

Protocol for evidence synthesis of market intelligence: Application to rice in the global South

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Abstract

Demand-oriented crop breeding relies on market intelligence to support market segmentation, target product profile (TPP) design, alignment of breeding pipelines, and prioritization and allocation of investments. Synthesis of existing evidence such as stakeholder preferences (e.g., consumers, farmers) is needed to inform discussions on the expectations and requirements of actors along rice value chains and the implications for current and future rice markets segments and product design. We designed a protocol carrying out a systematic literature review (SLR) as a tool for evidence synthesis. We used this protocol to review and synthesize current stakeholder requirements for rice seed products in the global South. The protocol can be used by researchers to synthesize market intelligence for specific market segments and/or other crops. At the global level, our findings suggest that the traits preferred by stakeholders are generally considered in the current portfolio of rice market segments and TPPs. This analysis can be scaled down to the market-segment level to verify whether the traits proposed in the TPPs are in line with stakeholder requirements in each market segment. Broadly, maturity, texture, and grain color are considered important in the reviewed farmer and consumer studies, and these are among the basic criteria for market segmentation. Specifically, farmer requirements for agronomic traits focus on yield, maturity, plant height, lodging tolerance, and tillering ability. These are generally included as essential traits in the rice TPPs. Through the systematic approach, potential areas for future research have been identified. In terms of geographical regions, we found that peer-reviewed publications on farmer evaluation of seed products and consumer preferences for rice are underrepresented in South Asia and in Africa. In terms of value chain stakeholders, we found limited evaluation by midstream stakeholders (i.e., processors). In terms of attributes, evidence on evaluation of chalkiness was missing in the reviewed studies. Limited evaluation of nutrition-related attributes was also found, which suggests that more research to identify future market segments for nutrition attributes.

Key points

- Understanding the current and future requirements of farmers, processors, and consumers for rice provides inputs for discussions on the design of seed products and the priorities for breeding investments. Before market intelligence undertakes new data collection efforts, it can be important to review the existing information available from different sources.
- While the main objective of this brief is to present a protocol for conducting a systematic literature review to assess stakeholder requirements for current and future rice seed products, we recommend applying this method at the market-segment level to assess the alignment of breeding pipelines, through their TPPs, with market segments.
- The protocol mainly targets market intelligence researchers because it can be adapted and applied to any specific seed product for any crop.
- By taking a systematic approach, we can substantiate the existing requirements of farmers and consumers at a global level. This information provides supporting evidence on the basic criteria used in current market segmentation and on the traits currently included in rice TPPs. We are also able to identify information gaps that require further research.



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

The CGIAR Initiative on Market Intelligence aims to render crop breeding more market-driven and impactful by engaging transdisciplinary teams of social scientists and crop breeders in the implementation of market intelligence research (CGIAR 2023). Critical to the success of demand-oriented breeding is the availability of reliable and timely insights on the evolving preferences and requirements of value chain stakeholders. This strategic information and insights help support alignment and prioritization of breeding pipelines and seed systems (Donovan et al 2022).

The Initiative has established a basic framework to organize and generate market intelligence (see *Market Intelligence Brief 1*). It has currently identified more than 450 seed product market segments (SPMSs) that include all crops for which the CGIAR currently has breeding investments in the global South (Rutsaert et al 2023). This effort stems in part from the fact that while there are many empirical studies that provide important insights on understanding varietal preferences, differences in study contexts (e.g., research design, methodology, interventions) and trait typologies have resulted in inconsistent findings and limited opportunities for consolidation and comparative analysis (Donovan et al 2022).

Since many empirical studies aimed at understanding the requirements of farmers and consumers exist, evidence synthesis of stakeholders' requirements for seed products can be a useful first step in market intelligence research. Specifically, a synthesis can provide for (1) the identification and revision of current and future market segments, (2) the design of target product profiles (TPPs) and their alignment to stakeholder preferences in the SPMSs, and (3) the identification of evidence gaps that may inform discussions on the expectations and future requirements of stakeholders. One of the advantages of a systematic literature review (SLR) is its reproducible methodology, which allows the approach to be replicated and scaled to other crops. The systematic approach also minimizes selection bias in article selection and captures relevant studies in a comprehensive manner.

This brief provides a practical guide for conducting an SLR on stakeholder requirements for seed products with an

application to the rice sector. The next section presents a simplified protocol implemented by the authors, followed by the key insights that emerged from an SLR.

Practical guide: Systematic literature review as a tool for evidence synthesis

This section provides a protocol that researchers can use to conduct an SLR. The full protocol was published by Custodio, Demont, and De Steur 2023 (see Table 1 for a step-by-step summary). This protocol can be adapted and applied to generate a global scan of market intelligence for seed products for a specific crop or for specific market segments. Here we will demonstrate how it can be used to generate a global scan of market intelligence for rice.

Useful frameworks in conducting systematic reviews

SLR is a tool for synthesizing empirical evidence in which the existing literature in a research area is compiled, organized, and evaluated (Paul, Khatri, and Kaur Duggal 2023). Such reviews can provide a comprehensive and unbiased summary of the current state-of-the-art evidence, research gaps, and potential areas for future research. When conducting a well-structured SLR, the development of a protocol is essential to ensure that the methodology is reproducible. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) is one of the most commonly used protocols for reporting results (Page et al 2021, PRISMA 2020, Liberati et al 2009). PRISMA can be used in conjunction with another framework such as the PICOS framework, which helps to define and report the participants or population of interest (*P*), the intervention included in the review (*I*), the comparison group or control (if applicable) (*C*), the outcomes of the studies included in the review (*O*), and the context or study design (*S*). When using the PICOS framework to develop the search syntax, the search terms may be structured based on a combination of keywords related to (1) the population of interest (e.g., value chain stakeholders such as consumers, farmers, processors, traders, etc.), (2) the "intervention" of interest (e.g., seed product, such as rice), and (3) the outcome indicators (e.g.,

Table 1. Steps for conducting a systematic literature review

Steps	Practical notes
1. Prepare a protocol based on the specific research questions	<ul style="list-style-type: none"> PRISMA and PICOS frameworks are useful frameworks that help in structuring the research questions and review protocol.
2. Develop the inclusion and exclusion criteria	<ul style="list-style-type: none"> These criteria will guide screening of articles.
3. Develop a search strategy and apply in selected databases	<ul style="list-style-type: none"> It is ideal to use the free text fields of the advanced search in the electronic databases. Translate the search syntax based on the specific requirements of the selected electronic databases.
4. File records in the reference manager	<ul style="list-style-type: none"> Export the records, save the files, and import them into the reference manager. Batch exports are possible in the WoS and Scopus.
5. Identify and screen records	<ul style="list-style-type: none"> Remove duplicate records. Screen the remaining records based on (1) title, (2) abstract, and (3) full text.
6. Extract data and synthesize results	<ul style="list-style-type: none"> Develop a data extraction form to systematically record variables of interest. Extract, check, and summarize the information on identified methods and results.

Note: Additional guide may be found at <https://guides.library.cornell.edu/evidence-synthesis>.

preference, acceptance, adoption, willingness to pay). To illustrate the use of PICOS in developing a search strategy, the following syntax was used to identify the rice stakeholder studies from the Web of Science (WoS): TS=(rice* OR "oryza sativa") AND (pref* OR accepta* OR adopt* OR lik* OR choice* OR choos* OR purchase OR valuation* OR sensory OR hedonic OR "willingness to pay" OR "WTP" OR "willingness to accept" OR "WTA" OR "willingness to adopt" OR "willingness to try" OR uptake OR evaluation*) AND (consum* OR shopper* OR buyer* OR panel* OR "purchas* decision*" OR farmer* OR "farming household*" OR "primary producer*" OR producer* OR landholder* OR processor* OR processing OR retail* OR market* OR "value chain" OR stakeholder*). After extraction of studies, inclusion and exclusion criteria should be developed to guide the screening process.

Selecting the databases and journals

The selection of electronic databases and journals is an important step because the relevant studies that will be included in the review determine the outcome of an evidence synthesis research (Gusenbauer and Haddaway 2020). Some of the most important criteria that may be considered are the subject area/s supported by the search system, the resource types (e.g., articles, books), the functionality when using Boolean operators, and the allowed length of the search syntax. Some SLRs also extend their search to specific databases, such as an organization's publications archive.

Article selection process

Article selection mainly involves (1) identifying records from the databases using the search syntax and (2) screening records (e.g., Figure 1). The screening process involves three steps based on (1) title, (2) abstract, and (3) full text. The first

step is to skim all titles and remove those that are clearly out of scope. The second step is to scan the abstracts of the remaining records. The third step is to read the full text and identify the final records to be included in the review. The process of screening and removing ineligible records should be based on the inclusion and exclusion criteria.

Data extraction

A data extraction form may be created as a tool to systematically record variables of interest from the studies included in the review. SLRs that include different study types and methods generally extract, check, and summarize information on determined methods and identified results (Kamrath et al 2019). In the rice case study, the key information in the data extraction form was the year of data collection and publication, country of study, urban/rural setting, cropping season (if applicable), target respondents, sample size, data collection approach, outcome indicators, and specific rice attributes.

Categorization of extracted variables

The extracted variables may then be categorized depending on the analysis the researchers want to conduct. In the rice case study, data were categorized mainly based on geographical coverage and attributes. The regional categories were based on the United Nations (UN) Classification of Major Areas and Regions (UN 2022) and CGIAR subregions. The regions in the case study were grouped into six: West and Central Africa (WCA), East and Southern Africa (ESA), Eastern Asia (EA), Southeastern Asia (SEA), South Asia (SA), Latin America and the Caribbean, Northern America, Europe, and Oceania (LNEO) (Figure 2).

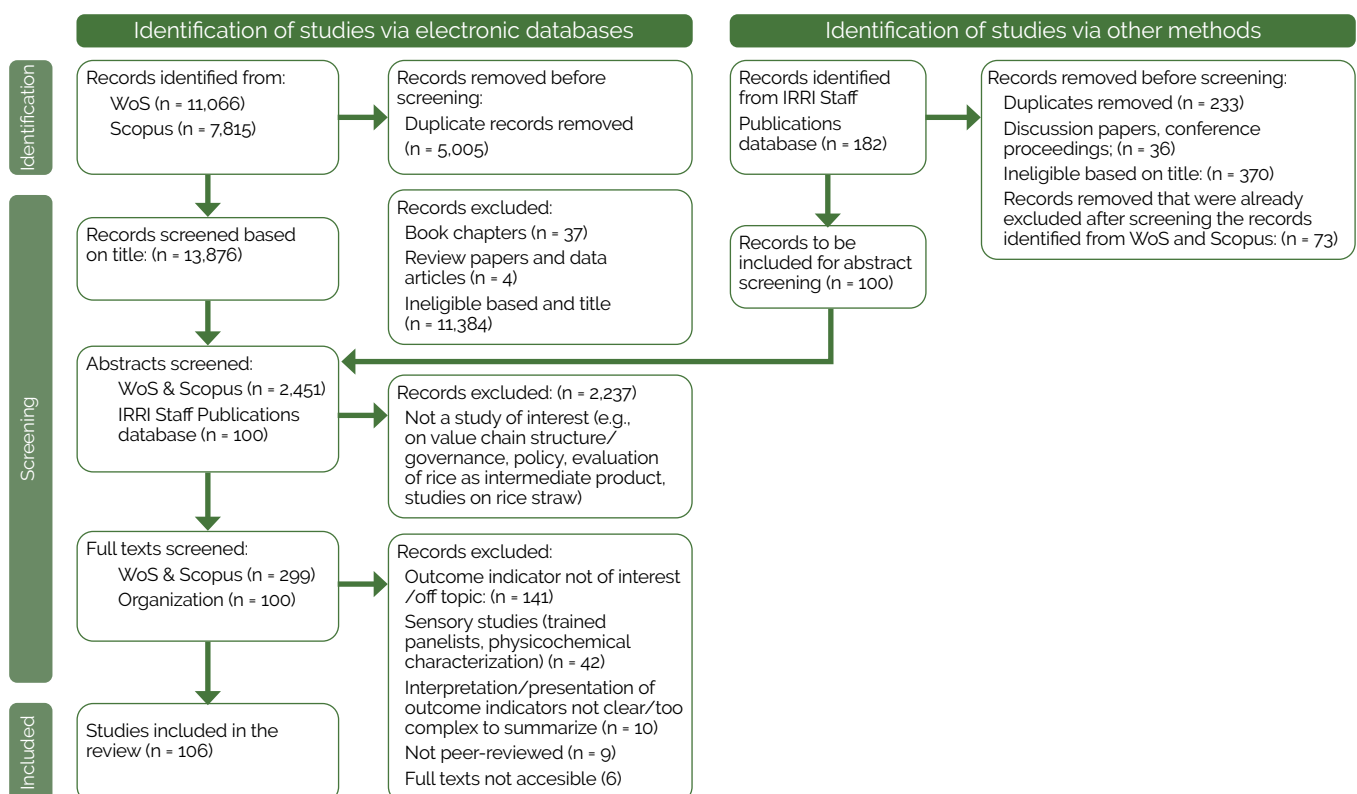


Figure 1. Example of article selection flow diagram. (Source: Custodio, Demont, and De Steur 2023.)

Application to the rice sector, key insights

This section summarizes key findings from the SLR of studies on stakeholder preferences in the global rice sector to illustrate how systematic evidence synthesis can help provide inputs for discussions on the requirements of value chain stakeholders and the implications for current and future market segments and product design. Evidence gaps are also discussed that can be used to provide inputs on the discussion of potential areas of future research. Readers are referred to the scientific paper for the full discussion (see [Custodio, Demont, and De Steur 2023](#)).

Key insights from the synthesis of consumer studies

Consumers have shared preference for whiteness, soft texture, and aroma. Comparison of consumer studies across regions and study years revealed a growing preference for whiteness (polished), soft texture, and aroma. This finding supports the previous proposition of a "jasminization" trend, which may be partly responsible for the shared preference for the distinct quality attributes of jasmine rice exported by Thailand, as the market leader in the export of high-quality jasmine rice, followed by Vietnam and Cambodia.

Consumers have heterogeneous preferences for taste, swelling capacity, and proportion of broken grains. Heterogeneity of preferences was observed for several intrinsic attributes. Taste is context-specific, and descriptors used were inconsistent. Swelling capacity (i.e., high volume expansion after cooking) is generally preferred in African regions but is not most preferred in Asian regions. Rice with a high proportion of broken grains was discounted by consumers in SEA and EA. This may stem from consumers' perceived importance of high head rice, which was partly due to upgrading of milling and parboiling technology in Asia. However, preferences for this attribute and WTP premiums for it were observed among consumers in WCA, which was partly due to the long-term importation of cheap broken rice from Asia brought about by colonial import-substitution policies.

Consumers have positive evaluation for provitamin A, folate, and zinc, but we found limited evidence on other nutrition attributes. We found limited studies that targeted evaluation of biofortified rice and most reported positive results, especially for provitamin A, folate, and zinc. Consumer evaluation of other micronutrient-enriched rice and low glycemic index rice is missing. Assessment of consumers'

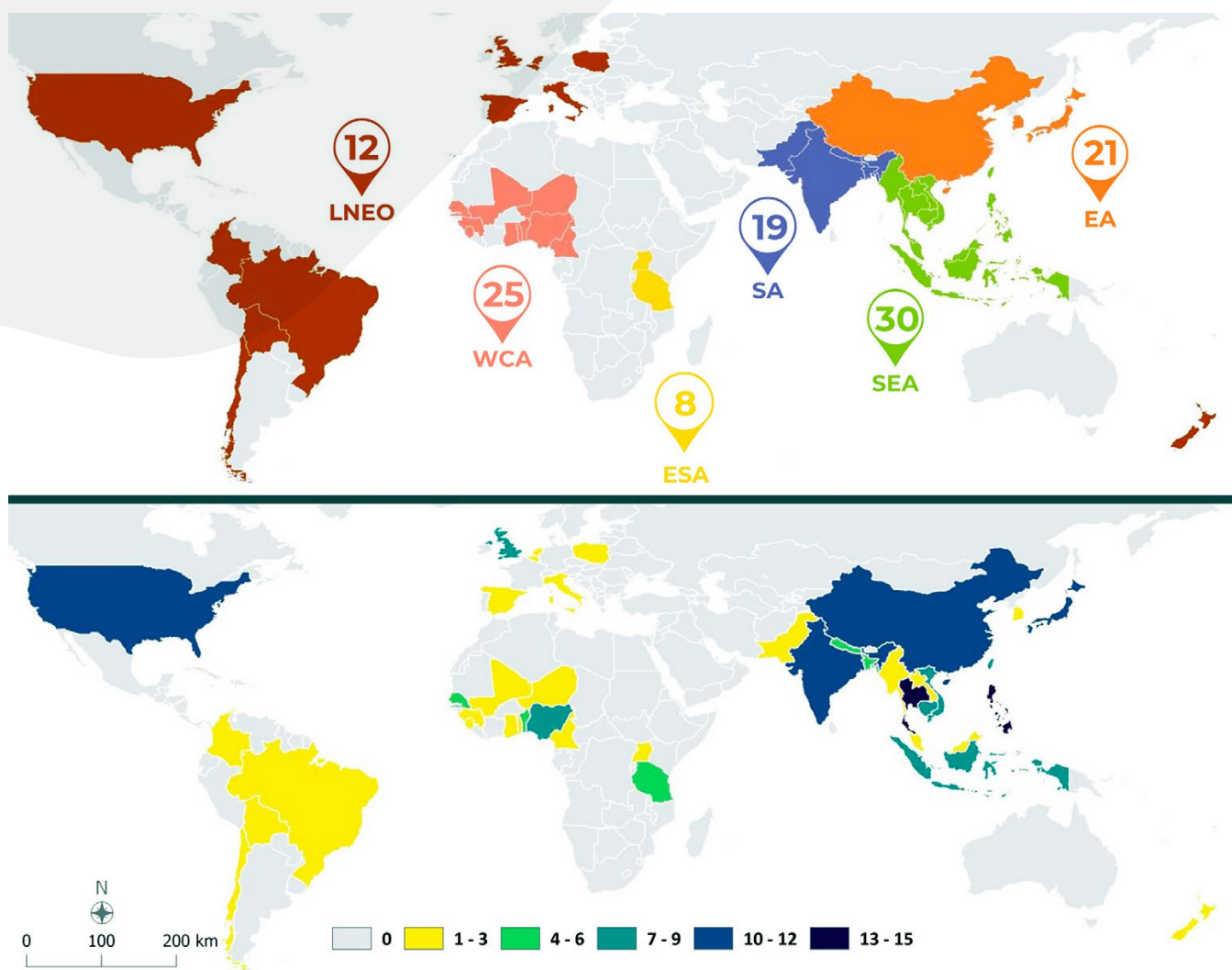


Figure 2. Maps showing the geographical distribution of the stakeholder preference studies included in the systematic literature review. Values refer to the number of studies. Maps were generated using QGIS software (QGIS Development Team 2020). WCA = West and Central Africa; ESA = East and Southern Africa; EA = Eastern Asia; SEA = Southeastern Asia; SA = South Asia; LNEO = Latin America and the Caribbean, Northern America, Europe, and Oceania. (Illustration by Neale Paguirigan (IRRI), Jhoanne Ynion (IRRI), and Norielli Palomares (University of the Philippines Los Baños)).

acceptance of rice with higher levels of micronutrients, higher levels of antioxidant properties, and lower glycemic index are potential areas of future research that will inform discussions on the identification of potential future market segments.

Consumers in South Asia have heterogeneous preference for size and shape. Studies conducted in SA provide evidence on the importance of physical traits in consumers' evaluation of rice (i.e., grain size, shape, color). Heterogeneity in preferences for grain size and shape was also found within the region and was more pronounced in SA than in other regions.

Consumers in Western and Central Africa consider eating and cooking quality, high swelling capacity, whiteness, and cleanness as important. Consumer studies in WCA revealed shared preference for imported rice due to better physical attributes such as whiteness and cleanness (e.g., absence of impurities) as well as eating and cooking quality (i.e., ease of cooking, taste, aroma, swelling capacity). This is partly due to consumers' long exposure to Asian imports.

Key insights from the synthesis of farmer studies

Farmer requirements for agronomic traits across regions focus on yield, maturity, plant height, lodging tolerance, and tillering ability. Synthesis of farmer studies in SEA suggests that the agronomic traits considered important by farmers are yield, uniform plant height, uniform tillers, long panicles, and reduction in shattering. In SA, farmers prioritize yield, plant height, early maturity, and rice straw quality. Farmers' preferences for tall and medium stature were specific for flood-tolerant varieties and for the wet season, respectively. Preference for lodging tolerance was observed, particularly during wet season. Rice straw yield was considered in several studies, which was almost unique in SA. In WCA, farmers also prioritize yield, early maturity, and tall plant height. Studies conducted before the 2000s identified yield, plant height, high tillering, ease in threshing, and early maturity as significant attributes that influenced adoption of improved varieties.

Farmers jointly consider yield and early maturity as priority attributes. Yield and early maturity were considered priority attributes across regions and study years. For many of these studies, yield and early maturity were jointly considered as most preferred, especially in SA, WCA, and ESA. It was also observed that early maturity may be prioritized over yield in certain growing conditions, such as in lowland agroecology. Early-maturing varieties offer several benefits for the farmers, the climate, and the environment, which may partly explain farmers' preference for this trait. Short duration varieties take 100–120 days to mature relative to 160–200 days for traditional varieties, which are highly susceptible to the adverse effects of climate change. Growing early-maturing varieties facilitates timely sowing of a succeeding crop, such as wheat, which allows for better crop rotation that farmers can employ relative to traditional varieties.

Information gaps in terms of geographical and stakeholder representation

To check representativeness of the primary studies included on the SLR (Figure 3a, outer ring), we compare the regional distribution of these studies with the allocation of rice production (Figure 3a, middle ring) and undernourished population (Figure 3a, inner ring). In SA, the share of consumer and farmer studies suggests underrepresentation of evaluation studies relative to both indicators. Within the African regions, although studies in WCA and ESA appear to be overrepresented relative to their production levels, they seem to match the share of the global undernourished population. In terms of stakeholder representation, the reviewed studies focus on either upstream (farmers) or downstream (consumers) stakeholders along the value chain, while missing midstream actors (processors, traders). In the consumer studies, urban consumption zones are adequately represented as sources of end-market opportunities for farmers to tap into demand (Figure 3b).

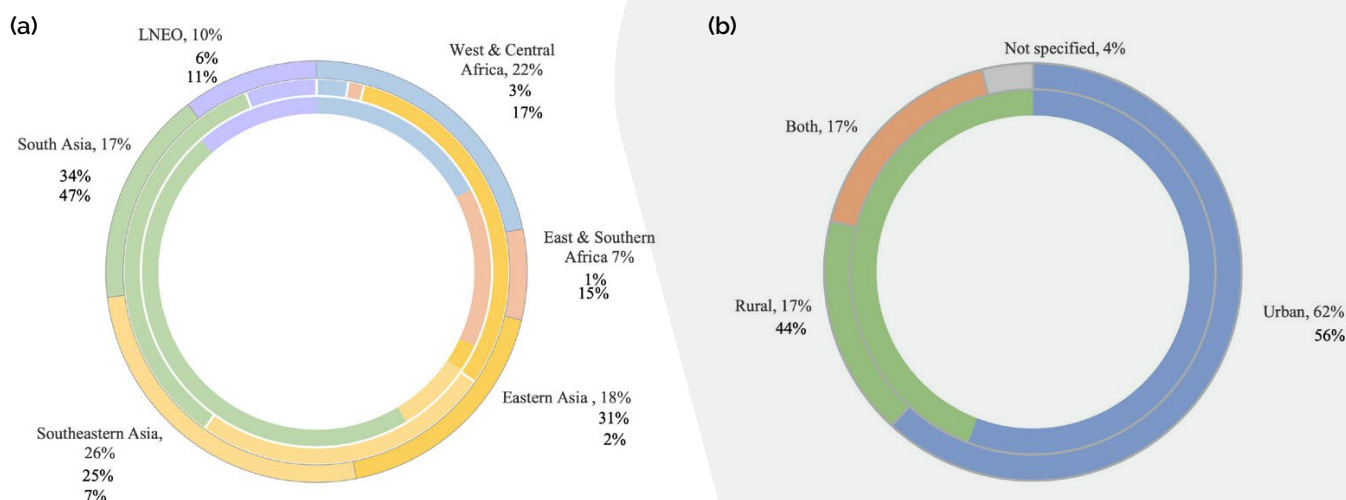


Figure 3. Example output: (a) share of regions based on study locations of farmer and consumer studies (outer ring), production levels (middle ring), undernourished population (inner ring); and (b) share of consumer studies conducted in urban and rural settings (outer ring), proportion of urban and rural population (inner ring). (Source: Custodio, Demont, and De Steur 2023.)

Conclusion and recommendations

Understanding current and future requirements of farmers, processors, and consumers for rice provides inputs for discussions on the design of seed products and the priorities for breeding investments. Before market intelligence teams undertake new data collection efforts, it can be important to review the existing information available from different sources. We designed a protocol conducting an SLR as a tool for evidence synthesis. The protocol may be adapted and applied to generate global scans of stakeholder requirements for seed products of a crop or at lower granularity for specific market segments. We applied this protocol to rice with the aim of uptake by market intelligence researchers for other crops.

In [Table 2](#), we corroborate the SLR's main findings with the current SPMSs and TPPs included in [GloMIP \(2023\)](#). The review suggests that farmer requirements for agronomic traits focus on yield, maturity, plant height, lodging tolerance, and tillering ability. The synthesis of consumer studies suggests that consumer requirements relating to grain quality include head rice recovery, texture, aroma, and color. These findings are consistent with and reflected in the rice SPMSs and TPPs, i.e., maturity, texture, and grain color are basic criteria for market segmentation, and plant height, lodging resistance, and head rice recovery are generally included as essential traits in the rice TPPs ([Table 2](#)). At the global level, our findings suggest that the traits preferred by stakeholders are generally considered in the current portfolio of rice market segments and TPPs. However, this analysis needs to be scaled down to the market-segment level to assess whether the traits proposed in the TPPs are in line with stakeholder requirements and fully tap into the impact opportunities presented in each market segment.

While the main objective of this brief is to present a protocol for conducting a systematic literature review to assess stakeholder requirements for current and future rice seed products, we recommend applying this method at the market-segment level to assess the alignment of breeding pipelines, through their TPPs, with market segments.

Potential areas of future research are also identified. For instance, chalkiness is included in the rice TPPs, but evaluation of this trait was lacking in the reviewed stakeholder studies. More importantly, evaluation of nutrition attributes also received limited attention in the reviewed studies, possibly because stakeholders do not yet think of nutritionally enhanced rice, which is an emerging product in global rice markets. Future market intelligence studies may target these traits to inform market segmentation, especially as several new nutrition-related attributes such as iron, zinc, vitamin A and low glycemic index are being developed for rice to address micronutrient deficiencies and non-communicable diseases (NCDs). On the other hand, volume expansion (which refers to swelling capacity) may also be considered in some TPPs, as it has been found to be a source of heterogeneity in consumer preferences across subregions and market segments. Currently, volume expansion is not included in the rice TPPs.

Finally, the involvement of midstream stakeholders in assessing stakeholder requirements could provide additional insights in identifying essential grain quality traits that may be included in the TPPs. The gaps identified in terms of geographical representation relative to their production level and undernourished population ([Figure 3a](#)) suggest further exploration of impact opportunities in South Asia, in Western and Central Africa, and in East and Southern Africa to address nutrition and food security challenges.

Table 2. Comparison of essential traits identified in stakeholder preferences studies with the current rice seed product market segments and target product profiles

Trait	SLR	SPMS criterion ^b	TPPs ^b	Trait requirement ^b
Agronomic				
Yield	✓		✓	Essential: Improve/Threshold
Maturity	✓	✓	✓	Essential: Threshold
Plant height	✓		✓	Essential: Threshold
Lodging	✓		✓	Essential: Threshold
Tillering ability ^a	✓		✓	N/A
Grain quality				
Head rice recovery	✓		✓	Essential: Improve
Cooked grain texture	✓	✓	✓	Essential: Threshold
Aroma	✓		✓	Essential: Threshold/Nice to have
Grain color	✓	✓		
Volume expansion/swelling capacity	✓			
Chalkiness			✓	Essential: Threshold
Nutrition				
Zinc content (polished rice)			✓	Essential: Threshold/Nice to have
Iron content (polished rice)			✓	Essential: Threshold/Nice to have
Protein content (unpolished rice)			✓	Essential: Threshold/Nice to have

^a Tillering is used as scale descriptor or trait description for (1) early vigor, (2) sheath rot (biotic stress, disease), (3) salinity/alkalinity (abiotic stress), and (4) iron toxicity

^b Source: GloMIP (2023).

Note: SLR = systematic literature review; SPMS = seed product market segment; TPP = target product profile.

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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 Lila Train at <Ltrain@cgiar.org>.

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