Globally, RTB crops are of particular importance to the poorest households in developing countries (Wiebe et al., 2020). They enhance the resilience of food systems, and increase food availability and diversity, especially during hunger periods or in the event of failure or damage to cereals during extreme weather events. Through biofortification, RTB crops can contribute to reducing widespread micronutrient deficiencies of vitamin A (VA), iron (Fe) and zinc (Zn), particularly in young children and women of reproductive age.

In the humid tropics in Africa, RTB crops are the most important staple and culturally preferred. The contribution of foods derived from RTB crops to calorific needs ranges from 25% in Nigeria to 57% in the Democratic Republic of Congo. Populations are growing rapidly in SSA. By 2050 just these six countries (Table 1) are projected to have a combined population of 0.81 billion (UNDP, 2019). The number of people involved in RTB-dominated agri-food systems could more than double by the end of the 21st century—most of it in SSA. Preferences for RTB crops and population growth mean that Africa commands a rising share of area under these crops in developing countries (Table 2).

Yet, low productivity means production of RTB crops in SSA does not satisfy basic food security needs in rural areas and is often uncompetitive with imported staples for urban consumers, resulting in missed smallholder income opportunities. As people move to cities, value chains for RTB crops need to be reconfigured to improve efficiency and convenience and reduce post-harvest losses to compete with imports.
Outside of the humid tropics in Africa and in most of Asia and Latin America, RTB crops are generally important in rotations with cereals or legumes, as part of agroforestry systems, such as bananas and coffee, or as secondary crops. In this way they contribute resilience, increase efficiency of cropping systems, provide key micronutrients in the diet, and generate off-season income.

Using the global partial equilibrium model IMPACT, future agricultural demand and supply for RTB crops were projected, considering future climate and socioeconomic changes. These forecasts predicted RTB crop production reaching 1,400 million tons (fresh produce) by 2050, a global increase of almost 50% from 2010, with Africa emerging as the world’s largest producing and consuming region (Petsakos et al., 2019).

Significant technological change will be needed to cope with climate change, especially in SSA, where RTB crops are of the highest importance (Thiele et al., 2017). Therefore, a key dynamic will be crop substitution, especially in areas where RTB crops can replace more sensitive cereals and legumes. Maize will be particularly vulnerable to higher frequencies of periodic drought, whereas production of cassava and sweetpotato can be more reliable. In addition, there are specific traits that make RTB crops particularly tolerant or resistant to abiotic stresses like heat, drought, soil salinity and water-logging, and shocks like typhoons/cyclones. For this reason, roots and tubers are important contributors to post-disaster recovery and mitigation due to the possibility of piecemeal harvesting, protection underground and short growing cycles (Prain and Naziri, 2020).

Considering the wide diversity of RTB crops, their significant roles in every major cropping system, and climate change trends, RTB research can contribute in multiple ways to the Sustainable Development Goals (SDGs).

**SDG 1: No poverty**

Because RTB crops are more perishable and bulkier than cereals, they create opportunities for value addition and employment in post-harvest and processing in rural areas, especially for women. Providing growing urban populations with RTB crops-based food will require extensive transformation of current technology to capture these benefits. But unless gender roles and needs are considered, innovation can worsen gender inequity (Sarapura, 2012). Increasing opportunities for women can have a powerful impact on productivity and agriculture-led development, and reduce gender disparities in access to inputs, assets, opportunities, information, and other resources (Margolies and Buckingham, 2013; FAO, 2014).

Investment in RTB crops compared to cereals has lagged, slowing yield growth. RTB crops offer high potential yields, but farmers often realize less than half potential due to poor quality planting material of limited genetic potential, biotic and abiotic constraints, and poor management practices. Bottlenecks in markets and policy further restrain willingness to invest in yield-increasing input intensification. Where market conditions are favorable and appropriate new technology available, yield gains have been considerable, as in Southeast Asia for cassava (Malik et al., 2020). In Africa, potato is grown increasingly as a cash crop for urban markets and showing consistent growth with the second highest rate of yield increase (after banana) of any crop over the last decade.

Recent adoption studies in SSA are grounds for optimism that yield gaps can be closed. In Nigeria, modern varieties of cassava are grown on 39.9% of area with a yield increase of at least 60%, bringing an estimated 1.6 million people out of poverty each year (Wossen et al., 2018). However, in general, adoption rates of modern varieties of RTB crops are below 40% so more investment in breeding and seed development, and Naziri, 2020

**Table 1.** Contribution of RTB crops to food intake in selected African countries in kilocalories (kcal) per capita (2017)

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (000s)</th>
<th>Grand total kcal</th>
<th>RTB foods kcal</th>
<th>% RTB foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Democratic Republic of Congo *</td>
<td>62,523</td>
<td>1,605</td>
<td>916</td>
<td>57</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>24,437</td>
<td>2,730</td>
<td>970</td>
<td>36</td>
</tr>
<tr>
<td>Ghana</td>
<td>29,121</td>
<td>3,033</td>
<td>1,430</td>
<td>47</td>
</tr>
<tr>
<td>Nigeria</td>
<td>190,873</td>
<td>2,464</td>
<td>622</td>
<td>25</td>
</tr>
<tr>
<td>Rwanda</td>
<td>11,981</td>
<td>2,215</td>
<td>1,046</td>
<td>47</td>
</tr>
<tr>
<td>Uganda</td>
<td>41,167</td>
<td>2,144</td>
<td>659</td>
<td>31</td>
</tr>
</tbody>
</table>


**Table 2.** Change in production, area, and yield for RTB crops in developing countries

<table>
<thead>
<tr>
<th>Crops</th>
<th>Production (million t)</th>
<th>Yield (t/ha)</th>
<th>% area in Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>21.1</td>
<td>47.5</td>
<td>112.9</td>
</tr>
<tr>
<td>Cassava</td>
<td>74.6</td>
<td>155.2</td>
<td>281.8</td>
</tr>
<tr>
<td>Plantain</td>
<td>13.4</td>
<td>25.5</td>
<td>38.7</td>
</tr>
<tr>
<td>Potato</td>
<td>28.8</td>
<td>80.2</td>
<td>225.7</td>
</tr>
<tr>
<td>Sweetpotato</td>
<td>93.1</td>
<td>122.4</td>
<td>88.6</td>
</tr>
<tr>
<td>Yam</td>
<td>8.6</td>
<td>22.1</td>
<td>72.9</td>
</tr>
</tbody>
</table>

systems is required (Thiele et al., 2020). Seed systems for RTB crops can be a particular challenge, as farmers can more easily share and retain planting material which lowers private sector seed company interest. Hence, some public sector seed system investment is usually required. RTB crops and their residues are finding increasing uses in animal feed including high quality cassava peels which is being taken to scale in Nigeria with interest elsewhere in SSA, and sweetpotato silage widely used in Asia and more recently validated and promoted in Uganda (Asindu et al., 2020). Cassava starch is particularly important for its specific functional properties and it constitutes the largest source of starch in tropical regions, improving small and medium scale processing technology is key to expanding the market in SSA (Chapus et al., 2016). Women's farm yields and incomes are typically much lower than men's, reflecting specific gender barriers affecting women's productivity: competing priorities (e.g., childcare) and limited access to information technology, land and markets (FAO 2014; Mudege et al., 2015). COVID-19 may be undoing recent progress on reducing gender gaps and compromising food and nutrition security (Doss, et al., 2020).

**SDG 2: Zero hunger and SDG 3: Good health and well-being**

With an average production of approximately 820 million tons on 64 million hectares (ha) in 2016–2018 (FAOSTAT, 2020), RTB crops represent the second most important set of crops in developing countries after cereals. The yield potential of RTB crops is very high, providing one of the cheapest sources of dietary energy (Lebot 2020). In 2017, RTB crops provided around 10% of the daily per capita calorie intake for the 864 million people living in least developed countries (Kennedy et al., 2019).

In SSA and Asia, hunger is still common. RTB crops can increase food availability and diversity, especially during hungry periods or in the event of failure or damage to cereals during extreme weather events. Furthermore, vitamin A deficiency (VAD) is widespread, contributing to increased risks of blindness, illness, and premature death, particularly in young children and pregnant/postpartum women. Globally, 163 million children under five years of age are vitamin A deficient and prevalence rates of Fe and Zn deficiencies are even higher. Orange-fleshed sweetpotato (OFSP) is a proven biofortified crop: 100 g/day can meet the vitamin A requirements of a young child, and 6.2 million households (HH) have been reached with improved sweetpotato varieties – mostly OFSP – across 15 African countries (Low and Thiele, 2020). HarvestPlus and its partners delivered cassava varieties enriched with vitamin A to more than one million farming households in Nigeria and the Democratic Republic of Congo (Ilona et al., 2017). Banana cultivars can be significant sources of vitamin A (Amah et al., 2018) and are being promoted in East Africa. Potato breeding has achieved significantly enhanced levels of Fe and Zn (Amoros et al., 2020), and where consumed as a staple, biofortified potatoes can contribute up to 50% of women's requirements for these micronutrients (Burgos et al., 2019).

Much current work on RTB crops in SSA and Asia is demonstrating the power and effectiveness of these crops in fighting hunger and nutrition insecurity, especially within the current content of climate change and COVID-19. RTB crops are mostly produced, processed, and traded locally, making them less vulnerable to abrupt price rises in international markets and interruptions due to epidemics. RTB-based products, such as orange-fleshed sweetpotato puree-based baked products, are already developed, promoted and being taken to scale in African markets. There is growing demand for innovative ingredients globally to meet growing consumer tastes and needs. Their potential is often limited, however, by the lack of preferred nutritious varieties, instability of micronutrients particularly when processed, unfavorable value chains, and weak institutional arrangements.

**Ten priority areas for research and scaling to continue on RTB crops in One CGIAR**

1. **Advocacy with policy makers** so that the critical role played by RTB crops in local and national food systems is understood and needed investment made along the value chain.
2. **Better understanding of household heterogeneity** in RTB agri-food systems (social, cultural, agroecological) and gender analysis as a basis for innovation design, testing and scaling
3. **Transforming RTB value chains** to make more nutritious food cheaply available in cities and rural markets, by improving fresh supply and developing new RTB food products, supporting different typologies of small and medium– scale processors,
4. **Developing new methods to discern sensory and physiochemical properties of new, manufactured foods**, and increasing the understanding of consumer needs and demands.
5. **Gender research integrated with biological research** to improve women and men's equitable access to and benefits from innovations for production and processing of RTB crops,
6. **Sustainable intensification of RTB agri-food systems** to reduce deforestation, conserve soils and improve water use efficiency while addressing yield gaps, enabling rural women and men smallholders to meet food and income needs while safeguarding environmental health.
7. **Rapid response capability to emerging pests and diseases**, both at the regional surveillance and field management levels.
8. **ITC solutions for reaching farmers at scale** for agronomy and pest and disease management, considering the challenges of accessibility and the intersect with gender and age of farmers.
9. **Strengthening and enabling seed systems** for increased access to improved varieties and encouraging improved quality in dominant informal seed systems.
10. **Accelerating availability of user demanded new varieties** with climate resilient traits of drought and heat tolerance and waterlogging through mainstreaming of genomic tools and high throughput phenotypic screens, improved management of breeding programs to increase efficiency and effectiveness, and enhanced use of crop genetic diversity.
References


AUTHORS

Graham Thiele and Michael Friedmann

CONTACT

Michael Friedmann
RTB Senior Science Officer • m.friedmann@cgiar.org