

Market intelligence for informing crop-breeding decisions by CGIAR and NARES

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Abstract

Crop breeding by the Consultative Group on International Agricultural Research (CGIAR), in partnership with national agricultural research and extension systems (NARES) and privately owned seed companies, forms the backbone of the research and development (R&D) effort needed to ensure future food security in developing regions. Over the past decades, varieties derived from CGIAR germplasm have helped provide food for hundreds of millions living in harsh and vulnerable environments. However, the capacity to deliver increased benefits from crop breeding will depend on effective strategies to address the stubbornly slow rate of uptake of improved varieties. Meeting the challenge will require, among other inputs, deeper insights on the evolving preferences and requirements of farmers, processors and consumers. In short, breeding will need to be led more by demand. Key to the success of demand-led breeding will be the availability of reliable and timely intelligence on the current and future preferences and requirements of farmers, processors and consumers. Although 'market intelligence' has existed in various forms in CGIAR's social science research agenda, an opportunity exists for increased relevance based on shared approaches and tools and new partnerships, both within CGIAR and between CGIAR and its partners. Beginning in 2022, a coordinated effort through the CGIAR Initiative on Market Intelligence looks to build cross-functional and transdisciplinary teams to provide market intelligence in support of crop-breeding and seed-system development.

Key points

- The CGIAR Initiative on Market Intelligence provides data, information and insights to inform decisions that will prioritize and align investment in breeding pipelines and seed systems. These investments aim to maximize contributions to the five CGIAR Impact Areas: poverty reduction, food and nutrition security, gender and youth inclusion, climate adaptation and environmental protection.
- Critical to the success of the CGIAR and NARES approach to market intelligence will be a common understanding of key approaches, methods and definitions related to market segments and how they are operationalized to inform decisions and guide investments in crop breeding and seed systems development.
- This brief provides an outline of the approach to market intelligence, covering key approaches, methods and definitions related to seed product market segmentation, opportunity for impact, future priorities, product concepts and the way forward.
- Reliable processes are urgently needed within CGIAR and NARES to implement effective cross-functional teams, feedback loops and decision-making processes that will integrate market intelligence data, information and insights for decisions on breeding-pipeline investment, target product profile (TPP) design and seed systems development.



INITIATIVE ON
Market Intelligence

This Initiative aims to maximize CGIAR and partners' returns on investment in breeding, seed systems and other Initiatives based on reliable and timely market intelligence that enables stronger demand orientation and strengthens co-ownership and co-implementation by CGIAR and partners.

Introduction

In response to climate change, population growth and persistent rural poverty, crop-breeding teams are challenged to deliver improved varieties in less time and with fewer resources. Since the 1970s, researchers have captured the varietal preferences of farmers and documented the opinions of seed-system actors, including extension agents and policy makers, regarding varietal performance and farmers' needs. Nevertheless, more systematic, accurate, forward-looking and scalable approaches are necessary to capture the size and nature of current and future demand for varieties to inform decisions on varietal design and public-sector investments. Future development strategies for breeding and seed systems will benefit from an ability to better anticipate how farmers, processors and consumers may respond to emerging threats and opportunities in light of seed-sector and product-market evolution and the changing environment in which farmers operate.

Broad agreement exists that demand-led breeding is essential to achieve more impact from investments in crop breeding (Anthony 2013). This recognizes a perceived supply-side bias in how breeding pipelines have been designed and prioritized—with investments among crops and within pipelines tending to reflect strongly held breeder assumptions about current and future farmer requirements. The continued interest in a demand-led approach to the design of varieties and the prioritization of breeding pipelines requires reliable, comparable and timely market intelligence. It also requires new mechanisms for how market intelligence is collected, shared and discussed with those engaged in the design and funding of breeding pipelines and seed systems.

Acronyms used in this brief

CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CGIAR	Consultative Group on International Agricultural Research
EiB	Excellence in Breeding Platform
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IRRI	International Rice Research Institute
NARES	National agricultural research and extension systems
SPMS	Seed product market segment
SPMSD	Seed Product Market Segment Database
TPP	Target Product Profile

Over the past 25 years, researchers have generated important insights on the traits and varieties farmers prefer. These farmer preferences for traits and varieties have been explored through household surveys, participatory rural appraisals and participatory varietal selection (Smale, Heisey and Leathers 1995; Harris et al. 2001; Ceccarelli and Grando 2007; Witcombe et al. 2008; Singh, Nayak and Sharma 2014). More recently, economists have employed tools such as choice experiments (e.g., Arora, Bansal and Ward 2018; Okello et al. 2022), experimental auctions (e.g. Demont and Ndour 2015) and gamification of farmer priority traits (Steinke and van Etten 2017; Maligalig et al. 2019, 2021). Studies have explored the differences in trait preferences between men and women (Marimo et al. 2020). Other efforts have assessed the potential impact of specific traits (productivity, climate, disease or pest resilience, nutrition) within a region. Overall, a large body of work has emerged, but variations in research questions, methodologies and interventions have contributed to disparate research findings and limited the opportunities for consolidation and comparative analyses.

Looking ahead, a strategic opportunity to guide more impactful investments in crop breeding and seed systems development lies in

- establishing a common set of terms and consistent approaches for generating and disseminating market intelligence that is relevant for guiding decisions on program design and implementation at multiple levels (national, (sub)regional and global);
- coordinating research across CGIAR and NARES to deliver timely market intelligence across regions and crops;
- establishing processes and structures for coordination and engagement across social science teams and among social science, crop modelers, CGIAR-NARES networks and the private sector.

The CGIAR Initiative on Market Intelligence ('Market Intelligence' for brevity) represents a new effort to engage social scientists, crop breeding teams and others to work together toward the design and implementation of a demand-led breeding approach.

This brief defines several important concepts that, when taken together, form the basic framework used by the Initiative to generate comparable and useful market intelligence. Some of the definitions are inspired by previous work on demand-led breeding (Persley and Anthony 2017), while others build on work by CGIAR's Excellence in Breeding Platform (EiB). A confusing set of terms and definitions has emerged around market intelligence—a field rooted in commercial product innovation—with different terms and definitions for similar concepts. In the interest of clear communication and understanding among those engaged in crop breeding, seed systems and social science, this brief presents key concepts and definitions that have been discussed extensively during the initial months of implementation of Market Intelligence. We conclude the brief with reflections on the way forward for implementation.

Core concepts and definitions

Market intelligence research

Market intelligence research in the context of crop breeding and seed systems is the practice of gathering and analysing data to identify and describe opportunities for increased positive outcomes and impacts derived from innovation in product design and delivery. CGIAR uses and enhances the use of market intelligence research to maximize contribution to the five Impact Areas addressing poverty reduction, improved nutrition, gender equality, climate change and environment. In this context, market intelligence research seeks to

- identify and describe current seed product market segments (as defined in the following subsection) as the basis for discussions on relative opportunities for increased impact;
- assess the opportunities for impact across the CGIAR Impact Areas from different types of investments (e.g. crop breeding, agronomy and seed systems) and within seed product market segments;
- identify future requirements for varieties by farmers, processors and consumers in response to external trends and assess the contribution to the CGIAR Impact Areas;
- estimate the potential for crop breeding to drive value chain development—for example, new cereal varieties that allow for increased commercial production of flours with longer shelf life.

Seed product market segment

A seed product market segment (SPMS) is a group of farmers with common variety requirements. In the context of CGIAR and NARES crop breeding, these segments are defined based on grower requirements (where and how the crop is grown) and end-user requirements (what the crop is used for). A consistently defined and described set of SPMSs provides the basis for

- setting priorities based on comparisons of market segment data and information (e.g. area, rural population in poverty, yield and yield potential, value of crop);
- informing the design of a TPP—a blueprint for the design of new varieties tailored to the requirements of a given market segment;
- using a common language for discussions with NARES, breeders, social scientists, seed companies and CGIAR leadership and funders on prioritization and investment levels.

Market segmentation criteria

Table 1 presents the eight criteria used to define the SPMSs. The first three criteria (crop, material type and subregion) form the basic building blocks of the segmentation. Twenty-five crops are considered, some of which are specified by germplasm (e.g. spring and durum wheat). These are listed at the bottom of table 1. Material type distinguishes crops that are hybrid (hybrid maize, sorghum and rice, for example). The 10 subregions were derived from the seven CGIAR recognized regions. The inclusion of a geographical criterion

recognizes the variation in natural environments—climate, diseases and production systems. The subregion level strikes a balance between the lower country level (where various small countries may share similar natural environments) and the higher regional level (where regions may hide important variations in natural environments). Two or more subregions can be combined to reach the regional level, while subregions can be separated into countries for discussions with NARES and other country-level stakeholders.

The remaining five criteria further refine the segmentation based on grower, processor and consumer requirements. They are considered in terms of the production environment—the biophysical conditions under which the crop is grown (elevation, rainfall), the production system employed by the farmer and farmers' requirements for the seed maturity class (extra early, early, mid and late). One example of production system is the farmers' use of direct seeded rice—this is how the crop is grown, which drives a unique SPMS and requires varieties with specific traits, captured in a TPP for that market segment. End-user requirements distinguish the product's use, for example, as input for a particular process or as an ingredient in a particular type of food, as well as the color of the grain or flesh.

For a given crop and region combination, multiple segments will emerge that are driven by a particular combination of farmer, processor and consumer requirements. Hybrid maize in East Africa provides an illustrative example where farming requirements play a strong role in determining the market segments: all segments include white grain, grown under rainfed conditions and used for human consumption. It is maturity that plays the key role in determining multiple segments: some maize farmers in this region require early maturing varieties while others require intermediate or late maturing varieties, depending on the respective agro-ecological zone and personal preferences. A farmer in East Africa falls in the early maturity segment if he or she prefers early hybrid white maize to provide grain earlier in the season to meet family needs and/or to sell at a higher price before a bumper harvest. The targeted varieties for these market segments would need to be different in terms of maturity. In crops such as groundnuts, potatoes and cassava, consumer requirements play a strong role in determining the market segments.

Seed Product Segment Database

Version 1.0 of the [Seed Product Market Segment Database](#) (SPMSD) contains more than 400 SPMSs identified using the criteria presented in Table 1. The database covers crops and subregions where CGIAR and NARES currently target investments in crop breeding and seed systems.¹ For each market segment in the database, data are presented to describe the segment (segment descriptors). These descriptors provide an understanding of the size and relevance of each segment. Examples of descriptors are area under production, production volume, value, total and rural population, population in the market segment footprint (total, in poverty and undernourished). These data

¹ Version 1.0 of the SPMSD evolved from a previous version that was designed to classify segments according to CGIAR center, crop and subregion. As a result, version 1.0, which dropped 'CGIAR center' as a classifier, contains duplicity of market segments where two or more centers have pipelines for the same crop that feed the subregion (e.g. rice and cassava in East Africa). Future versions of SPMSD will strive for a 'one crop' focus.

Table 1: Criteria for identification of seed product market segments

Criteria	Description	Examples and notes
Crop*	Crops in the CGIAR crop breeding portfolio	In some instances, the criterion is further specified by germplasm (e.g. banana and plantain, spring, durum and winter wheat, pearl and finger millet)
Material type	Hybrid seed production system	<ul style="list-style-type: none"> • yes or no, where no implies the traditional material type (open-pollinated variety, inbred variety or clone) • examples of hybrid crops in the CGIAR breeding portfolio include maize, sorghum, rice and millet
Subregion	Subregion(s) where the crop is grown (subregions derived from the seven regions recognized by CGIAR**)	One of the following: <ul style="list-style-type: none"> • Central Asia • South Asia • West Asia • South-East Asia • Central Africa • East Africa • North Africa • Southern Africa • West Africa • Latin America
End use	Use of the product by processors and consumers (on farm, off farm)	Examples include: <ul style="list-style-type: none"> • food, human consumption, with variation in size and hardness (e.g. long soft rice, large bean) • feed, animal feed and fodder • food processing, with specific raw material requirements (e.g. potato chips and crisps)
Color	Description of the color of the grain, skin or flesh	Examples include: <ul style="list-style-type: none"> • grain color: white or yellow maize, brown or white cowpea • skin or flesh color: orange or white sweet potato, yellow or white cassava
Production environment	Where the crop is grown (climate, elevation)	Examples include: <ul style="list-style-type: none"> • lowlands or uplands for rice • drought-prone or high-temperature regions for spring wheat
Production system	How the crop is grown	Examples include: <ul style="list-style-type: none"> • rainfed or irrigated • direct seeded or transplanted • solid stand or intercropped
Maturity***	Length of time from planting to harvest	One of the following: <ul style="list-style-type: none"> • extra early • early • mid • late

* Rice, maize, sorghum, spring wheat, durum wheat, winter wheat, cassava, cowpea, groundnut, soybean, sweet potato, chickpea, barley, finger millet, pearl millet, pigeon pea, potato, common bean, faba bean, forages (*Bracharia and Penisetum*), lentil, banana, yam, plantain, grass pea.

** For list of regions recognized by CGIAR, see <https://www.cgiar.org/research/cgiar-regions/>.

*** May not apply in all cases

were collected from available sources including FAO Stat and geospatial data. Current estimates on the size of the market segment (acres under production) per country were derived from extensive consultations with CGIAR breeding teams in 2022 by Module One of the CGIAR EIB.

Investment opportunity: macro view

Having defined market segments, the primary question becomes: What opportunities exist within a market segment or set of segments to achieve greater impact from future investments in crop breeding? Insights come from considering two perspectives: a macro view and a micro view. The macro view utilizes the segment descriptors from the SPMSD to highlight variation between segments and potential impact of breeding investments for a respective market segment. The dashboard feature of the database allows for easy comparisons of descriptors across segments in one or more (sub)regions. Descriptor comparisons across segments and (sub)regions can induce critical reflection within breeding networks and seed systems teams: Are

current investments targeted toward those segments where the potential for impact is greatest? Which (sub) regions present the greatest opportunity? What are potential barriers to impact in those segments where the need is greatest? Macro-level analysis also highlights those segments that need deeper dives to better understand the realities on the ground and the implications for greater impact from crop breeding and seed systems development.

Investment opportunity: micro view

Informed investment prioritization discussions will also require deeper, more context-specific analysis. Through case studies, field experiments, surveys and other means, Market Intelligence looks to understand the needs, strategies and challenges faced by participants in seed systems and the implications for crop breeding and seed systems interventions. Attention may be directed at farmers' preferences for and access to seed products: what products are preferred, how do preferences differ by gender, which products are reliably available and what factors may trigger

changes in preferences (e.g. a shift from older varieties to newer ones). Important questions remain about the role of information, price and trust in farmers' decisions about seed preferences and seed product uptake. Often little, if any, credible evidence exists on end-user requirements, especially those of final consumers and food processors. Insights into these requirements would prompt new discussions on the potential for crop breeding to respond to the requirements and the implications of doing so for farmers (e.g. higher income) and processors and retailers (e.g. new products and higher margins). The performance of seed systems represents another micro-view issue that, in many contexts, deserves more attention, given its implications for the prioritization of investments in crop breeding. Where seed systems have struggled to deliver new improved varieties to farmers, questions arise about the underlying causes and the sequencing of investments between crop breeding, seed systems development and other intervention areas (e.g. extension). Embedded in the seed systems discussion are issues about the willingness of the private sector to invest in the production and distribution of new varieties; the role of regulations, competition and infrastructure in shaping its willingness; and options for more effective partnerships with the public sector.

Future seed product market segment

A future seed product market segment will be identified and defined based on evidenced-based assumptions about changes in varietal requirements by farmers, processors and consumers in response to external trends. They respond to economic, regulatory or biophysical changes that are likely to result in significant changes in what will be demanded or accepted by the market and where and how the crop will be produced. Dialogues with private sector actors (e.g. seed companies, cereal millers, animal feed producers and food processors), analysis of climatic and geospatial data and product concept testing (described in the following subsection) are some of the methods for identifying future segments. An example of a future segment is one for an early maturity variety: in the future some farmers may require earlier maturing varieties of a crop they currently grow to optimize water use and to avoid rainfall uncertainty linked to climate change. They may also require varieties that are tolerant to new pests and diseases or a different crop based on changes in the market demand or changes in environmental conditions, such as significant changes in temperature or duration, amount and variation of rainfall. Processors may have new requirements for raw materials that conform to specific quality parameters, for example, specialty starch or characteristics that enable faster processing. Consumers may have future requirements for products that are more nutritious, store longer or are more convenient to prepare. The challenge for Market Intelligence is to identify where these changes are likely to take place and assess the implications for crop breeding and seed system development. The new segments should be identified based on farmer, processor and consumer requirements and the impact on existing SPMSs understood and documented.

Product concepts

Product concepts are descriptions of actual or hypothetical varieties and their potential uses and benefits for farming, processing and end-use consumption. Discussions with farmers and others on their concept preferences and their

underlying reasons for those preferences can provide important insights for the design of future seed products. Concepts can explore the relevance of potential new varieties that respond to preferences related to gender equity (e.g. easier to harvest varieties), food security (e.g. varieties resistant to mold) and home consumption (e.g. 'sweet tasting' varieties). Concepts may reflect production-related requirements, such as maturity and drought resistance, while others may respond to end-user considerations, such as those related to taste, storability and marketability. The design of concepts takes place over multiple rounds of engagement with breeders, seed company representatives and farmers and farmer organizations. Once concepts are designed, multiple options exist for engaging with farmers to assess their preferences for product concepts, from qualitative deep dives with a limited number of farmers to the use of videos to present concepts to hundreds, even thousands, of farmers. By generating reliable evidence about farmers' preferences for product concepts, Market Intelligence provides a reliable basis for discussions on the product feasibility (and potential impact) for SPMSs that could exist in the future.

The way ahead

This new CGIAR Initiative on Market Intelligence aims to consistently and systematically improve market intelligence information. It brings together researchers from social and environmental sciences, crop breeding and seed systems to advance a shared vision of how to define and describe current and future seed product market segments and the opportunities and challenges inherent in these segments. Understanding the opportunity for impact of each market segment and having a robust TPP developed for each market segment offers the best potential for elevating contributions from breeding and seed systems development to the CGIAR Impact Areas.

This brief has provided core concepts and definitions and outlined the broad approach to be applied within current CGIAR efforts. Success of Market Intelligence will depend on its ability to deliver reliable data, information and insights into market segments. This new *Market Intelligence Brief* series responds to the need for clear, short and actionable communication about market intelligence across teams and partners involved. With comparable and actionable market intelligence comes the need for new mechanisms that engender robust cross-functional team discussions to identify and develop scenarios that will be used to prioritize breeding and seed systems investments.

Looking ahead, the success of the CGIAR Initiative on Market Intelligence will depend on consistent, productive engagements that cross disciplinary and institutional boundaries to address the following needs

- **Refine current SPMSD:** New evidence can refine the existing SPMSD. In practice, this means identifying market segments that exist but were not included in the database. Intelligence that focuses on processor and consumer requirements is especially promising for the identification of new segments.
- **Identify future segments:** Intelligence on the future requirements of growers, processors and consumers, including the variations in requirements across socioeconomic and gender dimensions, will provide the

basis for predicting future segments. Having identified future SPMSs, teams can put forth evidence-based scenarios on the potential contribution of the segments to the CGIAR Impact Areas. .

- **Inform prioritization discussions:** Whether based on analysis of secondary data or deep-dive research, intelligence informs discussions on the potential for crop breeding vis-à-vis other intervention areas (e.g. seed systems, agronomy and value chains) to contribute to CGIAR Impact Areas in a market segment, viewed from either the country, subregional or regional level (or, in some cases, aggregated at the global level).
- **Design new methods and tools:** The design intelligence-gathering methods and tools that strike a balance between ease and robustness of evidence and address the unique features of different crops (from cereals to tubers) will be essential for generating comparable evidence and for ensuring productive collaboration with local partners
- **Build engagement platforms:** Discussions are overdue about the design of new spaces at the (sub)regional level for critical reflection and discussion among transdisciplinary and multi-institutional teams about the implication of reliable market intelligence for crop breeding and seed systems development.

Concepts and definitions for market intelligence

Breeding pipeline: All population improvement, early- and late-stage variety identification efforts for a TPP or a group of similar TPPs that results in the identification of distinct varieties.

CGIAR Initiative on Market Intelligence: One of 31 initiatives launched in 2022 as part of the One-CGIAR portfolio. The initiative provides a structure and process for the systematic description of opportunities for increased development impact through crop breeding and for supporting program leaders, funders and local stakeholders in their prioritization and investment decisions.

End users: Persons, businesses and organizations that consume, trade, distribute and/or process agricultural products. End users may have distinct needs, preferences and requirements in terms of fresh product/raw material attributes, including taste, color, texture, storability and processability, which will drive unique SPMSs.

Future seed product market segment: Future assumptions about changes in demographics, socio economic status and technology that alter the variety requirements of farmers, processors and consumers.

Market intelligence: Practice of gathering and analysing data to identify and describe opportunities for breeding and seed systems to optimize their contribution to CGIAR Impact Areas of nutrition and health, poverty reduction, environmental health, gender equality and social inclusion, and climate adaptation.

Pipeline investment case: Assessment of the potential return to investment of public resources to the CGIAR Impact Areas of a breeding pipeline that is aligned to one or more SPMSs/TPPs.

Preferences: The decision by a farmer to choose between SPMSs.

Product concept: Description of a hypothetical variety and its potential use and benefit for farmers, processors, and consumers. Choices between product concepts provide insights on preferences for current and future SPMSs.

Product design: An overarching term that covers product concept, product specification (which is included in TPP—see definition below) and product assembly.

Product description: Description of traits and characteristics of a variety that distinguishes it from other varieties in a market segment. It serves as a guide for breeders, product managers and seed suppliers to position new varieties in a market segment and for farmers to select between varieties within a market segment.

Requirements: Critical factors that are considered by farmers for growing, marketing or consuming a crop in a certain region. Requirements within each criterion drive a unique market segment. Requirements define market segments.

Seed market segment descriptors: Data used across seed product market segments to describe each seed product market segment's size and relevance (impact opportunity).

Seed Product Market Segment (SPMS): A group of farmers with common variety requirements. In the context of CGIAR and NARES crop breeding, these segments are defined based on grower requirements (where and how the crop is grown) and end-user requirements (what the crop is used for).

Seed Product Market Segment Database: Database that presents known SPMSs. The current database has more than 400 segments. These will be refined and expanded based on evidence gathered in collaboration with NARES, seed producers, seed retailers and others.

Target Product Profile (TPP): A blueprint for the design of new varieties that indicates the traits and characteristics required in a new variety to meet or exceed the requirements of growers, processors and consumers in an SPMS. For each trait in the TPP, details are included on the scale used to measure it and the threshold score applied for evaluation.

Variety: A distinct germplasm product that is a clonal variety, true-to-seed variety or a hybrid.

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About this series

The *Market Intelligence Brief* offers evidence-based insights into the potential for increased impact toward the CGIAR Impact Areas from investments in crop breeding and seed systems development. This peer-reviewed series brings together voices from diverse fields, including marketing and agribusiness, gender, plant sciences and climate change to inform debates on future priorities and investments by CGIAR, NARES, the private sector and non-governmental organizations (NGOs). This series is a collaborative effort of the CGIAR Initiative on Market Intelligence. For more information, including potential submissions, please contact Meliza Peña, editorial assistant, at <c.pena@cgiar.org>.

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