



From roots to riches in Southeast Asia: Improved cassava reduces poverty, hunger and climate risk

Scientists from CGIAR's International Center for Tropical Agriculture (CIAT) and a wide range of national partners in Southeast Asia have developed improved cassava varieties and promoted best management practices, creating opportunities for poor small-scale farmers to improve their food security and incomes.

Key highlights and results

- Farmers' gross annual income rose by US\$386 million, or US\$51 per family in Vietnam and US\$460 in Thailand, due to increased cassava yields.
- The adoption of improved varieties resulting from research by CIAT and its partners in the region has generated benefits worth almost US\$12 billion over the last 20 years.
- The returns on investment in cassava research in Southeast Asia are very high, reaching an internal rate of return (IRR) of 345% in Vietnam.

From roots to riches in Southeast Asia

In Southeast Asia, cassava is grown by over 8 million farmers and is a primary source of income and calories for poor, rural communities. The crop has the ability to withstand harsh conditions, including drought, heat and infertile soils, making it a key crop for protecting smallholder farmers against the impacts of climate change. Despite these qualities, by the 1980s, cassava yields had stagnated and attempts to improve local varieties were unsuccessful due to the lack of genetic variability within the region.



Tita Ty, cassava farmer, Kampong Cham, Cambodia
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In response, CGIAR's International Center for Tropical Agriculture (CIAT) cross-bred landrace varieties of cassava from its genebank to generate a large number of hybrid seeds, and then introduced the seeds into national breeding programs throughout the region. CIAT's genebank contains the world's most important collection of cassava germplasm. A total of 6,592 accessions from 28 countries are conserved using in vitro techniques, and are a valuable resource for cassava improvement. This germplasm is evaluated and used to generate advanced breeding materials which are shared directly with research partners all over the world. Extensive evaluation of the CIAT collection allows breeders to narrow the search for parents that will produce hybrids showing the highest potential in specific target regions. In order to ensure local adaptation and acceptability, CIAT provided training to national partners so they could carry out the significant local testing and selection required, which was as much a key to success as the germplasm itself.

Over the last 30 years, scientists from CIAT and its partners have developed improved cassava varieties and promoted best management practices, creating opportunities for smallholder farmers to improve their food security and raise their incomes by catering to diverse and expanding markets. High-yielding varieties, in combination with strong market demand beginning in the 1990s, have transformed cassava into a prized crop.

Cassava improvement and adoption

In the 1980s CIAT began a collaborative breeding program with the Thai Department of Agriculture and Kasetsart University bringing together CIAT's genebank resources and breeding knowledge, and Thai expertise. Together they developed improved cassava varieties that have significantly higher productivity in terms of fresh root yields, starch content, and improved disease resistance and environmental adaptability. For example, Kasetsart 50 (KU 50), which was officially released in Thailand in 1992, and Vietnam in 1995 (as KM 94) is both high-yielding and has high starch content.

Across Southeast Asia, 48 CIAT-related varieties are now planted on an estimated 1.5 million ha, comprising about 40% of the total cassava growing area in the region. KU 50 is the most commonly adopted variety and grown on over 1 million hectares in Thailand and Vietnam, and has also been

adopted in Cambodia and Indonesia, becoming the world's most grown cassava variety. According to 2011 estimates, the adoption of improved varieties resulting from research involving CIAT and national partners has reached nearly 90% in Thailand and Vietnam, generating benefits worth almost US\$12 billion over the last 20 years. Also, nearly half a million seeds from CIAT's breeding program have been introduced into other Asian cassava development programs, including those of China, Indonesia, the Philippines and Vietnam, greatly widening the genetic base of the crop and speeding up progress in cassava breeding.

Sustainable growth with crop and soil management

As cassava production began to take off in the region, CIAT recognized the importance of improved crop and soil management to ensure that intensive production could be sustained. When not managed properly, cassava can cause serious soil losses through erosion, leading to nutrient depletion and soil degradation, especially when grown on sloping land, as occurs in many parts of Southeast Asia.

The adoption of improved varieties has generated nearly US\$12 billion in benefits over the last 20 years

CIAT and national research and extension programs in Thailand, Vietnam and China conducted approximately 1,000 farmer trials in 99 villages during a 10 year project, funded by the Nippon Foundation. The farmers tested new cassava varieties, erosion control measures, fertilization, intercropping, weed control and plant spacing. The trials demonstrated, for example, that contour hedgerows reduced soil losses to erosion by as much as 80%. Farming communities were more open to adopt improved agronomic and soil conservation practices because they could see direct benefits in combination with adopting improved varieties. Adoption rates of effective practices were quite high: purchased fertilizers (84%); contour ridging (30%); contour hedgerows (30%); and intercropping (37%). Additionally, thousands of additional farmers were reached through training courses, farmer field days, brochures, and radio and TV programs.

Benefits to smallholder farmers

Today, Indonesia, Thailand and Vietnam are Asia's leading cassava producers, the bulk of the crop being grown by farmers with holdings of less than five hectares, often in marginal upland environments. In 2013, a study commissioned by the CGIAR Standing Panel on Impact Assessment found that in Thailand, higher yielding cassava varieties were the principal driver of production increases. Average national yields were 14 tons/ha when KU 50 was released in 1992 and reached 22.7 tons/ha in 2009, 81% higher than global averages. According to the same study, production in Vietnam increased four-fold between 1995 and 2010, due to doubled area



Cassava harvesting near Khorat, Thailand

© CIAT/Neil Palmer

under cassava and yields that increased from 8 to 17.2 tons/ha, 38% higher than global averages. An estimated 40 million people across Southeast Asia now sustain their livelihoods from the annual production of about 75 million tons of cassava grown on 4 million hectares.

Increases in cassava yields in Southeast Asia between 1994 and 2004, on average 4.2 tons/ha, have resulted in an annual increase in farmers' gross income equivalent to US\$386 million, or US\$51 per family in Vietnam and US\$460 in Thailand. The 2013 study further calculated that by 2010, the net present value of the economic surplus generated by KU 50/KM94 in Thailand had reached nearly US\$250 million and almost US\$149.91 million in Vietnam.

In small rural communities across the region, the extra income generated creates benefits for smallholders like Bui The Hung, a small-scale cassava processor and starch producer in Bac Kan, Vietnam, who uses improved cassava varieties because they are considerably higher in starch (20-62%) than varieties he used previously. By providing more starch from every cassava root, the boosted starch yields cut Bui The Hung's transport and processing costs, allowing him to invest more in his business. Women also capture a significant share of the benefits because of the important roles they play in cassava production and, in some communities, processing. More detailed impact studies in Southeast Asia will be conducted in 2015, with support from the Bill & Melinda Gates Foundation, the CGIAR Research Program on Roots, Tubers and Bananas (RTB), and others.

Farmers' gross annual income rose by US\$386 million due to increased cassava yields

In addition to the benefits for smallholder farmers, increasing demand for cassava is helping drive wider economic development in the region. Cassava trade is expanding quickly, with a boom in exports of dried cassava chips and starch to China, where demand is expected to double in the next 5-10 years. In Vietnam alone, 3.1 million tons of cassava fetched US\$1.1 billion in exports in 2013, with the bulk supplied by smallholder farmers.

Returns on investment in cassava research are very high, with an internal rate of return of 345% in Vietnam

Securing cassava's future

Over the period 1991-2009, the total research cost attributable to KU 50 was only US\$21.6 million in Thailand, and US\$2.39 million for KM94 in Vietnam. The benefits of these investments were incredibly high. Cassava research efforts by national and international institutions generated net benefits of US\$9 billion in Thailand, of which KU 50 contributed 43% (US\$3.9 billion).

In Vietnam the net benefits were US\$1.32 billion of which KM 94 contributed an astounding 92% (US\$1.22 billion), and the internal rate of return (IRR) for KM 94 in Vietnam was estimated at 345%.

Despite the success achieved, emerging pests and diseases are threatening cassava production. First reported in Thailand in 2008, cassava witches' broom disease and the pink mealybug have spread across the region. A network of research partners spearheaded by the CGIAR Research Program on Roots, Tubers and Bananas, with additional funding from the International Fund for Agricultural Development (IFAD), is investing time and resources in clamping down on this wave of invading pests and diseases. Scientists are staying ahead of the curve through diagnostic and training programs currently being rolled out to speed up pest and disease detection – for example by holding training workshops for local researchers and developing low-cost kits for rapid detection of cassava threats.



Women play important roles in production and processing

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Tapioca 'pearls' made from cassava starch are widely used in Asian cooking © CIAT/Georgina Smith

Researchers are also using biological control as part of wider integrated pest management efforts – including the release of the *Anagyrus lopezi* wasp, the mealybug's natural predator, in Indonesia in 2014.

The CGIAR Research Program on Roots, Tubers and Bananas continues to build on achievements in the region by breeding new crop varieties that will address constraints such as low production and low resistance to diseases. A new emphasis on genomics – the study of genes and their functions – should accelerate future progress toward these goals. A new round of evaluation

of accessions held in the CIAT cassava genebank is already being undertaken, with funding from RTB, to identify valuable traits, including root quality, that were not recognized during previous rounds of evaluation.

The Program is also working to improve systems for cassava processing and the development of value-added varieties for industrial markets. For example, utilizing source materials and technical support from CIAT, the Thai Tapioca Development Institute and Kasetsart University have developed new cassava varieties containing amylose-free starch (commonly described as waxy), with high potential in the processed food industry. While still requiring broad testing and multiplication before they are used in commercial production, it is expected that these novel varieties should add value for farmers and the industry by commanding a premium market price, further solidifying cassava's role in Southeast Asian farmers' livelihoods, and in the future economy and food security of the region.

“Cassava is a survivor. It deals with almost anything the climate throws at it. It thrives in high temperatures, and if drought hits it simply shuts down until the rains come again. There's no other staple out there with this level of toughness.”

Andy Jarvis, CIAT climate scientist, CCAFS Theme Leader

CIAT cassava scientists are also contributing to the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). In Laos, Cambodia and Vietnam, for example, CGIAR researchers are initiating collaboration with local communities, development organizations, national meteorological institutions and private sector stakeholders in selected 'Climate-Smart Villages.' At these sites, scientists will work with local communities to make them aware of the impacts of climate change and to present them with scalable options for mitigating and adapting to weather variability in their area.

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Additional information and resources

- International Center for Tropical Agriculture (CIAT): www.ciat.cgiar.org
- CGIAR Research Program on Roots, Tubers and Bananas (RTB): www.rtb.cgiar.org
- CGIAR Research Program on Climate Change, Agriculture and Food Security: www.ccafs.cgiar.org

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