, Togo), the West Africa Rice Development Association (WARDA, Senegal, Côte d'Ivoire) and the International Rice Research Institute (IRRI, Philippines).