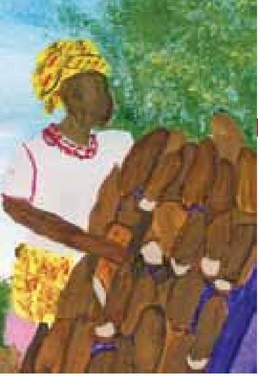

Molecular and conventional breeding through an economic lens

Facts and figures to shed light in a heated debate

Contemporary advances in crop science are helping farmers fight back against drought, disease and destructive insects. In recent years, to better address the needs of resource-poor farmers, the CGIAR Generation Challenge Programme (GCP) has promoted and employed a suite of efficient crop breeding approaches collectively known as marker-assisted breeding (MAB). By going straight into a plant's genetic code to identify desired traits, MAB saves time compared to phenotypic selection (PS), more popularly known as conventional breeding. In PS, breeders must wait until the plant is fully mature so they can identify desired traits by observing the plant. While MAB saves time, it however costs considerably more, thus raising questions on its net superiority over PS: just how cost-effective is it?

> Though upfront costs associated with marker-assisted breeding are much larger compared to phenotypic selection, the precision of MAB over phenotypic selection significantly slashes both breeding time and future costs.

Putting MAB to the test

To answer this question through a better understanding of the economics of MAB, a cross-continental study was conducted in Africa and Asia to evaluate the quantitative impact and investments of two GCP projects which used MAB to develop improved varieties of rice and cassava. For rice, GCP strived to develop a variety more tolerant to saline soil and better able to thrive in phosphorus-depleted soil. For cassava, the goal was a stronger tolerance against cassava mosaic disease, green mites and whiteflies.

For this study, researchers gathered information covering aspects such as crop yields and costs, farmer adoption rates, market prices and quantities, breeding cycles, input costs, costs of development, and more. These data provide a firm foundation for computing the net present value (NPV, ie, future benefits less future costs) of using MAB rather than PS (see table).

Larger incremental benefits from MAB

For rice, using MAB saved between three and six years in development time when compared to PS. Financially, this equates to an NPV of USD50–500 million higher, depending on the constraint and country. Similar results were found for cassava, where MAB was shown to save three to five years,

Monetary benefits of using MAB

Crop, constraint, country	Incremental net present value over phenotypic selection (USD million)
Rice	
Salinity	
Philippines	49
Bangladesh	499
India	447
Indonesia	194
Phosphorus deficiency	
Indonesia	282
Cassava	
Cassava mosaic disease, cassava green mites	
Nigeria	817
Ghana	371
Cassava mosaic disease, cassava green mites, whitefly	
Uganda	34

a benefit of USD34–817 million over PS. Though upfront costs associated with MAB are much larger compared to PS, the precision of MAB over PS significantly slashes both breeding time and future costs. Hence, the technology is well worth the investment in the context of these studies.

Through the gender lens: Talking to the women

In conjunction with quantifying the advantages of MAB, data were gathered on the gender impacts of adopting improved varieties of cassava in Nigeria, where women are predominantly responsible for the production, processing and marketing of cassava.

Most of the women reported an increase in their household income as a result of the improved cassava. However, they also reported an increase in the amount of time spent on cassava-related tasks. Since women are the primary producers and processors of cassava, to encourage adoption of improved varieties, future crop improvement research must take a bottom-up approach, by first talking to female farmers to ensure that improved crops retain characteristics they already value, in addition to the new traits.

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Adding value to farm products: a cassava processing centre in Nigeria.

What next?

The ability of MAB to save not only time but also money in the context of these studies suggests that to streamline future breeding efforts, economic analyses are essential. "With MAB, researchers select traits based on the genotype, considerably enhancing the chances of getting a particular phenotype," observes Carmen de Vicente, Leader of GCP's Subprogramme on Capacity-building and enabling delivery.

But regardless of which breeding method is used, the research also conveys the pressing need for technologies to tackle saline and phosphorus-deficient soils to boost rice production. Depending on the area of focus, the cumulative economic gains of solving this problem can be as high as USD 6.6 billion over the next 25 years.

Finally, although these two studies clearly and convincingly demonstrate the economics of MAB, findings cannot be uncritically generalised to other crops, countries and constraints.

Acknowledgements: This brief summarises studies by George W Norton, Vida Alpuerto, Nderim Rudi, Priscilla Marimo (Virginia Polytechnic Institute); Abdelbagi Ismail (IRRI); Martin Fregene (Danforth Center); Emmanuel Okogbenin and Chiedozie Egesi (National Root and Tuber Crops Research Institute, Nigeria).

Md Sazzadur Rahman

In the background, genotyping in progress at the Department of Biochemistry and Molecular Biology, Dhaka University. In the foreground, student– supervisor consultations. In the picture are (left to right): Dr Zeba I Seraj, Roman, Adnan, Sarwar, Debashis, Rabin, Dost, Mishu, Shamim and Rejbana.

Further reading

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Selling *garri* in Nigeria. *Garri* is derived from cassava and is a common staple across West Africa.

Nazrul Islam

Md Sazzadur Rahman of the Bangladesh Rice Research Institute assesses progress on a salt-tolerant rice variety in the field.

Pathways to impact briefs

1. ***Where in the world do we start?*** Pinpointing global 'hunger hotspots' by merging worldwide data on poverty, drought and crop production
2. ***A call for collective action in agricultural research:*** A multi-faceted approach to solve a multi-faceted problem
3. ***Molecular and conventional breeding through an economic lens:*** Facts and figures to shed light in a heated debate

Briefs and datasets on GCP's socioeconomic studies are publicly accessible at: http://www.generationcp.org/sp5_impact