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

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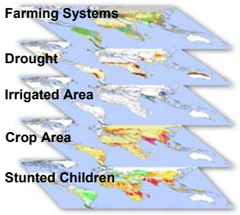
- **This study prioritizes areas of high poverty, the key problem of high drought risk and the crops grown and consumed in these areas.**
- **We identified areas of high priority for crop improvement using global spatial data, spatial overlay methods, drought modeling and descriptive statistics.**
-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

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.

Agriculture, Poverty and Drought



- *Dixon et al. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World.*
- *FAO. (2003). Chronic Undernutrition Among Children: An Indicator of Poverty.*
- *You and Wood (2006). An entropy approach to spatial disaggregation of agricultural production.*
- *Jones (2006). Failed Seasons Drought Model.*

- Numbers of stunted children was used as measure of poverty.
- Digital crop maps in GIS formats were used:
  - 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.

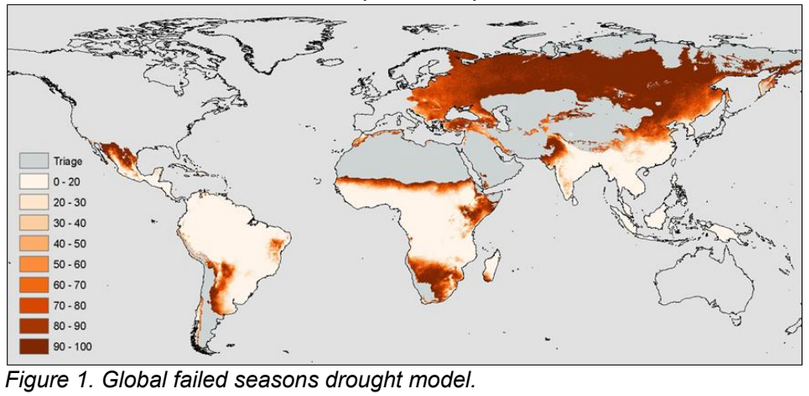


Figure 1. Global failed seasons drought model.

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Farming Systems (Figure 2)

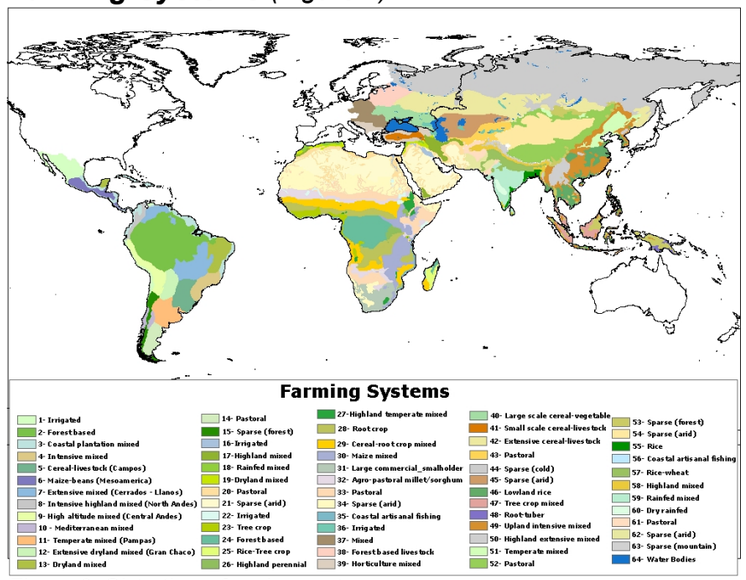

Figure 2. Sixty-three farming systems

The farming system region was the geographical unit of analysis and based on the knowledge of experts of these regions at local, regional and global scales.

Results

Population and stunted children by farming system

Farming System	Region	Stunted Children (millions)	Stunting Prevalence %	Potential Drought Impact Index	Avg Fail	Global Rank	RegionalRank
Rainfed mixed	SA	24.5	63	8.2	16	1	1
Lowland rice	EAP	13.3	34	8.0	15	2	1
Cereal-root crop mixed	SSA	6.3	43	5.3	17	3	1
Rice-wheat	SA	28.3	52	4.1	42	4	2
Upland intensive mixed	EAP	15.4	35	3.7	28	5	2
Agro-pastoral millet/sorghum	SSA	3.1	37	2.6	52	6	2
Rice	SA	11.6	51	2.6	5	7	3
Maize mixed	SSA	6.3	43	2.5	23	8	3
Root crop	SSA	5.0	40	1.8	8	10	4
Dry rainfed	SA	3.6	65	1.2	31	14	4
Maize-beans (Mesoamerica)	LAC	2.8	37	1.2	15	15	4
Highland temperate mixed	SSA	2.8	50	0.9	18	21	7
Temperate mixed	EAP	2.6	26	0.8	77	23	3
Highland mixed	SA	5.1	48	0.8	18	24	5
Highland extensive mixed	EAP	2.5	44	0.7	12	28	5

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 accounts for staple crop area and frequency of drought.

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

- High value and perennial systems are in well-watered areas, while pastoral systems are 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 systems attemp to cope with a range of drought regimes by maintaining a diversity of cropping

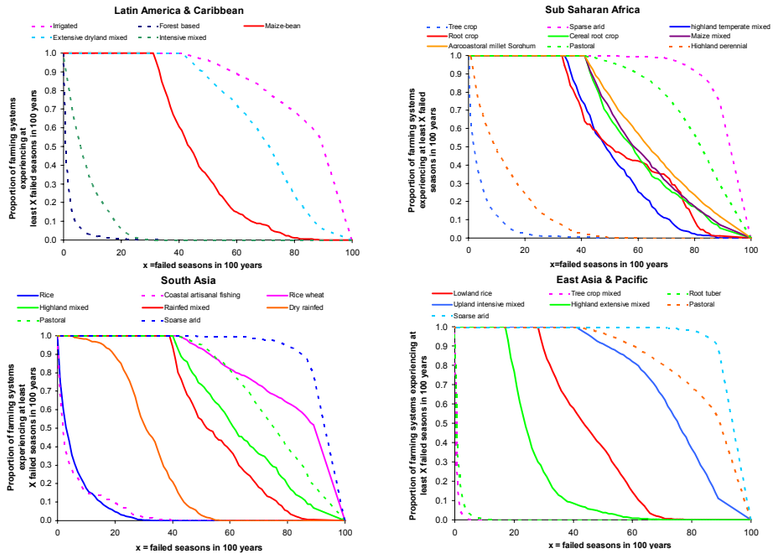

Figure 3. Proportion of area in each farming system experiencing at least a given number of failed seasons in a 100 year period. Systems represented by solid lines are among the 15 systems of the world with more than 2.5 million stunted children.

Conclusions

- Given 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, we identified:
- 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.
- These 15 systems rely largely on just 13 crops.
- Crops appearing first time in the list are highlighted and in italics.

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

Table 2. 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.