

Assessing production constraints and opportunities for GCP priority food crops and farming systems*

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* GCP SP5 Project G4008.36: *Getting the focus right: Food crops and smallholder constraints*

Objectives

This project has two major objectives:

- Participatory assessment of smallholder production constraints for six food crops in 15 farming systems that exhibit extreme poverty and are high priority for the Generation Challenge Program (GCP).
- Consultative identification of potential solutions to the more important constraints, especially those with a varietal (genetic or germplasm) component.

Context and Focus

Drought has been identified as a major priority for food crop improvement programs in international agricultural research, including for the GCP. However, other important constraints limit productivity in good seasons, as well as in drought years. There are many geographically widespread studies of particular types of constraints such as pests and diseases or socio-economic issues and many more-comprehensive studies at a local level. There are also a few collections of broader assessments across important production regions for several food crops, e.g. Evenson et al (1996) for rice and Reynolds et al (2008) for wheat. Few of these studies provide sufficient contextual information to extrapolate the results across zones, seasons and years, which is important in priority setting.

In recognition of the complexity of factors which affect the improvement of food crop yields and productivity under smallholder conditions in different farming systems throughout the developing world, the relative importance of a broad range of abiotic, biotic, crop management and socioeconomic constraints needs to be assessed in biophysical and economic terms. A systematic tapping of the knowledge of experienced research and development practitioners is needed to provide valuable information on the relative importance of different production constraints and traits. Thus to generate information to support existing projects and identify areas for future investment, the GCP is funding a study of production constraints and opportunities for important food crops in priority farming systems.

The study covers six high priority food crops for the GCP – wheat, rice, sorghum, cassava, cowpea and chickpea – in 15 broad-based farming systems that have a high priority for the GCP (Table 1). These priority farming systems feature high degrees of poverty (with up to 28.3 million stunted children in South Asia rice wheat system and these 15 systems include 73% of total stunted children in developing countries (Figure 1) and drought incidence, and large production areas of food crops. They were identified in a previous GCP project undertaken by CIAT, CIMMYT and IFPRI (Hyman et al 2008) from the larger set of farming systems described in Dixon et al (2001). Five of the farming systems are in Sub-Saharan Africa, five in South Asia, four in East Asia Pacific and one in Latin America (Table 1). This new project was developed from a pilot study on constraints with maize that was completed by CIMMYT for the GCP in 2007 (Gibbon et al 2007). Results will guide those involved in food crop breeding and related research by prioritizing key traits for improvement in each system, and by eliciting ideas on solutions to key constraints, especially those that may offer opportunities for investment by the GCP.

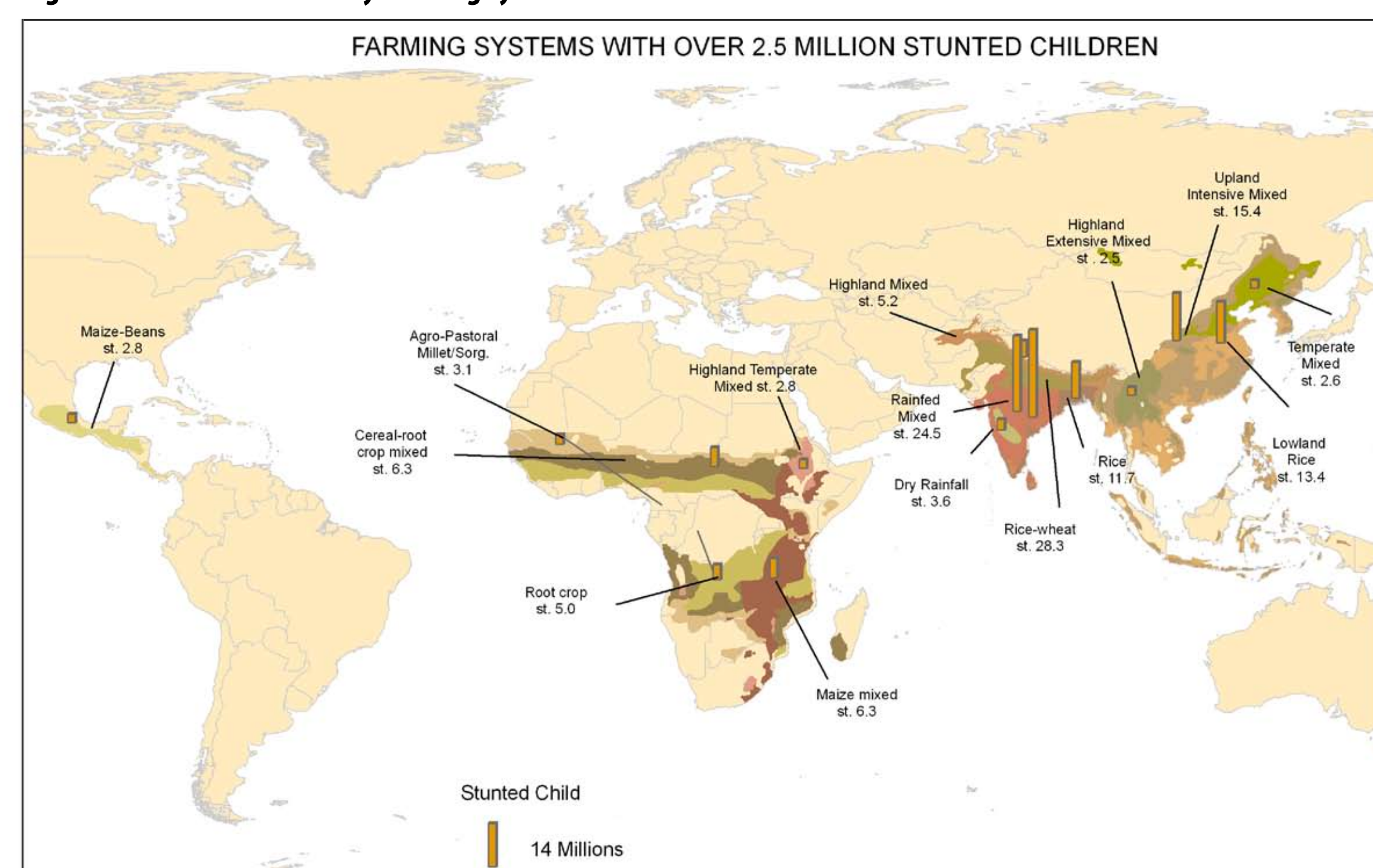


Table 1. The 15 focus farming systems and 6 crops

Region	Farming System	Wheat	Rice	Sorghum	Cassava	Cowpea	Chickpea
Sub Saharan Africa	Highland Temperate Mixed	✓		✓			✓
	Root Crop		✓	✓	✓	✓	
	Cereal-Root Crop Mixed		✓	✓	✓	✓	
	Maize Mixed		✓	✓	✓	✓	
	Agro-Pastoral Millet/Sorghum			✓		✓	
South Asia	Highland Mixed	✓	✓		✓		✓
	Rice-Wheat	✓	✓				✓
	Rice		✓		✓		✓
	Rainfed Mixed	✓	✓	✓			✓
	Dry Rainfed	✓	✓	✓			✓
East Asia Pacific	Lowland Rice	✓	✓		✓		
	Upland Intensive Mixed	✓	✓		✓		
	Temperate Mixed	✓	✓				
	Highland Extensive Mixed	✓	✓				
Latin America	Maize-Beans (Mesoamerican)			✓			
No. of Systems		9	11	8	7	4	6

Farming systems featuring high levels of poverty; crops planted on > 3% cropped area or > 100,000 ha in system

Figure 1. Stunted children by farming system



Methods

The study uses a modified "Delphi" methodology (Gibbon et al 2007). Three rounds of interaction take place with panels of experts on the crops in the farming systems, primarily using a series of questionnaires administered through regional focal point persons and Email contacts. This allows convergence on important constraints, issues and solutions for the crops in the farming systems. The expert knowledge of around 450 panelists familiar with the crop and region is being sought, including plant breeders, agronomists, agricultural economists and other researchers; extension and NGO staff, seed houses and other input suppliers. Many NARES institutions and several CGIAR institutions are participating.

Emphasis was on identifying and quantifying important constraints that contribute to the smallholder farm yield gap which is defined as: Best achieved yield on farm – Average yield on farm, and then using the information for priority setting among opportunities to alleviate the constraints (Shumba et al 1990; Evenson et al 1996). Round 1 questionnaires were sent for all six crops and information has been returned by panelists on yield gaps, important constraints, yield losses, their spatial and temporal distribution and effects on income. Important constraints were identified within four broad categories: Abiotic, Biotic, Management and Socio-economic.

Initial Findings

Large smallholder farm yield gaps were identified for most crops and farming systems, including the high input and management rice and wheat systems in South and East Asia where the yield gap ranged from half to the same size as current farm yields

(Table 2). With sorghum and the legumes, the yield gap was at least double current farm yields. Abiotic and management constraints were considered by panelists to be especially important for most of the crops and systems while biotic constraints were reported important for the legumes. Socio-economic constraints were considered more important with the rice and sorghum crops.

Examples of the most important constraints and associated yield losses reported by panelists are in Figure 2 for several key crops and farming systems. The initial main constraints for wheat in the rice-wheat system of South Asia were 'heat during grain filling' (average loss 153 kg/ha grain), the related 'late planting of crop' (150 kg/ha loss), and 'weed competition' (155 kg/ha loss), while socio-economic constraints were relatively less important. In contrast, for rice in the East Asia lowland rice system several socio-economic and management constraints such as 'low price of output' (177 kg/ha loss, referring to average conditions over recent years), 'inappropriate fertilizer use' (217 kg/ha loss) and 'inadequate water management' (191 kg/ha loss) were reported more important than abiotic or biotic constraints. For cowpea in the sub Saharan Africa maize mixed system, the most important constraints are 'P deficiency' (129 kg/ha loss) and 'Unavailability of quality seed from supplier' (103 kg/ha loss).

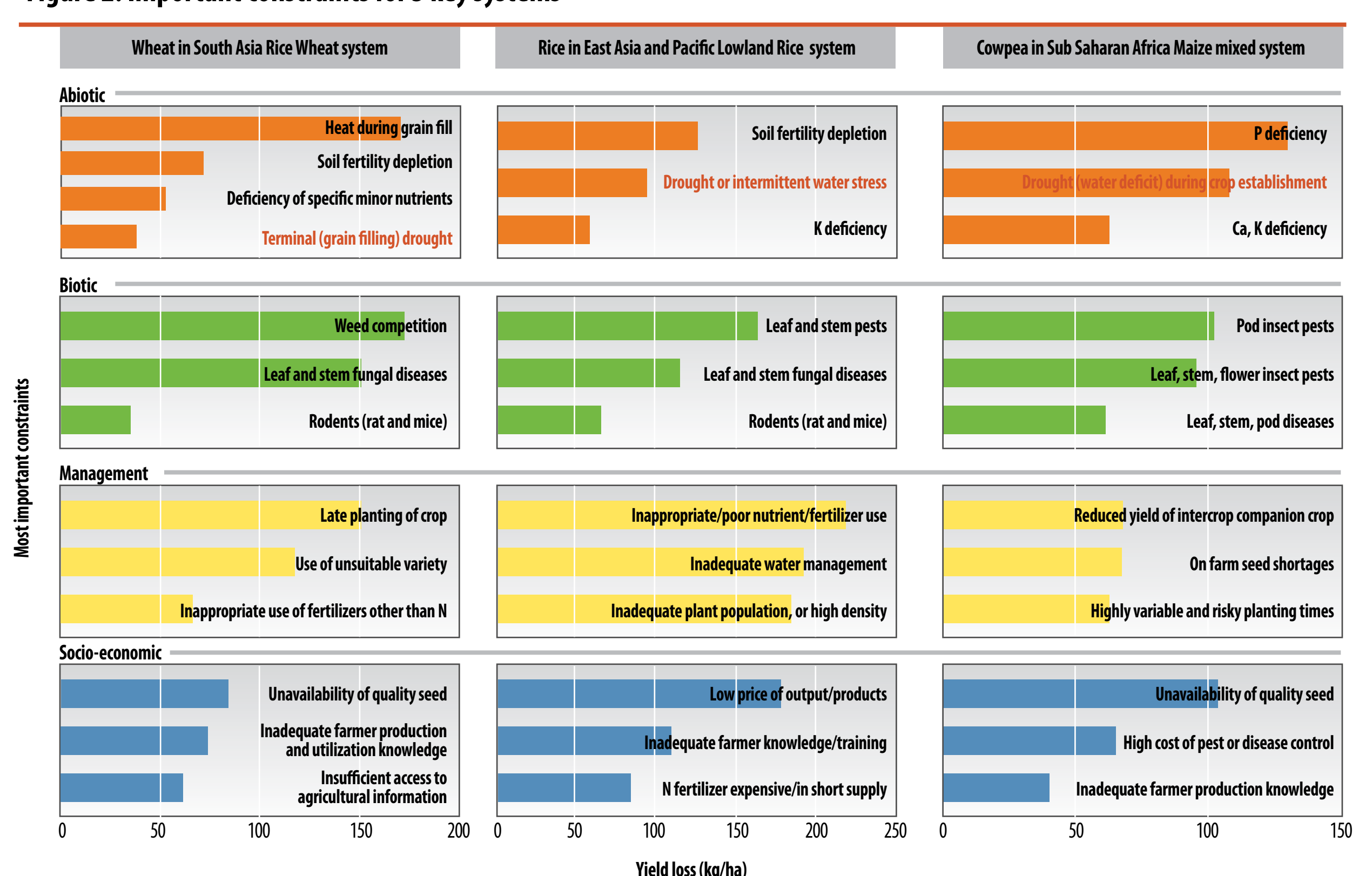
Future Rounds

Round 2 of the study is asking panelists to confirm or modify important constraints and the magnitudes of losses, as well as to examine constraint interactions and effects of constraints on the broader farming enterprise. Round 3 will elicit ideas from panelists on solutions and opportunities to alleviate the constraints, particularly identifying those of a varietal or genetic nature that can be addressed by the GCP. A comprehensive report and journal article of findings will guide GCP priority setting.

Table 2. Yield gaps and yield losses by constraint category for key crops and farming systems

Crop	Farming system	Highest smallholder farm yield (t/ha)	Average smallholder farm yield (t/ha)	Smallholder yield gap (t/ha)	Yield losses by constraint category (Percent of total yield gap, %)			
					Abiotic	Biotic	Management	Socio-economic
Wheat	South Asia-Highland Mixed	4.2	2.1	2.1	29.8	20.8	27.0	22.6
Wheat	South Asia-Rice Wheat	4.6	2.4	2.2	25.0	22.6	31.3	21.2
Wheat	South Asia-Rainfed Mixed	5.0	2.4	2.5	28.1	22.0	28.4	20.4
Wheat	East Asia Pacific-Temperate Mixed	9.0	6.1	3.2	32.9	18.7	25.6	19.3
Rice	South Asia-Rice Wheat	5.4	3.1	2.3	26.5	20.5	27.0	26.3
Rice	East Asia Pacific-Lowland Rice	9.3	6.5	2.9	21.1	17.4	34.6	27.5
Rice	East Asia Pacific-Upland Intensive Mixed	10.3	7.2	3.1	29.1	18.7	26.3	25.9
Sorghum	Sub Saharan Africa-Maize Mixed	3.0	0.9	2.2	27.5	17.8	23.2	31.5
Sorghum	Sub Saharan Africa-Agro pastoral Millet/Sorghum	2.7	1.0	1.8	31.4	17.9	26.9	24.3
Chickpea	South Asia-Rice Wheat	2.1	0.6	1.2	30.3	31.3	23.8	14.8
Cowpea	Sub Saharan Africa-Maize Mixed	1.4	0.4	1.0	29.0	26.7	24.8	22.8

Figure 2. Important constraints for 3 key systems



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