Estimating **Targets for GLDC**

This report is commissioned by ICRISAT to accompany the proposal on
CGIAR Research Program on
Grain Legumes and Dryland Cereals Agri-food Systems

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Prioritization of Crops and Estimating Targets for GLDC

Methodology: To quantify the value of production and contributions of the target crops to the three SLOs, crop wise national crop area, production and yield projected by the World Bank's forecaster model (http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129825) was used along with population, poverty, percentage population engaged in agriculture, population growth rates and malnourishment (World Bank Data). The projector model estimated country specific productivity and acreage for 2022 and 2030 for the GLDC target countries. However, based on expert opinion, two discount factors were applied: Crop Discount Factor and Country Discount Factor. The product of these two discount factors estimates the strength of research and development for each crop and institutional barriers and enabling environment for each country. When taken together, these offer greater granularity and were cross-referenced with historical adoption studies for mandate crops where data existed.

Value for money

The SRF was designed to illustrate the impact of agricultural research for development by 2030; it evaluates systemwide anticipated achievements towards the Sustainable Development Goals measured by the three SLOs of reducing poverty, improving nutrition, and improved natural resources/ecosystem services. GLDC leverages enabling environments to take advantage of policy, technology and partnerships converge to accelerate the adoption of profitable technologies by farmers while recognizing advantages (and disadvantages) in regional and national enabling environments, production challenges and market opportunities. CGIAR has received considerable return on investment (ROI) while converging policy, technology, and partnerships. The Tropical Legumes II (TL II) is a good example of this investment;[1] GLDC will use the same strategy to scale technologies and livelihood strategies in the drylands.

GLDC has set targets contributing to the SLOs (and thereby the SDGs) in the areas of poverty reduction, improved nutrition, and sustainable production. Due to the nature of the target crops, the CRP is getting value for money in the case of improving nutrition for health. In addition, many cropping systems for the drylands are grown in marginal lands, adding carbon to the soil profile that would otherwise be disproportionately impacted by climate change. A proven technology that has reached over 400,000 farmers in the Sahel of Africa is microdosing in dryland cereal cropping systems. The legumes, grown as companion crops to cereals, will further increase soil health through nitrogen fixation – a distinguishing feature of GLDC within the agri-food system portfolio. Our efforts will contribute to CGIAR efforts of keeping global temperature rise under 2 degrees by reducing agriculturally-related greenhouse gas emissions by 0.8 Gt CO_2-e yr–1 (15%)[2]. Conservative estimates over current annual levels of nitrogen fixation in residues that remain in the system for GLDC target countries is 27,500 tons of N by 2022 (assuming 25 kg N/ton of legume residue + 30% for roots)[3] [4]. Fixing nitrogen and carbon in the drylands directly contributes to SLO3, which aims to sustain production for future generations by restoring 190 million ha of degraded land, conserving 7.5 million ha of forest, reducing agricultural greenhouse gas emissions.[5]

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[1] Enhancing Grain Legumes Productivity and Production and the Incomes of Poor Farmers in Drought-Prone Areas of Sub-Saharan Africa and South Asia, Found Online at: http://www.icrisat.org/TropicalLegumesII/

[2] CGIAR SRF 2016-2030: Redefining how CGIAR does business until 2030, found online at: https://library.cgiar.org/.../CGIAR%20Strategy%20and%20Results%20Framework.pdf.

[3] Unkovich, Murray J., John S. Pate, and Paul Sanford. "Nitrogen fixation by annual legumes in Australian Mediterranean agriculture." *Australian Journal of Agricultural Research* 48.3 (1997): 267-293.

[4] Herridge, David F., Mark B. Peoples, and Robert M. Boddey. "Global inputs of biological nitrogen fixation in agricultural systems." *Plant and Soil* 311.1-2 (2008): 1-18.

[5] Ibid. ii

Calculation of targets

The CRP is proposing to contribute an estimated cost per beneficiary based on $ weighted contributions across the five GLDC flagships for each SLO target. SLO1, to reduce poverty, was calculated at the expected rates the GLDC can improve incomes above the US$1.9/day threshold (The hypothesis used to calculate poverty reduction originally set poverty at US$1/day threshold in 2001. However, considering inflation compounding over the last sixteen years, the hypothesis is assumed to be valid at current poverty which is set to US$1.9/day threshold). The best means to improve rural livelihoods is by improving production, and for each 1% increase in yields, there is a corresponding 0.8% reduction in poverty[6] at US$1/day.

These targets are calculated using baseline data for population, poverty and malnutrition from the World Bank in 2014. They are also supported by 2014 data from FAO on harvested and yield area per crop. The number of assumptions made in these calculations was minimal and limited to productivity discount factors (yield gaps) rolled up by crop and country. It is important to note that GLDC achieves gains through partnerships (particularly when the target description mentions “assists”). For example, the core implementers of the CRP have little comparative advantage in evaluating community nutrition, and so will rely on partners such as the Global Alliance for Improved Nutrition (GAIN) to meet targets.

SLO1: Using the assumption from the Schneider article, we were able to calculate GLDC improved production into poverty reduction (Figure 1). Discount factors were calculated per crop and calculated into the total production data. These include the capacity for adaptive research and the ceiling level of adoption**.** Over Phase I of the CRP, impact has gained a lot of traction in alleviating poverty. In India alone, pearl millet has realized a 3-3.5% yield increase annually since the mid-1990s.[7] GLDC will meet poverty alleviation targets by providing access to improved varieties in the current development pipeline which include: Aschochyta blight-resistant chickpea, Striga- and Alectra-resistant cowpea, Striga-resistant sorghum, blast- and Striga-resistant pearl millet and more that are traits specific to regional growing challenges (See full list in Table FP4.2 Breeding Pipelines in the Proposal). These traits have been selected not only for yield improvement, but also considering their marketability and profit lenses. By doing this, GLDC is stepping beyond traditional CGIAR interventions to encourage local, regional and global market access.

SLO2: Variance of GLDC crops baseline is very low compared with major commodities giving this target an advantage over other CRPs. Annual growth rates for dryland crops were estimated by region taking area weighted averages for growth rates. Three-year FAO data were used to develop regional and crop weights (2012-14) giving a true historical account of yield gain per region. The 2030 target is based on the current breeding pipeline considering national discount factors.[8] Most traits are selected based on their ability to build resistance to stresses and alleviating losses (and thereby increasing yields), rather than their reaction to inputs such as fertilizers and natural resources management. In addition, the total was split by region to recognize different enabling environments.

Knowing the baseline production and populations, these targets were calculated to accommodate yield/production gains and energy/protein availability per crop. The quantum of increased calories (energy) was divided by total population and average daily caloric consumption. To calculate benefits to women of childbearing age, it was assumed that 25% of the total population represents this subgroup. Target crops for the GLDC inherently have higher protein levels representing better value for money on this SLO.

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[6] Schneider, Kate, and Mary Kay Gugerty. "Agricultural productivity and poverty reduction: Linkages and pathways." *Libraries Test Journal* 1.1 (2011): 56-74.

[7] Yadav, O. P., and K. N. Rai. "Genetic improvement of pearl millet in India." *Agricultural Research* 2.4 (2013): 275-292.

[8] Nedumaran, S., et al. "Grain legumes production, consumption and trade trends in developing countries." *ICRISAT Res Progr Mark Inst Polic Work Pap Ser* 60 (2015): 4-7.

The targets for SLO2.1 were based on expert opinions of breeders with critical inputs from various cross-cutting disciplines.

To estimate GLDC CRP's contribution to SLO2, the nutritional composition of GLDC crops (Table 1) and the minimum dietary energy requirements (2000 kcal/day and 46 g protein for women; 2500 kcal/day and 56 g protein for men) were used to compute the "Number of people assisted to meet the daily dietary and protein requirements" from the estimated incremental production obtained earlier. These two measures apply for all SLO2 targets.

Table 1. Nutritional constitution of GLDC crops (per 100 grams).

Crop	Calories (Kcal)	Energy (kJ)	Fat (g)	Carbohydrate (g)	Protein (g)	Calcium (mg)	Iron (mg)
Chickpea	364	1524	6.0	60.6	19.3	105	6.2
Groundnut	567	2373	49.2	16.1	25.8	92	4.6
Millet	378	1582	4.2	72.9	21.7	8	3.0
Pigeonpea	343	1436	1.5	62.8	11.3	130	5.2

The targets computed for SLO 2.2 and 2.3 assume that 50% of the impacted population are women. To further arrive at the target for SLO2.4, it was assumed that 50% of the women impacted would be of reproductive age. Therefore, 50% of the "No. of women assisted in meeting their daily dietary requirements" was multiplied by 50% to arrive at the measure "No. of women of reproductive age in GLDC farming households consuming minimum dietary protein requirements".

SLO3: Using best management practices for residue removal, carbon sequestration was calculated accommodating stover and root mass estimations per target crop. These are not new techniques, but rather an extension of existing farmer practices to the incremental area planted to improved varieties.

Carbon sequestered was considered the best indicator of sustainable farming systems to quantify GLDC CRP's contribution to SLO3. Cropwise estimates of carbon added (tons) for every ton of GLDC crop residue incorporated into soils were estimated in Table 2. The incremental production of GLDC crops by 2022 and 2030 was then used to estimate the cumulative "soil carbon input" in tons for the goal to restore degraded soil under SLO3 - Improved Natural Resources Systems and Ecosystems services.

Table 2. Cropwise estimates of carbon addition from incorporating GLDC crop residue.

Crop	Expected increase in grain producti-on by 2022 (M t)	Harvest index	Increase in stover biomass (M t)	Stover biomass removed (%)	Increase in residual stover (M t)	Shoot: Root ratio	Increase in root biomass (M t)	Total biomass (M t)	Carbon (%)	Carbon added (M t)
Sorghum	1	0.4	0.4	0.8	0.1	0.7	0.3	0.36	0.48	0.17
Pearl millet	1	0.3	0.3	0.8	0.1	0.7	0.3	0.36	0.48	0.17
Finger millet	1	0.3	0.3	0.8	0.1	0.7	0.3	0.36	0.48	0.17
Chickpea	1	0.3	0.3	0	0.2	0.8	0.2	0.4	0.4	0.16
Pigeonpea	1	0.2	0.2	0.8	0.1	0.6	0.4	0.48	0.4	0.19
Groundnut	1	0.3	0.3	0.9	0.0	0.8	0.2	0.22	0.4	0.09

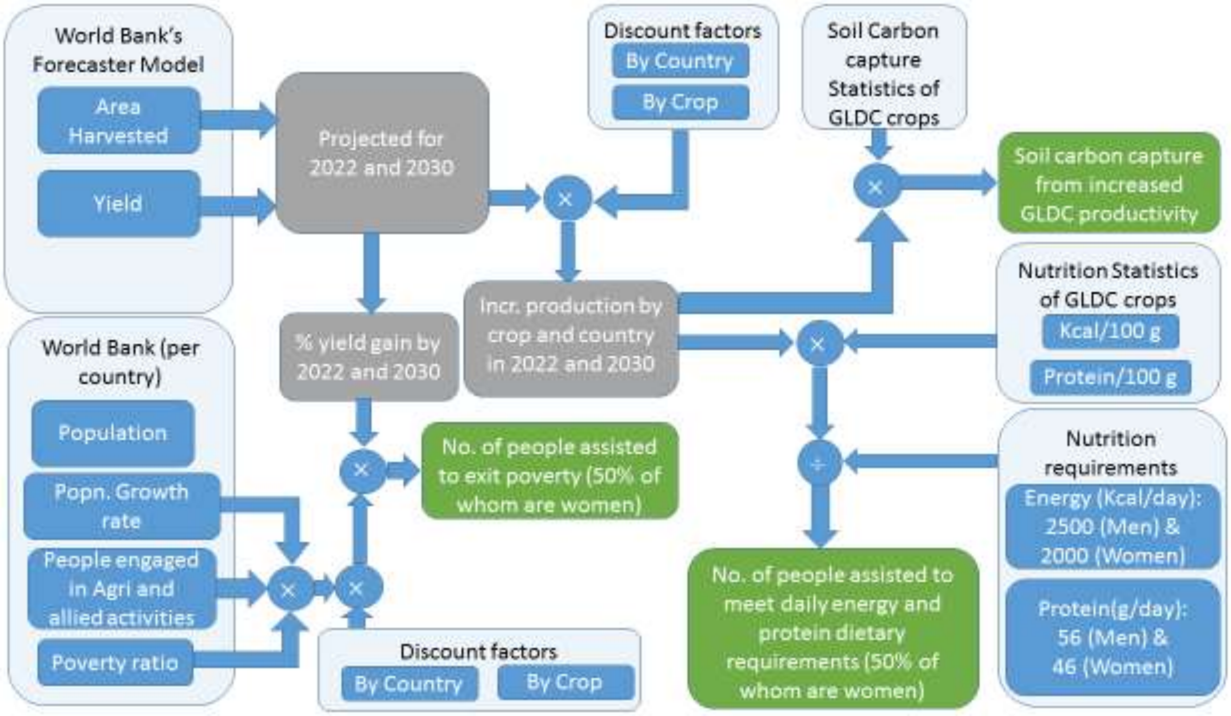

Figure 1. The computations for SLOs 1.2, 2.2, 2.3 and 3.