



EVOLUTION OF MARKET SEGMENTATION AND TARGET PRODUCT PROFILE DEVELOPMENT IN THE CIP POTATO AND SWEETPOTATO BREEDING PROGRAMS

OCT
2024

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DOI: 10.4160/cip.2024.10.001

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Citation:

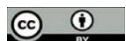
Friedmann, M.; Chaudari, S.; Mendes, T.; Polar, V.; Ssali, R. 2024. *Evolution of Market Segmentation and Target Product Profile Development in the CIP Potato and Sweetpotato Breeding Programs*. 14 p. DOI: 10.4160/cip.2024.10.002

Design and Layout:

Communications Department

October 2024

CIP also thanks all donors and organizations that globally support its work through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders



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Acronyms

ABI	Accelerated Breeding Initiative
BPAT	Breeding Program Assessment Tool
CIP	Centro Internacional de la Papa (International Potato Center)
CGIAR	Consultative Group on International Agricultural Research
EiB	Excellence in Breeding
G+	Gender Plus
GloMIP	Global Market Intelligence Platform
MI	Market Intelligence
NARES	National Agricultural Research and Extension Systems
TPP	Target Product Profile

Introduction

The CGIAR Initiative on Market Intelligence (MI Initiative) is bringing together a multidisciplinary team of scientists including breeders, agronomists, pathologists, seed system experts, social and gender scientists, crop and climate modelers along with national agriculture research and extension systems (NARES) from target countries to design a demand-led breeding approach of varietal improvement across CGIAR mandate crops. Although there is a large existing body of work on the traits and varieties farmers prefer, including the differences in trait preferences between men and women, this has not been compiled in a standardized form that can be used for comparative purposes to inform trait prioritization and breeding investments more systematically. Since demand-led breeding involves superimposing consumer and producer-centered thinking on the agroecology-driven breeding programs, this requires substantial efforts in collecting market intelligence data to understand the drivers of variety adoption (Lindqvist-Kreuze et al., 2024). Therefore, the MI Initiative is defining strategies for generating and using market intelligence in order to guide decisions on breeding program design and prioritization.

A central tenet of demand-led breeding programs is the identification of market segments and the definition of the ideal variety to meet the requirements within each segment. A market segment is defined as a group of farmers with common variety requirements that include production (where and how the crop is grown) and end-user requirements (what the crop is used for)¹. This segmentation takes into account the geographical region, agro-ecological zone(s), end use of the crop (fresh product, processed, as feed), color (for roots and tubers-skin, flesh), production environment, production system (rainfed/irrigated), and maturity (Lindqvist-Kreuze et al., 2024). Once the market segments are defined, then varieties are designed to have a set of traits that respond to the needs and preferences of producers, processors and consumers in the specific market segment. These are called TPPs and consist of critical traits that must be found in the new product, with defined levels and thresholds, usually compared to benchmark varieties that are popular in that market segment. There are additional traits that are also desirable, and might lead to particular impacts, be it in nutrition, gender equity, adaptation to climate change, or resistance to emerging diseases. These are also part of the TPP and undergo a prioritization process as not all traits might reach the desired levels during the breeding cycle. The current CIP breeding pipelines and market segments have been thoroughly described in detail in recent studies and datasets (Naziri, 2024a; Naziri, 2024b; Ojwang et al., 2023).

In 2018, the CIP potato and sweetpotato breeding programs underwent an evaluation using the Breeding Program Assessment Tool (BPAT)², with a subsequent evaluation of the Africa breeding hubs in 2021. The evaluations identified a number of strengths as well as gaps in the breeding programs. This resulted in several recommendations, among which was a call for carrying out market research to inform the breeding programs. The product profiles were found to need further refinement, be more focused on relevant market segments, and to use multidisciplinary teams to prioritize traits in a formalized process.

This brief looks at the evolution of the development of market segmentation to guide the definition of TPPs in the International Potato Center (CIP)-led potato and sweetpotato breeding programs. A survey questionnaire was developed to evaluate the development and use of market intelligence to inform the design of TPPs (see Annex 1). The questionnaire strove to separate activities predating the establishment of the MI Initiative (until December 2021) and those taking place since the start of the Initiative (January 2022). The questionnaire was shared with the CIP sweetpotato breeders based in Uganda, and lead potato breeders for South Asia and Southeast Asia, and East Africa. This was followed with individual interviews with the breeders to expand on some points discussed in the questionnaire.

Evolution of development of market segments

Until the end of December 2021, market segments were not clearly defined. The potato and sweetpotato breeding pipelines were based mainly along agro-ecologies and production constraints, with sweetpotato having

¹ <https://hdl.handle.net/10568/126019>

² <https://plantbreedingassessment.org/bpat-project/bpatmission/>

an emphasis on increased β -carotene content for nutrition impacts. There were two major breeding pipelines for potato, targeting mainly fresh market potato for tropical highlands and for tropical lowlands. In addition, there was another smaller pipeline focused on developing biofortified potatoes since 2004. However, there were processes in place to collect and use information on an *ad-hoc* basis from various sources, both within CIP as well as NARES partners. Moreover, the breeding programs followed the Excellence in Breeding Platform (EiB) Variety Replacement Strategy³. Certain national programs that had more advanced capabilities in breeding program design (such as the Vietnam potato program) through annual advancement meetings, would evaluate market segments according to their own set of criteria, some of which were quite similar to what was to become the MI Initiative criteria for market segmentation. In a number of regions, extensive extension networks collected and provided valuable market intelligence. A special public private partnership with HZPC and the Syngenta Foundation sought to develop potato varieties for tropical regions by combining genetic material from the private company and CIP and following a set of breeding objectives defined by the private seed company⁴. There were some similarities to the MI approach, but also differences in the process to design the desired varieties.

The EiB together with the MI Initiative has developed a set of eight criteria that define market segments in a standardized manner⁵. Following internal discussions within the breeding teams and using input from social scientists, market segments were initially defined for the sweetpotato and potato programs (Ojwang et al., 2023, Lindqvist-Kreuze et al, 2024). Market segments are defined following eight set by the MI Initiative⁶ as well as estimating the size of each market segment and the potential outcomes for poverty alleviation, nutrition enhancement and gender equity using data from various sources at the country level. This resulted in a set of 14 market segments for sweetpotato and 9 for potato⁷. Moreover, the team used the Gender Plus (G+) customer profile tool to map the customers for the various potato and sweetpotato products in the different market segments using both literature reviews and engaging multidisciplinary teams. This led to a description of the gender roles of the customers as well as their needs and preferences for both crops. In analyzing potential impacts, the analysis of the market segments showed that there is "significant scope" for adjusting the investments in the defined set of market segments when looking at impacts on poverty and malnutrition (Ojwang et al., 2023).

The MI Initiative has compiled market segments for the 25 CGIAR mandate crops into a dashboard, the Global Market Intelligence Platform (GloMIP).⁸ The dramatic increase in potato market segments, from 9 to 59, resulted from a consultative effort led by the CGIAR Market Intelligence Initiative, the International Potato Center (CIP), and national agricultural research and extension systems (NARES). This effort identified the need to refine the initial segmentation, which focused on segments aligned with existing breeding pipelines, excluding other potential markets. New segments were added in Eastern Africa, Southern Asia, Southeastern Asia, and Latin America, considering variations in end-use, skin color, and production environments. Additionally, previously unserved subregions, such as Central Asia and Western Africa, were included. This shift has expanded CIP's geographical reach, better aligning breeding priorities with market needs and opening up new opportunities for evidence-based expansion in unexplored regions. These are distributed across Asia (Central Asia 3, South Asia 13, Southeast Asia 4, West Asia 3), Africa (Central Africa 3, East Africa 8, North Africa 4, Southern Africa 8, West Africa 3), and Latin America and the Caribbean (10). There is a total of 30 sweetpotato market segments distributed across Asia (South Asia 3, Southeast Asia 4), Africa (Central Africa 2, East Africa 6, North Africa 4, Southern Africa 3, West Africa 4) and Latin America and the Caribbean (6). Moreover, surveys are being carried out by economists in South Asia and East Africa to better define market sizes, as this kind of information was lacking. This will allow the programs to reassess the set of market segments and undergo a prioritization process to inform investment decisions.

At this time there are annual or biannual product advancement meetings, where trait prioritizations are re-evaluated according to recent market trends. A confounding issue is the lack of control by the CIP programs on the variety release process and further promotion of the released varieties. This is under the control of the NARES programs, which might not have sufficient resources for variety dissemination and promotion. Moreover, the

³ <https://excellenceinbreeding.org/toolbox/tools/product-replacement-strategy-guide>

⁴ <https://cipotato.org/blog/tap5-cash-potatoes-for-tropics/>

⁵ <https://hdl.handle.net/10568/126019>

⁶ <https://hdl.handle.net/10568/126019>

⁷ <https://www.cgiar.org/news-events/news/refinements-to-potato-market-segmentation/>

⁸ <https://glomip.cgiar.org/market-segments>

release process is based on comparison to control varieties that serve as benchmarks for particular traits (such as yield, pathogen resistances and other traits) and do not follow a fit to a TPP template. However, collaborations with private seed companies are opening opportunities for variety dissemination, although these follow their own criteria for market segmentation.

Involvement of multidisciplinary teams

Until Dec 2021, multidisciplinary teams worked with the breeding programs through informal discussions to incorporate feedback into the breeding and testing strategies. It was mainly a consultative process with various experts from different disciplines within the organization. For example, plant pathologists highlighted emerging diseases, and value chain work provided feedback to breeders on post-harvest trait needs. Some of the public-private-partnership breeding pipelines, i.e. TAP5, adapted their product advancement meetings to include multidisciplinary stakeholders and private partners. In addition to the breeders, product specialists, agronomists, pathologists, seed producer and commercial teams are now involved in product advancement decisions. However, engagement with multidisciplinary teams still needs to be more formalized for systematic interactions, advancement decisions, and capturing feedback.

Evolution of the development of target product profiles (TPPs)

The potato breeding programs were focused for particular traits around yield, pest and disease resistance, and some quality characteristics, most of which were later included in the TPPs. With the assistance of the EiB, these traits were formulated into a first set of product profiles, as must-have, or nice-to-have traits and with defined thresholds being compared to benchmark varieties. The potato program took inputs from various experts, following the EiB product replacement strategy. For sweetpotato, the product profiles were developed by a multidisciplinary team that included breeders and support scientists such as plant pathologists, plant physiologists, and nutritionists, as well as social scientists including economists and gender specialists. Though the composition of this cross-functional team would vary, the product profile was well defined, structured and documented. The profiles followed an excel template that included worksheets to incorporate the cross-functional team members and responsibilities, as well as trait levels and thresholds with corresponding benchmark varieties. Trait decisions were based on market leader's variety characteristics in order to develop varieties that were better than a particular popular variety. Thus, these preliminary product profiles were submitted to the EiB, 9 for potato, 17 for sweetpotato.

The product profiles now have put increased emphasis on quality and processing traits. Moreover, several bilateral projects (such as RTBfoods⁹ & SweetGAINS¹⁰) invested in identifying and dissecting quality traits to develop corresponding phenotyping tools. In addition, there is now a formal process and group dedicated to developing and updating the TPPs. Both the functional team and individuals are well-defined with roles and responsibilities in the sweetpotato program. The sweetpotato program is integrating TPPs from NARES partners, especially in regard to trait thresholds. The product design team also doubles as the product advancement team. The potato program now has formal product design teams in target countries with TPPs linked to regional market segments endorsed by the Potato Breeding Network. NARES will start to take the lead on developing TPPs at a country level. As this will increase the number of market segments, work is ongoing with the national programs to document and re-prioritize these segments. However, it is important to note that the CGIAR is focusing solely on sub-regional market segments (MSs) and TPPs, and the development of country-level MSs would not necessarily translate into new sub-regional segments.

⁹ <https://rtbfoods.cirad.fr/>

¹⁰ https://cipotato.org/cip_projects/sweetgains-africa/

Use of market research in the breeding program

Market information was collected and used *ad hoc* in breeding decisions. There were inputs from national partners and information taken from literature. The NARES provided relevant information about their target markets through their regional research stations, seed sales, and feedback from the extension systems. Moreover, socio-economists are now carrying out surveys to better define the sizes of various market segments. There is ongoing support from WP1 of the Accelerated Breeding Initiative (ABI) for breeding teams to develop a portfolio of distinct, achievable product profiles¹¹. There is a more transparent process from designing to the development of a breeding pipeline/variety. Additionally, the MI Initiative GLoMIP platform opens opportunities to explore new investments. By providing access to the current market segments and associated TPPs, it is now possible to more easily evaluate the breeding pipelines and refine targets as market conditions change. A recent effort by a multidisciplinary team at CIP has examined potato farmers' needs and has led to a significant expansion of potato market segments in various regions across the Globe.¹²

A bottleneck is the lack of control over the release process and subsequent variety dissemination and promotion. This is compounded by issues of seed availability, which leads to potato farmers growing varieties for which seed is available, often imported European varieties.

The Sweetpotato program now collects market intelligence, and this is shared to inform all decision makers in the TPP development process. However, there is still a lack of funding to finance systematic information gathering from end-users, as well as a lack of expertise. To address this, the program is developing a market intelligence gathering tool for field teams to implement alongside other activities. The bringing together of several disciplines in breeding decisions has brought about intradisciplinary learning, inclusion of other stakeholders in the value chain, and increased phenotyping tools. At present, market intelligence is followed by concrete actions to integrate market intelligence research into breeding processes such as proof-of-concept studies, development of phenotyping tools and determining desirable thresholds for traits.

Attitudes, incentives, structures, and decision making in the research programs/breeding programs

The decision-making structure of the potato breeding program was carried out largely by the breeding team with consultations with climate experts and plant pathologists, and this was mainly project-based. The breeding team had various teams providing information. At present, there is more structure, and different experts and stakeholders participate in advancement meetings (e.g. in potato program in Vietnam). Moreover, the roles and responsibilities for the participants have been defined. In addition, socio-economists are using GBI¹³ tools to refine investments. In particular, a major effort towards a more collaborative approach for breeding with partners has been implemented through the establishment of a potato breeding network, which is now heading to its 3rd year. A major issue has been the funding for keeping the engagement with the national partners.

For sweetpotato, the decision-making structure of the breeding program was carried out largely by the breeding team until Dec 2021. At present the program has a product advancement meeting every 2 years. The breeding team was expanded to include other experts such as food scientists and gender specialists. Other major changes implemented since end of 2021 have included a central institutional governance of the breeding program now with a leadership for crop improvement (global and SSA).

In conclusion, both potato and sweetpotato breeding programs have evolved from rather *ad hoc* consultations with various disciplines including social scientists to inform TPPs and trait decisions to a more formalized decision-making process that involves multidisciplinary teams that include various stakeholders with defined roles and responsibilities. While gender researchers played a key role in advocating for this structure to ensure their perspectives are included to promote Gender-responsive breeding in program design and trait

¹¹ <https://www.cgiar.org/initiative/accelerated-breeding/?section=about>

¹² <https://www.cgiar.org/news-events/news/refinements-to-potato-market-segmentation/>

¹³ <https://gender.cgiar.org/tools-methods-manuals/g-tools-gender-responsive-breeding-new-crop-varieties>

prioritization. This approach also represents an opportunity for social science researchers more broadly and other disciplines, to contribute their expertise and enhance the relevance and impact of breeding programs.

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ANNEX I

Survey questionnaire to evaluate the development and use of market intelligence.

1. Breeding-related issues – particularly related to market intelligence

1.1. Market Segmentation and target product profiling

Overview: we are interested in information on market segmentation and the process of developing target product profiles. Please provide information on the following aspects of market segmentation separating the processes until Dec 2021 and what has changed since.

1.1.1. Market segmentation

- a) Were there defined market segments being targeted by your breeding program until Dec 2021?
- b) Are you targeting defined market segments now in your breeding program?
 - In absence of market segmentation, what was the basis for defining main breeding targets (Agroecological regions; Donor-based; TPEs, other?)
 - If you are targeting defined market segments, do you revise them over a certain time frame? If so, how often?
 - What information did you use to characterize market segments? Please indicate what characteristics are used (things like area, gender differentiated preferences, producer characteristics, consumer characteristics, etc.)?
 - Are market segments defined by the program or external to the program? (For example, donor-led.)
 - Is there any other information on how development and/or use of market segments is done that you can share? e.g. market research studies used to inform breeding program design (objectives, market segments and/or TPPs)
- c) Until Dec 2021, were there multidisciplinary teams established and contributing to market segment development?
- d) At this time, who is involved in market segment development, particularly in relation to involving several disciplines? (E.g., breeders, seed certification agencies, processors, economists, gender specialists, farmers). Are there multidisciplinary team established and are they involved in defining market segments?

1.1.2. Target product profiling

- a) Until Dec 2021, was there a set of defined product profiles developed (and submitted to EiB)? If so, how many? Were they linked to a particular market segment?
- b) At this time, is there a set of defined market product profiles? If so, how many? Are they linked to a particular market segment?

For both periods separately (until Dec 2022 and at present): Please mark the best answer for each:

- The product profiles were developed by a multidisciplinary team that included breeders and several of the following: plant pathologists, plant physiologists, seed systems specialists, food technologists, nutritionists, institution management and including the following social scientists (mark all that apply). **Economist(s), Gender Specialist(s) and Market Specialist(s).**
- The product profiles were developed by a multidisciplinary team that included breeders and several of the following: plant pathologists, plant physiologists, seed systems specialists, food technologists, nutritionists, and institution management, but no social scientists.
- The product profiles were developed by a multidisciplinary team that included breeders and just one or two of the following: plant pathologists, plant physiologists, seed systems specialists, food technologists, nutritionists, and institution management, but no social scientists.

- The product profiles were developed by the breeders only.
- To what extent are trait decisions made in response to a given target group? (trait decisions in the program are specifically made in response to a well-defined target group (i.e., a market segment), trait decisions are loosely geared towards a market segment, trait decisions are not made in response to a market segment(s).
 - a) Before Dec 2021
 - b) At present
- In regard to the process of developing target product profiles/trait selection related to how developed the process is? Which of the following best covers the situation? Please answer for the period until Dec 2021 and then for the situation at present.
 - There is a group and a formal process within the breeding team dedicated to developing and updating TPPs.
 - TPPs are developed within the breeding program but not through a formal process.
 - TPP development is done by an entity outside of the breeding program (e.g., CGIAR TPPs being used by NARES or vice versa).
 - Other, please share.
- Is there any other information on governance aspects of trait/TPP decisions you can share?
- Is there any other information on how product profiles are implemented and decided upon (trait decisions made) that you can share?

1.2. Market Intelligence / research and linking to the market/go-to-market strategy.

Overview: we are interested in getting a sense of how market intelligence and market research was used in the breeding program.

- How is market information used in breeding decisions – particularly the target product profile development? For example, is there a systematic process by which market research is collected and shared to inform all decisionmakers in the TPP development process; is market information collected and used ad hoc in breeding decisions; there isn't much use of any of market information in breeding decisions/TPP development; other (please expand).
 - a) Until Dec 2021,
 - b) At present
- Were there any bottlenecks or challenges regarding use of market intelligence in breeding decisions (e.g., lack of funding to finance systematic information gathering from end-users, lack of expertise, lack of availability or timeliness of the market information, lack of detail in market information, etc.)
 - a) Until Dec 2021,
 - b) At present
- Were there any proposed solutions, recommendations, or successes related to market intelligence/understanding the market(s)? Please summarize.
- Were there any challenges or successes associated with bringing together several disciplines in breeding decisions? Please summarize.
- What is your sense of how market intelligence was used in breeding decisions (e.g., defining market segments, deciding on traits, at breeding product advancement meetings, etc.).
 - a) Until Dec 2021,
 - b) At present
- Is there any other information on market intelligence and how it is used that you can share?

2. Attitudes, incentives, structures, and decision making in the research programs/breeding programs

Overview: we are interested in getting a sense of how decisions were made, the structure of the program, how coordination across disciplines took place, etc.

- Please provide information (if any) on the decision-making structure of the research program/breeding program (e.g., decision-making done by teams of individuals with diverse backgrounds/transdisciplinary teams, decisions are mainly taken by breeders, etc.)
 - a)** Until Dec 2021,
 - b)** At present
- What is the management and governance of the research program/breeding program? Describe where transdisciplinary teams might come in. Were there major changes implemented since end of 2021?
- Describe any partnerships involved in the research program and their effectiveness. Summarize. Also indicate what types of partners there are, and what disciplines those partners are coming from (e.g., distinguish within NARES between breeders, plant physiologists, gender experts versus economists).
 - a)** Until Dec 2021,
 - b)** At present.
- How is the quality of the breeding program measured?
 - Tangible outputs (e.g., germplasm) – Describe.
 - Measures of innovations and adoption of outputs coming out of the program (e.g., varietal release, sales volume, varietal turnover, etc.). Describe.
- Is there attention paid to impacts in the five CGIAR impact areas in measuring performance, and if so, which of the five impact areas are included? If no mention, then perhaps number of varietal releases, % adoption?
 - a)** Until Dec 2021,
 - b)** At present.
- Can you provide any other information on the disciplines involved in the research program, their respective contributions, and challenges or successes in involving actors from multiple disciplines?

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The International Potato Center (CIP) was founded in 1971 as a research-for-development organization with a focus on potato, sweetpotato and Andean roots and tubers. It delivers innovative science-based solutions to enhance access to affordable nutritious food, foster inclusive sustainable business and employment growth, and drive the climate resilience of root and tuber agri-food systems. Headquartered in Lima, Peru, CIP has a research presence in more than 20 countries in Africa, Asia and Latin America.

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CIP is a CGIAR research center, a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector.

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