



# The Generation Challenge Programme

## CULTIVATING PLANT DIVERSITY FOR THE RESOURCE-POOR



### Strategic approaches to targeting technology generation: Assessing the coincidence of poverty and drought-prone crop production

- This study prioritizes areas of high poverty, the key problem of high drought risk and the crops grown and consumed in these areas.
- We identified areas of high priority for crop improvement using global spatial data, spatial overlay methods, drought modeling and descriptive statistics.

- Drought coincides with high levels of poverty in 15 major farming systems, especially in South Asia, the Sahel, and eastern and southern Africa.
- Environments in these systems face high diversity in the frequency of drought.
- Thirteen crops make up the bulk of food production in these areas.

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#### Objectives, Materials and Methods

Farmers who face frequent but unpredictable drought are among the poorest in the world. The Generation Challenge Program (GCP) strives to improve crops for such farmers and regions.

#### Population, Poverty and crop production

- Global data sets provided estimates for grid cells of 1 km<sup>2</sup> to 400 km<sup>2</sup> resolution and included population information from the Gridded Population of the World (GPW) Version 3 project.
- Infant mortality rates, and prevalence and absolute number of underweight and stunted children were used as measures of poverty.
- Digital crop maps in GIS formats were used in our analysis:

- Barley
- Beans
- Cassava
- Groundnut
- Maize
- Millet
- *Musa*
- Other pulses
- Potato
- Rice
- Sorghum
- Soybean
- Sweet Potato
- Wheat

#### Modeling Failed Seasons (Figure 1)

- Failed season = <50 growing days or > 15% stress days.
- 100 years of daily rainfall, temperature & radiation data were simulated using MarkSim.
- Potential evapo-transpiration calculated using Linacre.
- Daily water balance calculated using WATBAL.
- Model makes no reference to specific crop.

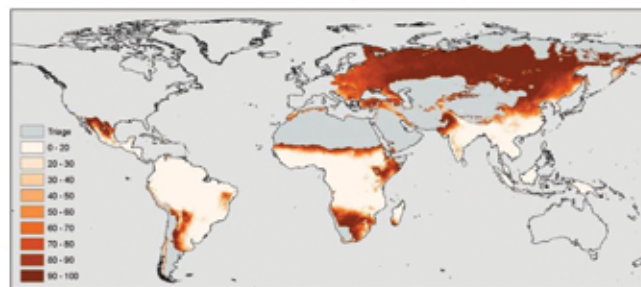


Figure 1. Global failed seasons drought model.

#### Farming Systems (Figure 2)

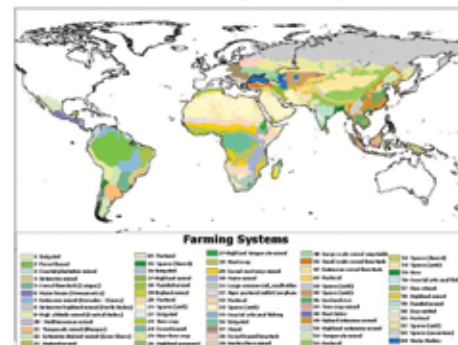


Figure 2. Sixty-three farming systems

We used the farming system region as the geographical unit of analysis, as mapped by Dixon et al (2001) for developing countries. The map was based on the knowledge of agricultural experts of these regions at local, regional and global scales.

#### Data Sources for Spatial Overlay

- Dixon, J. and Gulliver, A. with Gibbon, D. (2001). *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. FAO and World Bank, Rome and Washington DC.
- Food and Agriculture Organization. (2003). *Chronic Undernutrition Among Children: An Indicator of Poverty*. Poster and Unpublished data set, Rome: FAO.
- You, L. and Wood, S. (2006). *An entropy approach to spatial disaggregation of agricultural production*. *Agricultural Systems* 90:329-347.

#### Results

#### Population and stunted children by farming system

Farming Systems	Region	Stunted Children	Stunting Prevalence	Potential Drought Impact Index	Ag. Fail	Global Rank	Regional Rank
Barley mixed	SA	2,654,300	42	2,571,456	16	1	1
Lowland rice	SAP	12,287,886	34	7,982,217	16	2	1
Cereal-crop mixed	OSA	6,319,656	40	5,324,217	17	3	1
Rice-wheat	SA	28,318,391	52	4,859,261	42	4	2
Upland intensive mixed	CAP	16,424,790	35	3,725,591	28	5	2
Agropastoral-millet/sorghum	OSA	3,636,818	37	2,635,289	32	6	2
Rice	SA	11,644,190	51	2,632,872	5	7	3
Maize mixed	ISA	6,318,490	40	2,510,536	33	8	3
Road crop	ISA	4,385,830	40	1,802,376	8	16	4
Dry mixed	SA	2,650,280	45	1,227,361	33	14	4
Maize beans (Mesoamerica)	LAC	2,517,830	37	1,218,126	16	16	4
Highland temperate mixed	ISA	2,750,640	56	989,653	16	21	5
Temperate mixed	CAP	2,597,728	26	846,664	77	22	5
Highland mixed	SA	5,511,720	48	827,142	18	24	7
Highland extensive mixed	CAP	2,524,590	44	642,635	12	28	7

Table 1. Fifteen farming systems with over 2.5 million stunted children. The "Avg Fail" indicator is the mean probability of a failed season in the farming system. The "Potential Drought Impact" index takes account of staple crop area and the frequency of drought.

#### The spatial variability of drought frequencies within farming systems (Figure 3)

- High value and perennial systems are found in well-watered areas, while pastoral systems are found in drier areas.
- Farming systems with a wide range of failed seasons rely on a greater number of crops (curves closer to 45 degrees)

- High poverty, priority systems (solid lines on graph) all show moderate to severe drought risk in between the extremes.
- Farmers in these high-poverty systems are therefore attempting to cope with a range of drought regimes; and this is probably the reason for the diversity of cropping in these systems.

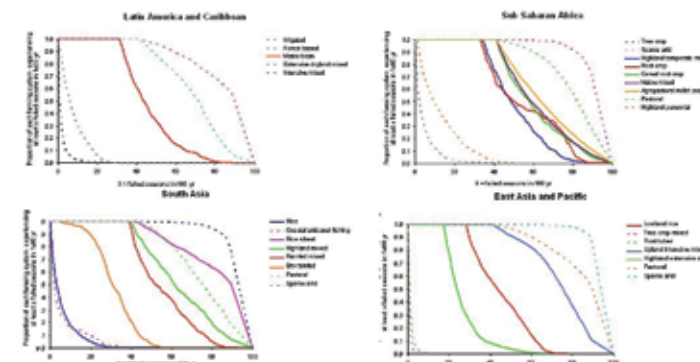


Figure 3. Proportion of area in each farming system experiencing at least a given number of failed seasons in a 100 year period. Systems represented by solid lines are among the 15 systems of the world with more than 2.5 million stunted children.

#### Conclusions

- We identified the coincidence of poor populations in developing countries, the production of key food staple crops on which the poor depend, and drought-prone production environments.
- 15 farming systems - where drought affects a substantial agricultural population and over 70% of stunted children in the world - should be a high priority for agricultural R&D.

System	Stunting	Crops	fsg for
SA rice wheat	28.3	Rice, pulses (chickpea), millet, wheat, maize, bean	4
SA rainfed mixed	24.5	Rice, millet, sorghum, chickpea, bean, groundnut, maize, wheat	1
EA upland intensive mixed	15.4	Maize, rice, wheat, sweet potato, potato, bean	5
EA lowland rice	13.4	Rice, maize, wheat, sweet potato, groundnut	2
SA rice	11.7	Rice, pulses (chickpea)	7
SSA cereal-root	6.3	Sorghum, millet, pulses (cowpea), maize, groundnut, cassava	3
SSA maize mixed	6.3	Maize, cassava, sorghum, pulses, groundnut, millet, bean, sweet potato	8
SA highland mixed	5.2	Rice, maize, wheat, potato, groundnut, pulses	24
SSA root	5.0	Maize, cassava, rice, sweet potato, cowpea, sorghum, groundnut, bean	10
SA dry rainfed	3.6	Sorghum, millet, chickpea, groundnut, bean	14
SSA agro-pastoral millet sorghum	3.1	Millet, sorghum, pulses, groundnut, maize	6
LA maize beans	2.8	Maize, bean, sorghum	15
SSA high temperate mixed	2.6	Maize, wheat, sorghum, millet, pulses	21
EA temperate mixed	2.6	Maize, wheat, potato, groundnut, millet	23
EA upland extensive mixed	2.5	Rice, maize, wheat, potato, groundnut, pulses	28

Table 5. Fifteen farming systems with over 2.5 million stunted children, with global (fsg) and regional (fsr) farming systems rankings according to potential drought impact index.