From Attractiveness to Feasibility: Assessing national capacity to adapt, deliver, and adopt GCP technologies

GCP SP5 Project G4008.24: From attractiveness to feasibility: a strategic assessment of the capacity to develop and adopt GCP technologies

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Introduction

This project assesses the capacity for development and adoption of GCP technologies. Building on an existing evaluation of high priority geographic areas and cropping systems at a regional scale (Hyman *et al.,* 2008), the assessment identifies local capacities for technology adaptation, delivery, and adoption at a national and local scale. The study develops and evaluates indicators according to combinations of priority traits and crops of the GCP. First, 36 unique combinations of farming systems and countries were ranked according to their levels of drought and crop production. Next, GCP research was inventoried according to country, crop and trait combinations, allowing us to delineate the extent of GCP activities in specific developing countries. An analysis of adoption capacity at country level has been initiated using the Agricultural Science and Technology Indicators (ASTI) database.

Attractiveness approach

Our approach considered regions with high poverty, a large area of staple crops and high drought as attractive for deploying GCP technology. The following analysis was made to stratify regions in developing countries according to these criteria. First, farming systems and countries were combined, resulting in 543 unique combinations. The combinations with less than 15% of drought probability and those outside of the 15 GCP priority FS were excluded from the sample. We then chose 36 unique combinations of farming systems and countries according to our poverty proxy: absolute number of stunted children and prevalence of stunted children. The list was then divided in terciles so we obtained three groups of 12 combinations each. We then sorted the list by drought probability, and area (absolute area and share of GCP priority crops as a percent of the total crop area). The top third of the 36 combinations received values of 1, the middle third received a value of 2 and the bottom third was assigned a value of 3 (Table 1). This results of this analysis are summarized in Table 2.

DROUGHT PROBABILITY \ CROP AREA Absolute/Relative	1	2	3
1	1	2	3
2	4	5	6
3	7	8	9

Table 1. Assigned values for combinations of drought probability and GCP crop areas.

The ranking of countries (drought Vs. absolute and relative crop area) was based on a 3x3 matrix where values 1, 2 and 4 were considered the best rankings (shown in red in Table 1). The next best are 3, 5, and 7, shown in orange. The least attractive have values of 6, 8 and 9 are shown in yellow. The geographic representation of the ranked countries (by absolute/relative GCP crop area) can be observed in Figures 2 and 3.

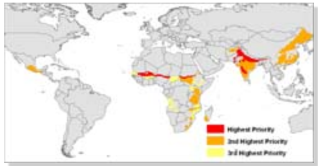


Figure 2. Geographical distribution of GCP priority areas (poverty, drought, food staple crops) using absolute number of stunted children and **absolute** area of the 6 GCP priority crops being affected by drought (preliminary).

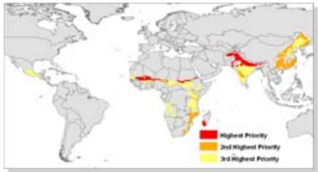


Figure 3. Geographical distribution of GCP priority areas (poverty, drought, food staple crops) using absolute number of stunted children and **relative** area of the 6 GCP priority crops being affected by drought (preliminary).

The Attractiveness and Feasibility Concept

- Prior studies have identified focus areas for GCP activities based on their potential contribution to the humanitarian and technical goals of GCP. We call this phase the "attractiveness" of satisfying those goals. That analysis assumed that GCP technologies will be broadly adapted to local conditions and adopted by farmers – both very strong assumptions. This study seeks to assess and take account of these factors.
- The GCP's initial target/focus areas need to be subjected to a second phase evaluation that makes provision for the likely capacity of local institutions and farmers to realize the projected potential for GCP impact. This second phase can be described as assessing the "feasibility" of achieving desired outcomes in the high-priority (most attractive) focus areas.
- We need to better understand the relationship between these two dimensions in each location, since in some areas the potential benefits may be very attractive, but the local feasibility of achieving them might be quite low and vice versa.
- How can we assess local scientific capacity for adaptive breeding? How can we assess whether adequate technology and delivery systems are in place? How can we likely assess the ability of farmers to adopt new technologies? Thus, three main factors need to be assessed and built into the analysis:
    - the level of local technology adaptation and development capacity of (primarily national) institutions and agents,
    - the capacity of the (public or private) systems for delivering and supporting new crop technologies for smallholders, and
    - the ability of local farmers and communities to adopt and apply locally-adapted GCP technologies.

Figure 1. Proposed activities and outputs linked to GCP's prior strategic targeting studies

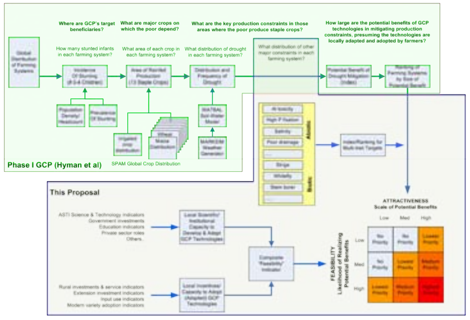


Table 2. Comparison of rankings using a two-way aggregate methodology

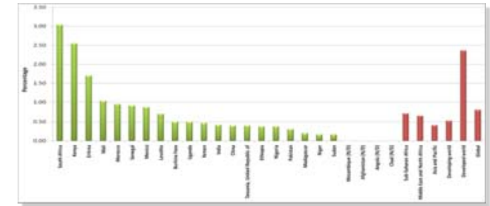
Country	Farming System	No. of stunted children	Prevalence of stunted children (%)	Mean Drought (%)	Mean drought (terciles)	Crop area - Wheat, Rice, Sorghum, Cassava, Chickpea, and Cowpea - (ha)	Absolute area (terciles)	Total crop area - 20 crops identified in the farming systems - (ha)	Crop share	Relative area (terciles)	Rankings: Absolute area	Rankings: Relative area	No. of GCP projects	Research intensity (public expenditures as a % of AgGDP)	Public researchers per $100 million AgGDP (2000 international dollars)	Commodity focus	Acreage weighted shared of modern varieties	Area share weighted average of modern variety adoption
		Attractiveness side												Feasibility side				
South Africa	Maize mixed	159,126,896	24.10	48.19	1	26,084	3	371,951	0.07	3	3	3	3	3.04	8.5	Maize, Wheat, Sorghum (yields)	17,700,000	69.64
Kenya	Maize mixed	859,591,104	37.70	40.21	2	551,077	2	2,251,381	0.24	3	5	6	6	2.55	16.9	Vegetables, Maize, Coffee, Fruits	1,374,856	13.96
	Agro-pastoral millet/sorghum	172,258,144	37.60	66.72	1	25,667	3	178,631	0.14	3	3	3						
Eritrea	Highland temperate mixed	105,139,952	39.30	49.07	1	66,623	3	99,723	0.67	1	3	1	1	1.70	16.7	Sorghum, Millet, Wheat, Barley	n/d	n/d
Mali	Agro-pastoral millet/sorghum	423,645,888	38.80	45.31	1	613,618	2	1,613,021	0.38	2	2	2	4	1.03	13.40	Rice, Sorghum	442,884	4.82
Morocco	Rainfed mixed	175,979,280	20.40	14.51	3	1,290,788	1	1,972,396	0.65	1	7	7	2	0.95	4.2	Wheat, Fruits, Vegetables	931,755	30.27
	Highland mixed	132,184,528	24.80	25.70	2	228,200	3	478,938	0.48	2	6	5						
Senegal	Agro-pastoral millet/sorghum	289,290,368	23.80	41.35	2	296,364	3	2,070,691	0.14	3	6	6	7	0.91	9.6	Rice, Millet	568,451	9.56
Mexico	Maize-beans (Mesoamerica)	1,738,349,056	37.80	22.49	2	934,241	2	5,794,810	0.16	3	5	6	2	0.87	8.6	n/d	1,005,974	19.19
Lesotho	Highland temperate mixed	102,499,168	46.00	44.38	1	84,003	3	256,479	0.33	3	3	3	0	0.71	8.5	n/d	n/d	n/d
Burkina Faso	Cereal-root crop mixed	559,547,456	38.00	16.88	3	978,700	2	2,345,542	0.42	2	8	8	5	0.50	5.7	Rice, Wheat, Maize	12,200,000	60.05
	Agro-pastoral millet/sorghum	267,906,256	36.90	46.58	1	315,312	2	817,502	0.39	2	2	2						
Uganda	Maize mixed	785,641,728	34.80	16.01	3	696,198	2	3,432,978	0.20	3	8	9	5	0.50	2.50	Bananas, Cassava	5,450	0.00
Yemen	Highland mixed	917,681,408	54.10	83.69	1	203,097	3	312,861	0.65	1	3	1	0	0.47	12.6	n/d	725,300	20.32
India	Rice-wheat	22,121,570,304	58.90	28.95	2	39,651,509	1	56,008,469	0.71	1	4	4	13	0.42	n/d	Rice, Wheat (based on crop yields)	5,559,910	43.41
	Rainfed mixed	24,475,873,280	63.60	17.25	3	32,298,494	1	73,201,765	0.44	2	7	8						
	Dry rainfed	3,610,071,040	65.50	32.29	2	5,057,643	1	12,754,535	0.40	2	4	5						
China	Upland intensive mixed	11,160,957,952	34.10	15.60	3	16,308,835	1	29,833,010	0.55	1	7	7	19	0.40	n/d	Rice, Wheat	798,200	30.78
	Highland extensive mixed	1,956,970,624	48.20	14.47	3	1,622,191	1	3,078,635	0.53	1	7	7						
	Temperate mixed	2,564,519,936	21.60	20.10	3	9,757,313	1	32,270,641	0.30	3	7	9						
Tanzania, United Republic of	Maize mixed	1,296,633,344	47.30	16.14	3	1,279,363	1	3,637,488	0.35	2	7	8	4	0.40	8.30	Rice, Maize, Coconut, Cassava, Tea, Coffee	0	n/d
Ethiopia	Agro-pastoral millet/sorghum	104,886,016	55.00	40.73	2	82,037	3	170,122	0.48	1	6	4	2	0.38	3.50	Wheat, Vegetables, Maize	924,238	82.35
	Maize mixed	1,223,741,568	46.30	32.72	2	57,467	3	219,048	0.26	3	6	6						
Nigeria	Agro-pastoral millet/sorghum	907,023,552	41.50	30.97	2	2,329,761	1	4,953,513	0.47	2	4	5	2	0.38	4.80	Cassava, Oilpalm, Yam, Bananas, Maize	938,712	5.73
Pakistan	Highland mixed	420,094,464	16.80	49.98	1	679,948	2	990,135	0.69	1	2	1	0	0.31	n/d	Wheat, Fruit	324,236	39.67
	Rice-wheat	3,906,886,400	34.20	88.96	1	10,680,767	1	16,484,549	0.65	1	1	1						
Madagascar	Cereal-root crop mixed	125,585,088	34.90	58.58	1	120,538	3	166,664	0.72	1	3	1	0	0.20	6.7	Rice, Vegetables, Cotton, Potatoes, Maize, Coffee	979,887	29.01
Niger	Agro-pastoral millet/sorghum	203,932,688	36.80	52.45	1	1,648,003	1	4,033,167	0.41	2	1	2	2	0.17	4.1	Millet, Cowpea, Sorghum, Vegetables, Rice	802,220	6.89
Sudan	Agro-pastoral millet/sorghum	264,941,216	45.50	49.40	1	1,259,814	1	3,008,930	0.42	2	1	2	1	0.17	3.7	Cotton, Vegetables, Wheat, Sorghum	6,811,199	61.33
	Cereal-root crop mixed	232,481,376	16.80	22.49	2	1,184,922	2	3,774,521	0.31	3	5	6						
Mozambique	Cereal-root crop mixed	642,457,344	58.40	22.05	3	773,258	2	1,590,515	0.49	1	8	7	4	n/d	n/d	n/d	255,200	0.00
	Maize mixed	295,101,856	54.40	36.27	2	329,609	2	970,370	0.34	2	5	5						
	Root crop	181,898,112	56.60	18.30	3	74,469	3	362,323	0.21	3	9	9						
Afghanistan	Highland mixed	595,539,712	14.00	29.11	2	458,155	2	560,498	0.82	1	5	4	0	n/d	n/d	n/d	n/d	n/d
Chad	Cereal-root crop mixed	360,810,880	39.30	16.60	3	687,714	2	1,710,493	0.40	2	8	8	0	n/d	n/d	n/d	9,202,586	52.35
Angola	Cereal-root crop mixed	541,478,528	52.90	17.88	3	106,914	3	368,519	0.29	3	9	9	0	n/d	n/d	n/d	1,117,350	52.00

Source: Compiled by authors from ASTI timeseries data and Pardey *et al.* (2006).
Notes: Data for 2000. However, ASTI data has been compiled for the latest available years: Lesotho (1991), Mexico and Yemen (1996), India (1999), Burkina Faso, Mali, Niger and Senegal (2001), Morocco (2002), and Pakistan (2003).

Two-way methodology – initial assessments of capacity

The results revealed that the best 7 ranked combinations of farming systems and countries, in terms of drought vs. crop area (absolute and relative) are: agro-pastoral millet/sorghum (Mali, Burkina Faso, Niger, and Sudan), rice-wheat (India and Pakistan), and highland mixed (Pakistan). We can say that these combinations show high attractiveness or good pay off compared to other ones (cells in orange and yellow). Nonetheless, areas with lower potential payoffs may still have an important role if local conditions make the realization of that potential more feasible than for the higher potential payoff areas. As part of the initial assessment of local R&D capacity an important indicator is the public agricultural research intensity ratio (total public spending as a % of the agricultural gross domestic product). Higher values, as found in Senegal (0.91%), indicate that the country invested $0.91 in agricultural R&D for every $100 of agricultural output. By comparison, Senegal's R&D intensity ratio was above the Sub-Saharan Africa average (0.72%) as well as that for the developing world (0.53%) in the year 2000 (Table 2 and Figure 4). Even though the potential pay off for GCP technologies is not in the highest category for Senegal, *a priori*, the research intensity ratio suggests that there is a better chance that Senegal's national breeding system might be able to adapt GCP technologies than many other countries of the same region – so the final impact in farmers fields could still be very significant. The number of researchers per $100 million of AgGDP in Senegal (9.6) is also one of the highest in the region. Currently we are gathering evidence on farm scale adoption of modern crop varieties across many countries and crops (e.g., from studies reported in Evenson and Gollin (2003).

Figure 4. Public agricultural research intensity compared regionally and globally, 2000



Source: See table 2.
Notes: See table 2.

The GCP footprint

The role of national programs in the delivery pathway of GCP technologies is unquestionably fundamental. An important assumption here is that the engagement of local institutions in the development of GCP research activities could potentially be of benefit to a large share of the production of a specific country. Using different sources, such as the GCP website and various GCP publications we put together a list of GCP projects and national partners per country. We mapped the number of projects per country that have engaged local collaborators (Figure 5). The map illustrates the intensity of science activity for each country (darker colors denote larger number of projects). This measure is also a key element to select of our portfolio of case study countries, therefore it was included as a column in the two-way methodology table (Table 2).

Figure 5. GCP projects that involve developing country partners

Next Steps

- Developing and utilizing capacity indicators (feasibility) will add new perspectives to the potential benefit (attractiveness) analysis used so far in GCP. We find several combinations of potential benefit (high, medium or low) with local capacity (high, medium or low) and are using this typology to guide the identification of (3-5) country case studies (and their associated crops and traits). Subsequent to identifying a case study countries we will proceed with;
- The preparation a methodology paper that describes the detailed approach to jointly assessing potential socioeconomic impacts and local implementation capacity with respect to GCP technologies. The approach (already under design) will allow for the structured integration of existing measure of attractiveness with measures of adaptation, delivery, and adoption (feasibility) to be developed by the project.
- In addition to the aggregate methodology described here that provides a framework for choosing relevant and representative country case studies, we will be launching country-specific data collection efforts to examine factors shaping the nature and effectiveness of local adaptive research, technology delivery, and farmer adoption as well as the scaling up/out of GCP technologies.
- Rapid identification of appropriate in-country collaborators is a crucial next step.

Literature cited

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