

A framework for assessing the impact of agricultural drought in developing countries

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Paper Session:

Reducing the Threat of Drought: Better Understanding
Drought Impacts and Risk Management Options

Motivation

- ❑ Drought: the most important constraint?
 - ❑ What crops to work on, and in which regions?
 - ❑ How might we develop a resource or information system that would guide a crop improvement initiative aiming to help farmers mitigate the negative effects of drought?
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Commissioned research: Generation Challenge Program

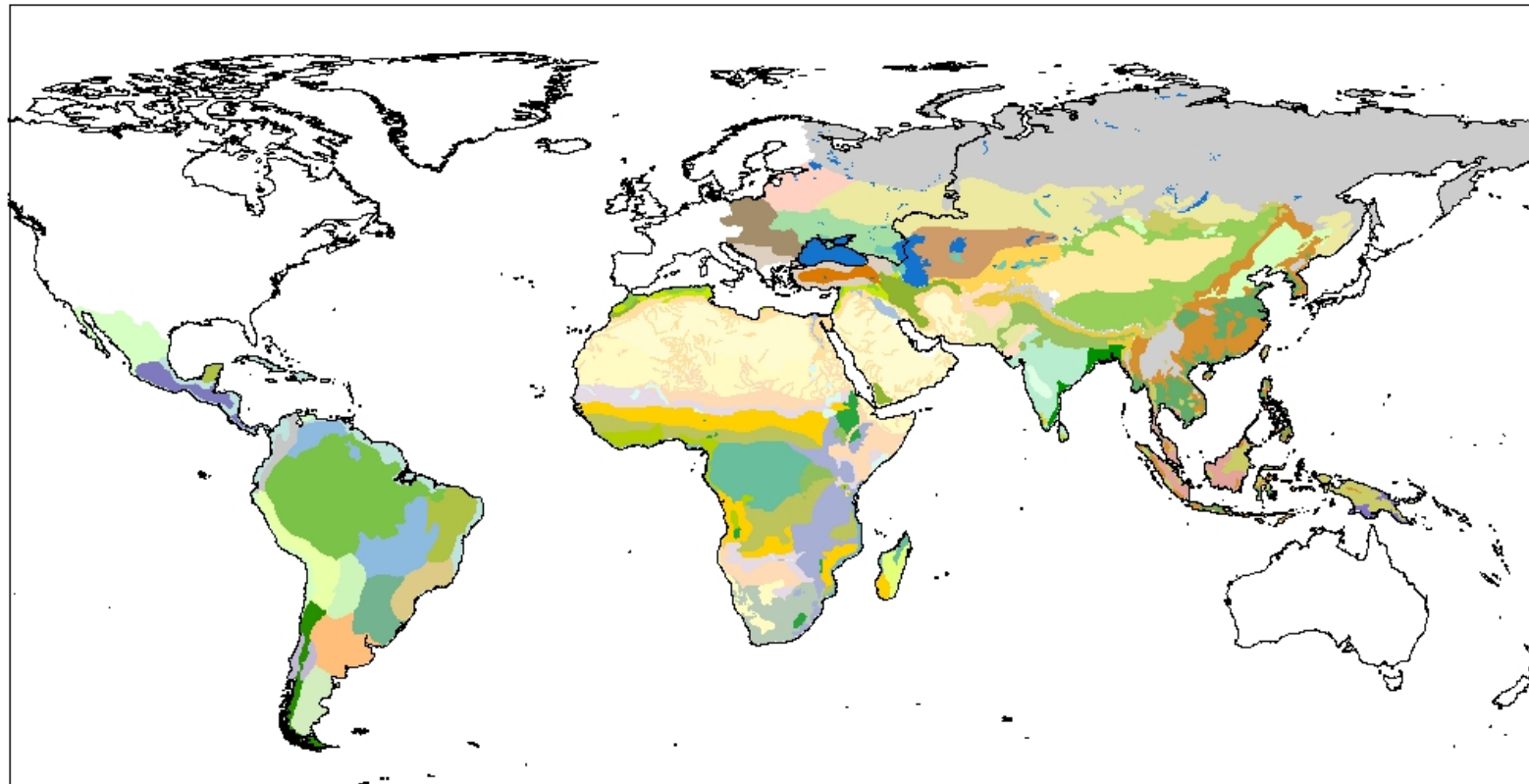
- ❑ To identify drought-prone regions with high poverty
- ❑ To focus on the most important crops in drought-prone regions



<http://www.generationcp.org/>

Collaboration

- ❑ Glenn Hyman, Peter Jones and Sam Fujisaka at the International Center for Tropical Agriculture (CIAT)
 - ❑ Stanley Wood at the International Food Policy Research Institute (IFPRI)
 - ❑ John Dixon at the International Maize and Wheat Improvement Center (CIMMYT)
 - ❑ Carmen de Vicente of the Generation Challenge Program (GCP)
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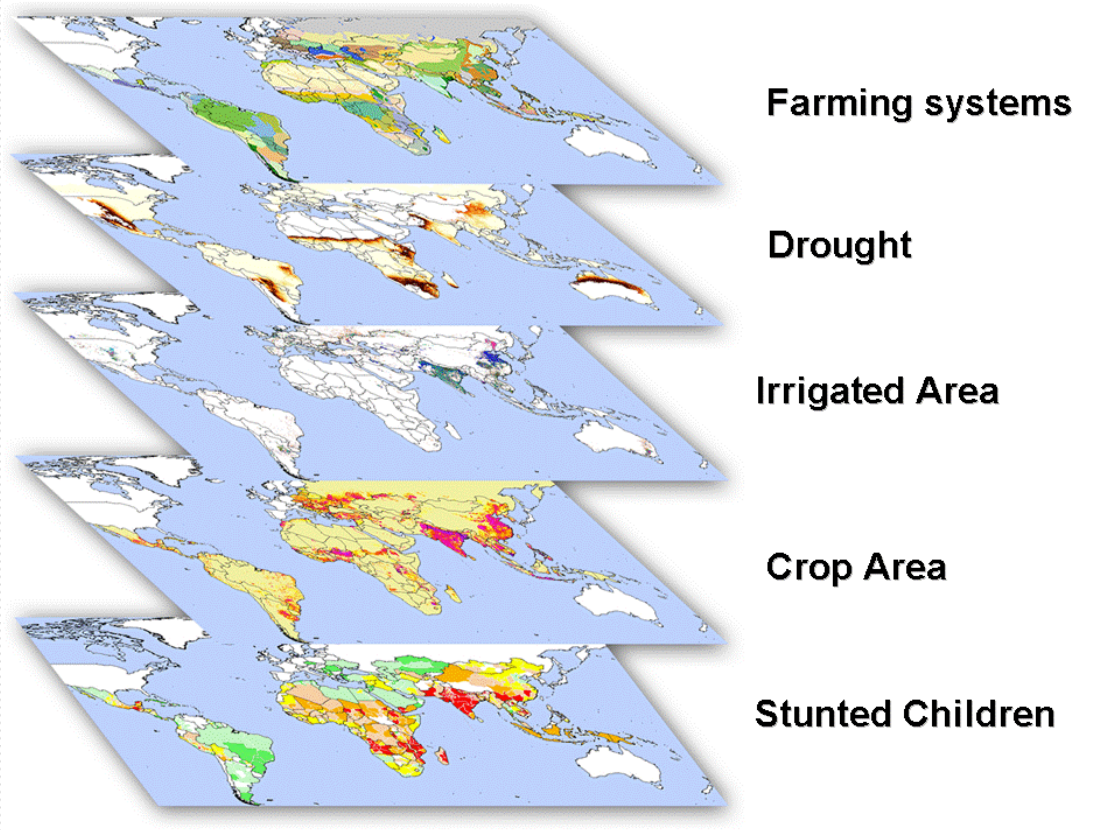


Farming Systems

1- Irrigated	14- Pastoral	27- Highland temperate mixed	40- Large scale cereal-vegetable	53- Sparse (forest)
2- Forest based	15- Sparse (forest)	28- Root crop	41- Small scale cereal-livestock	54- Sparse (arid)
3- Coastal plantation mixed	16- Irrigated	29- Cereal-root crop mixed	42- Extensive cereal-livestock	55- Rice
4- Intensive mixed	17- Highland mixed	30- Maize mixed	43- Pastoral	56- Coastal artisanal fishing
5- Cereal-livestock (Campos)	18- Rainfed mixed	31- Large commercial_smallholder	44- Sparse (cold)	57- Rice-wheat
6- Maize-beans (Mesoamerica)	19- Dryland mixed	32- Agro-pastoral millet/sorghum	45- Sparse (arid)	58- Highland mixed
7- Extensive mixed (Cerrados - Llanos)	20- Pastoral	33- Pastoral	46- Lowland rice	59- Rainfed mixed
8- Intensive highland mixed (North Andes)	21- Sparse (arid)	34- Sparse (arid)	47- Tree crop mixed	60- Dry rainfed
9- High altitude mixed (Central Andes)	22- Irrigated	35- Coastal artisanal fishing	48- Root-tuber	61- Pastoral
10- Mediterranean mixed	23- Tree crop	36- Irrigated	49- Upland intensive mixed	62- Sparse (arid)
11- Temperate mixed (Pampas)	24- Forest based	37- Mixed	50- Highland extensive mixed	63- Sparse (mountain)
12- Extensive dryland mixed (Gran Chaco)	25- Rice-Tree crop	38- Forest based livestock	51- Temperate mixed	64- Water Bodies
13- Dryland mixed	26- Highland perennial	39- Horticulture mixed	52- Pastoral	

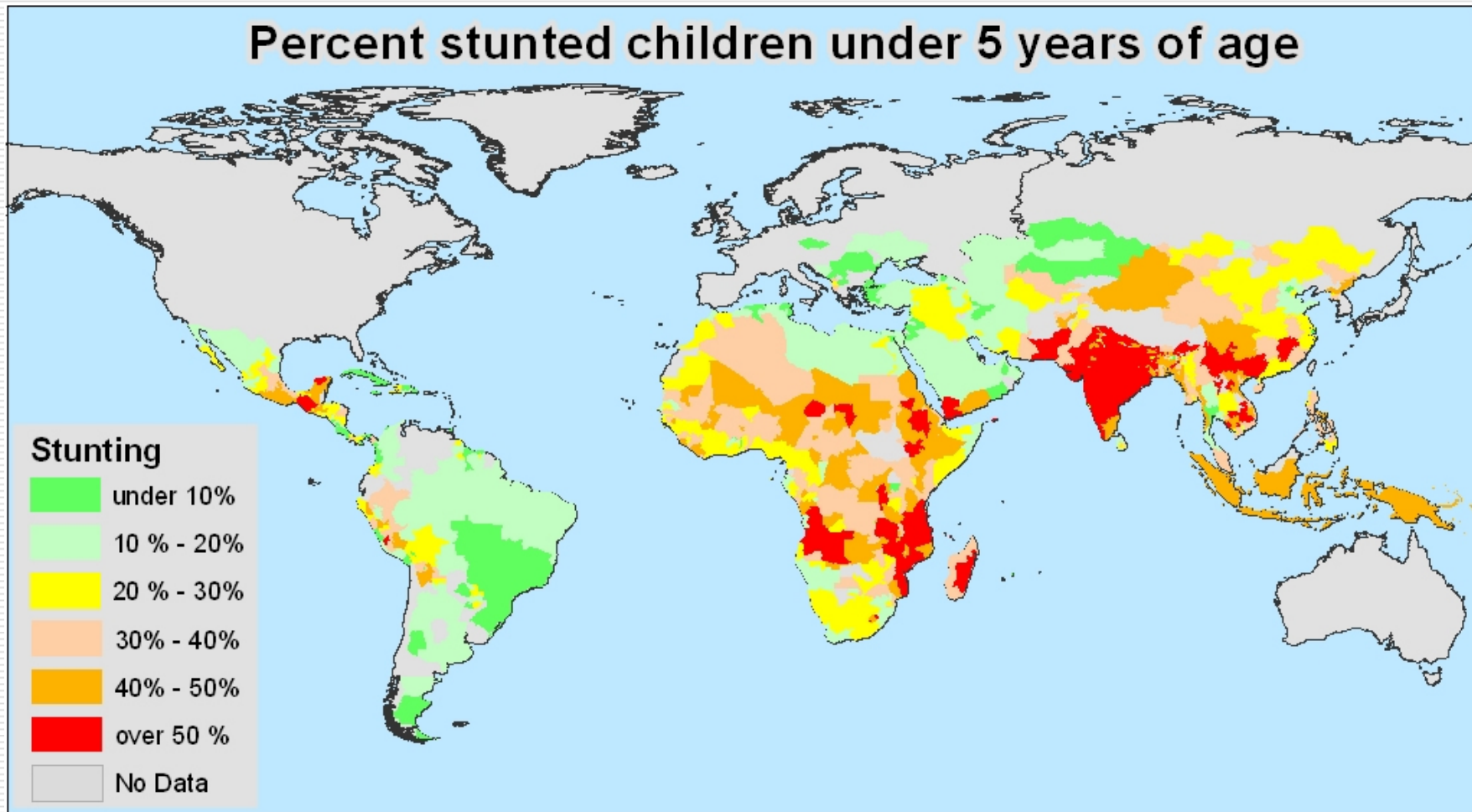
<http://www.fao.org/farmingsystems/>

Global spatial analysis framework

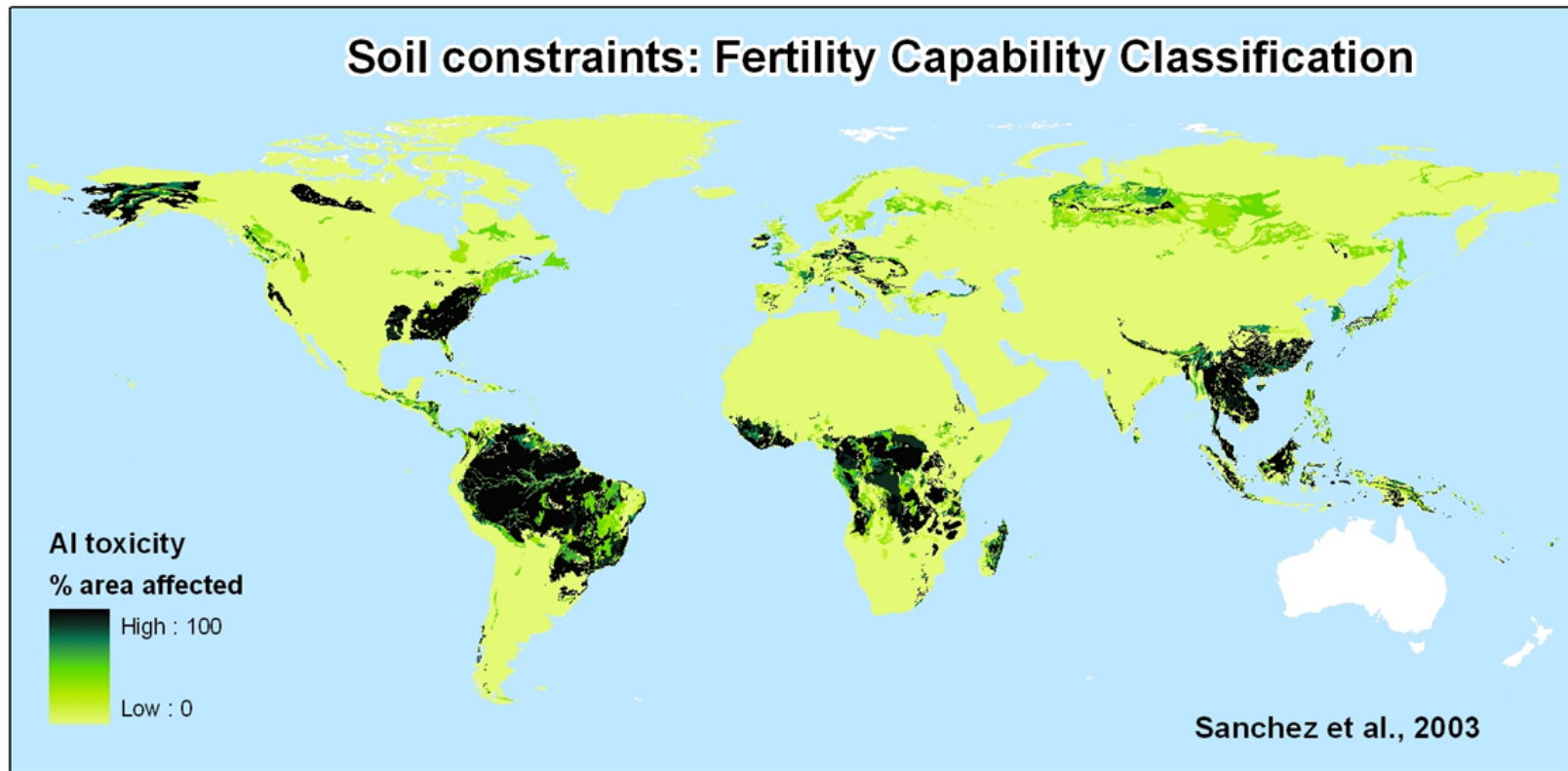


Hyman, G., S. Fujisaka, P. Jones, S. Wood, C. de Vicente and J. Dixon. 2008. Strategic approaches to targeting technology generation: Assessing the coincidence of poverty and drought-prone crop production. *Agricultural Systems*. 98:50-61.

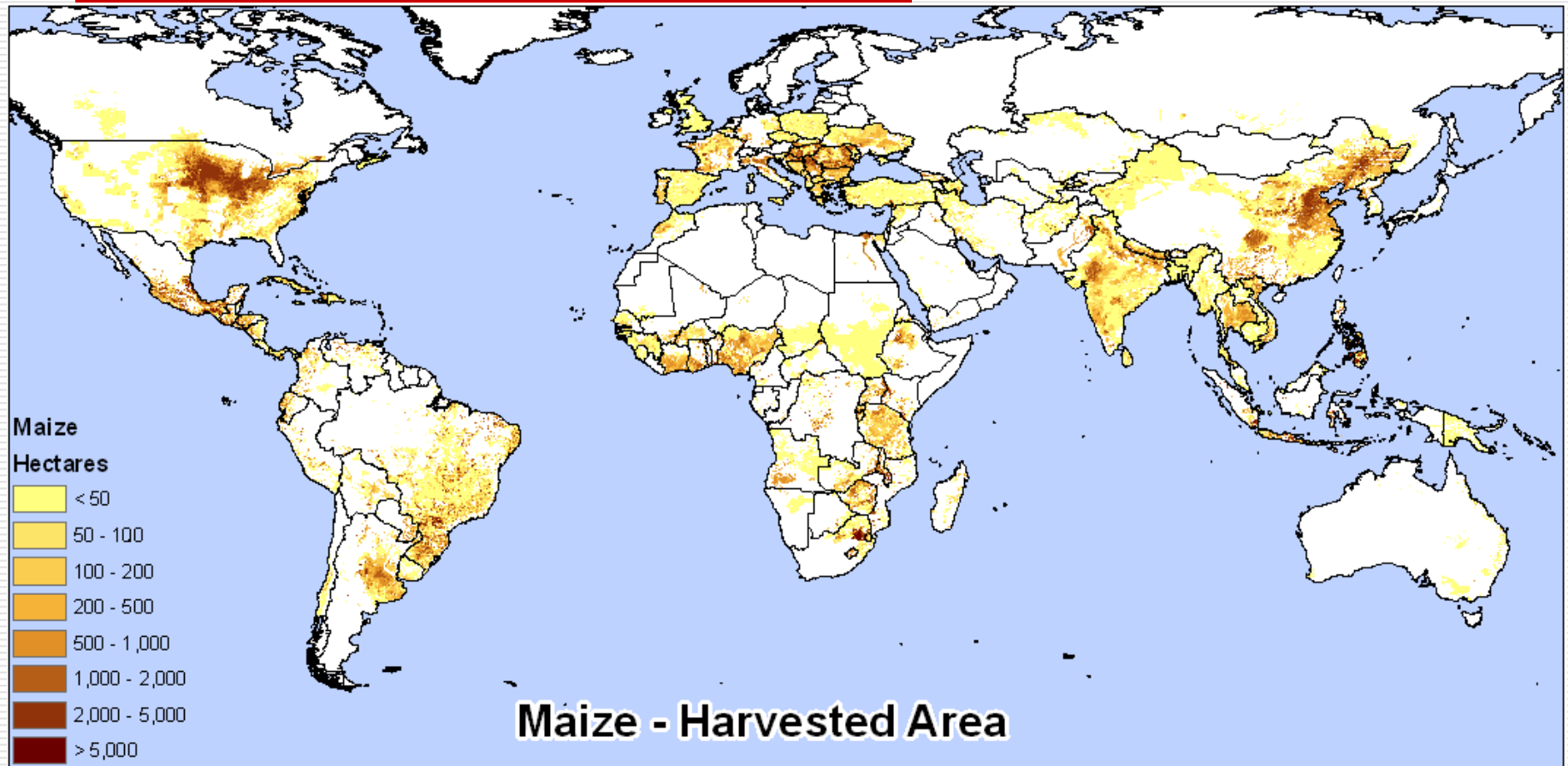
Stunting: < 2 SD below global mean of height for age



Aluminum toxicity: one of 22 soils constraints mapped

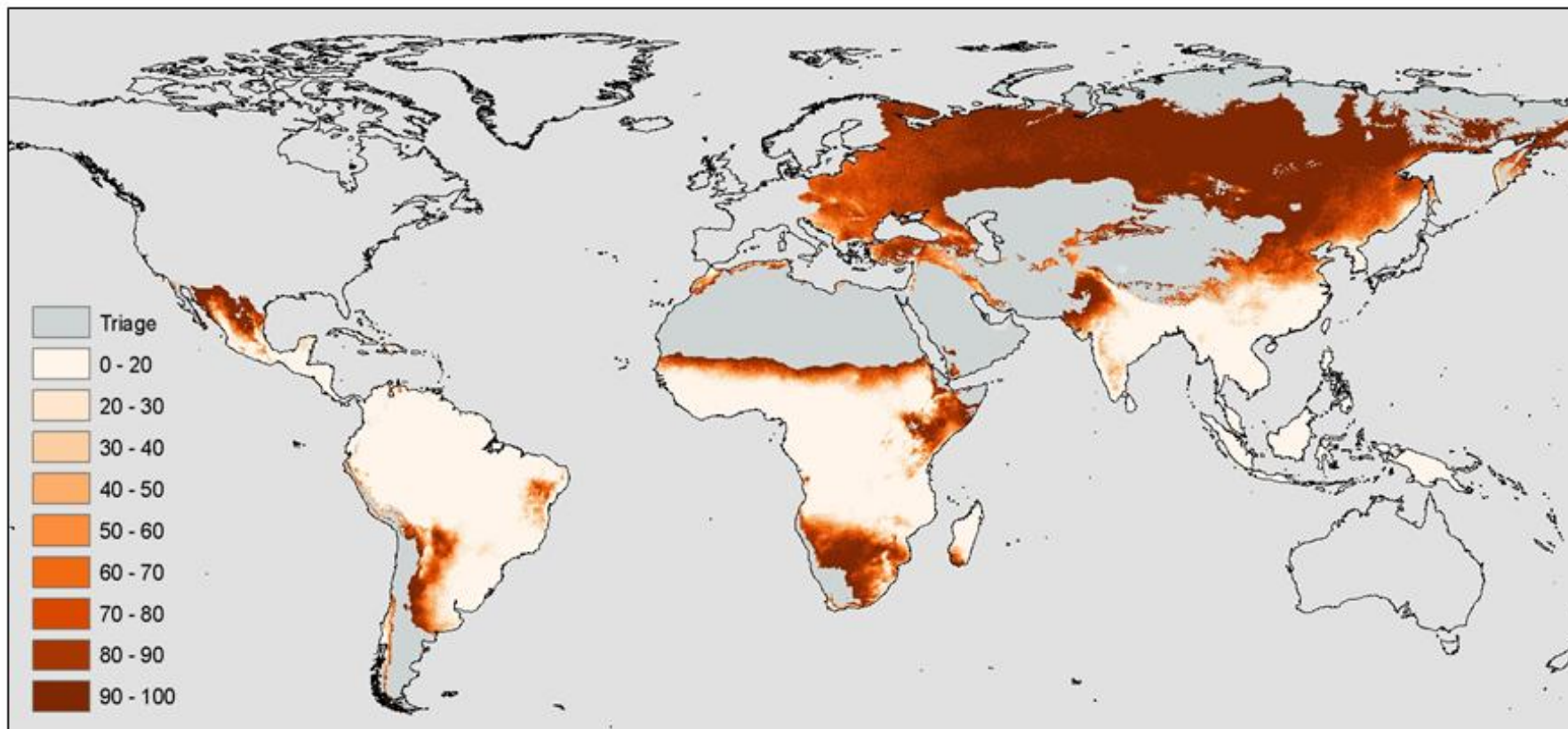


Global Maize Distribution: one of 20 major crops mapped



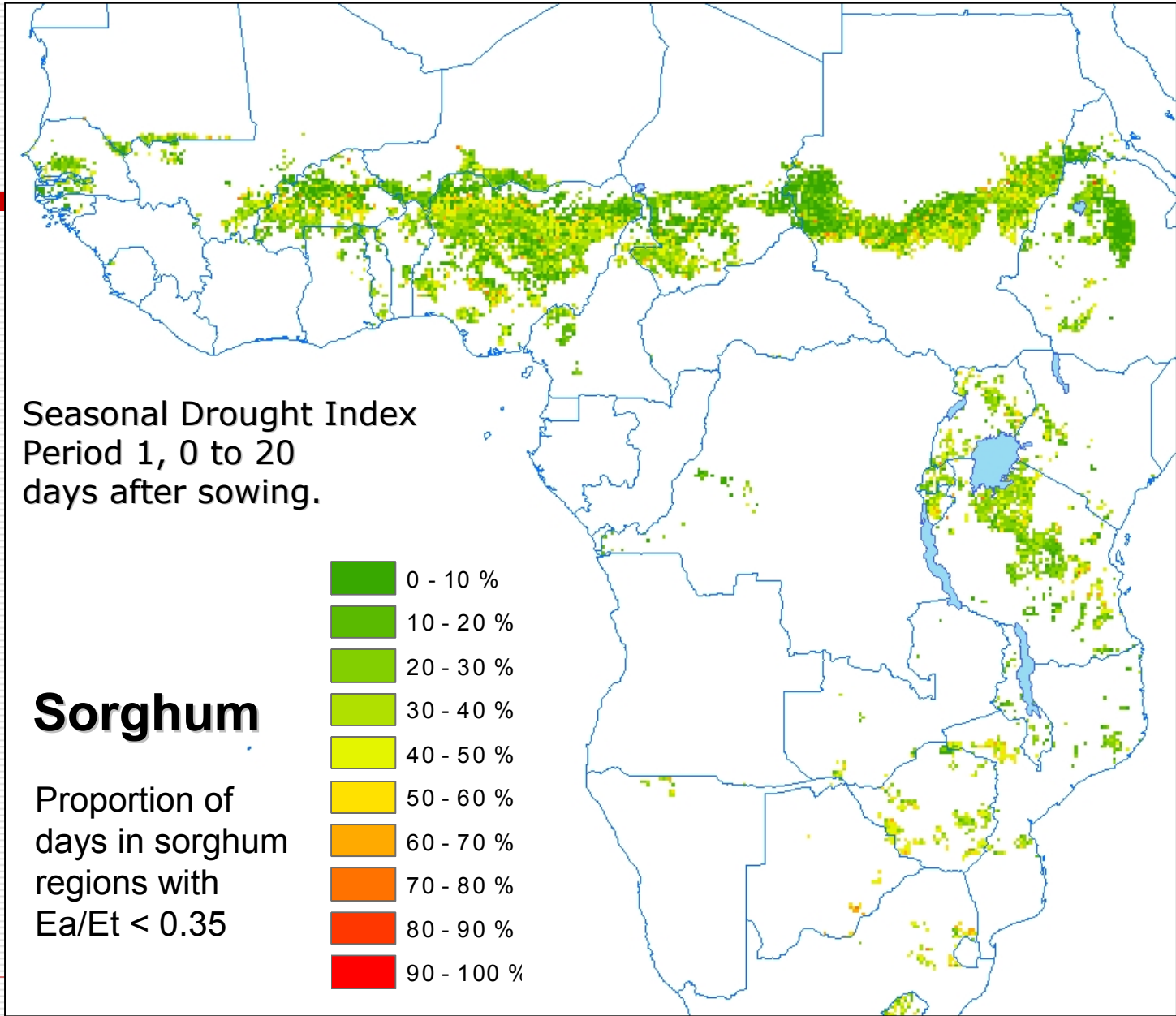
You, L., Wood, S., 2006. An entropy approach to spatial disaggregation of agricultural production. *Agric. Syst.* 90, 329–347.

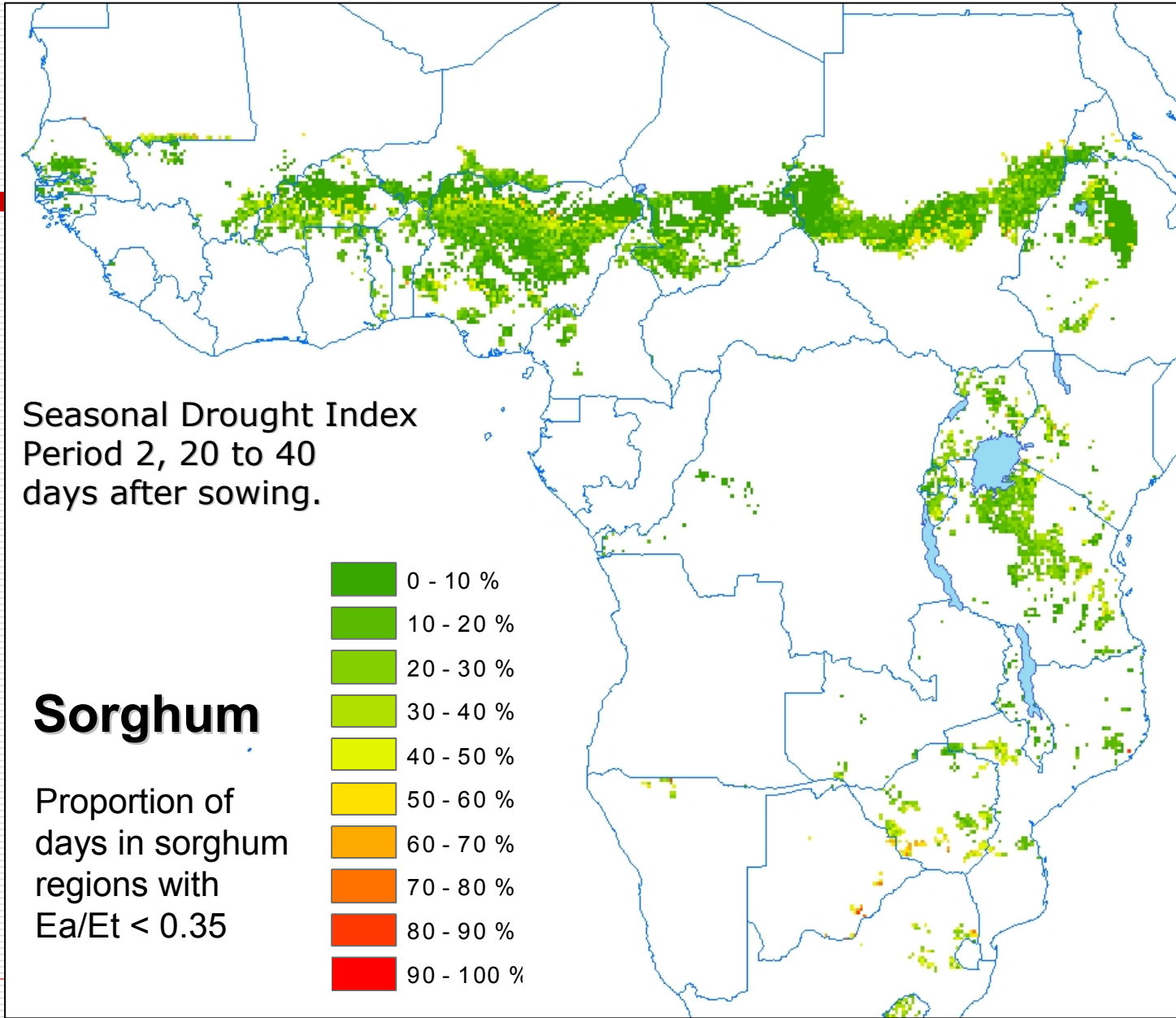
Failed Seasons Drought Model

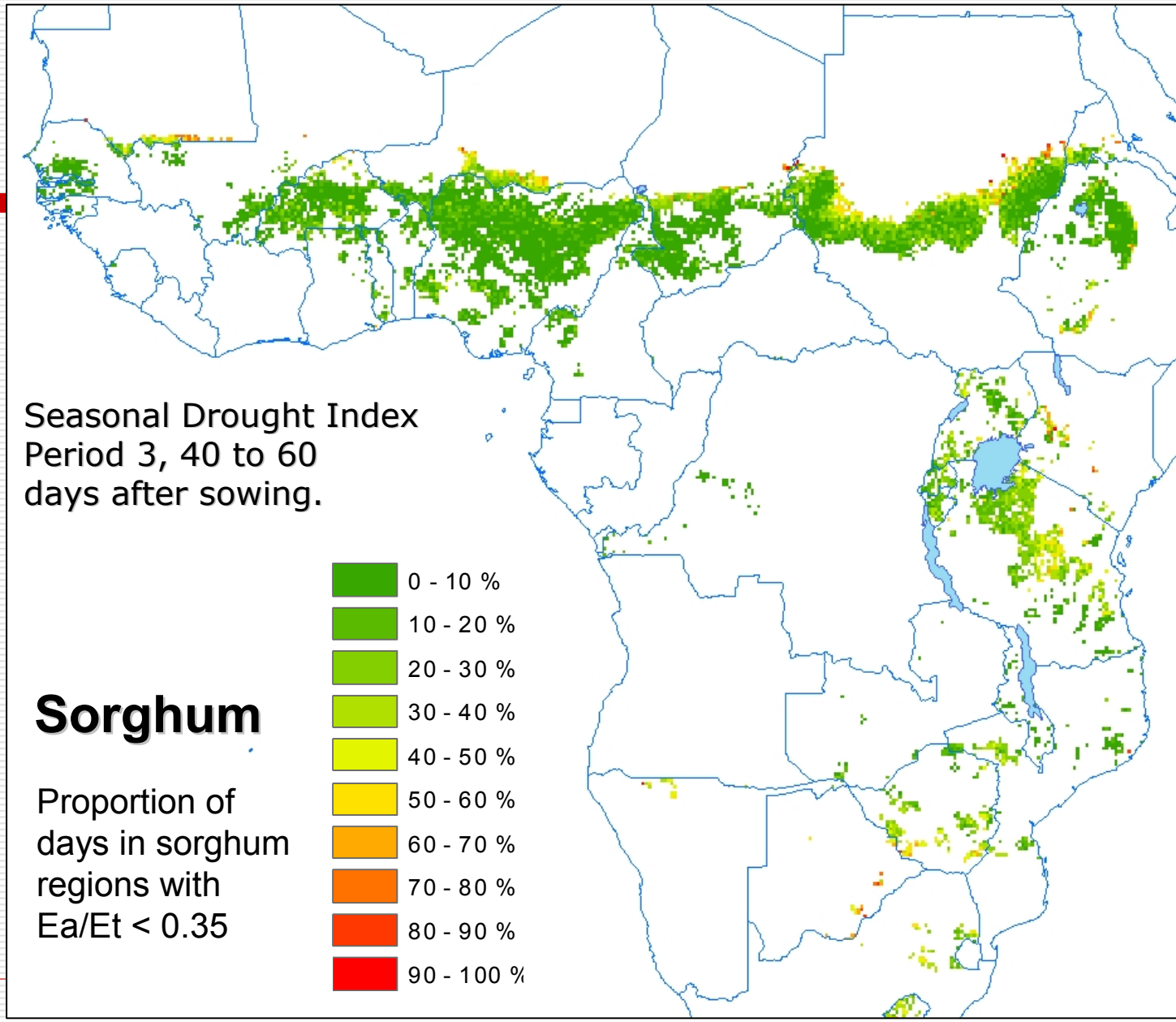


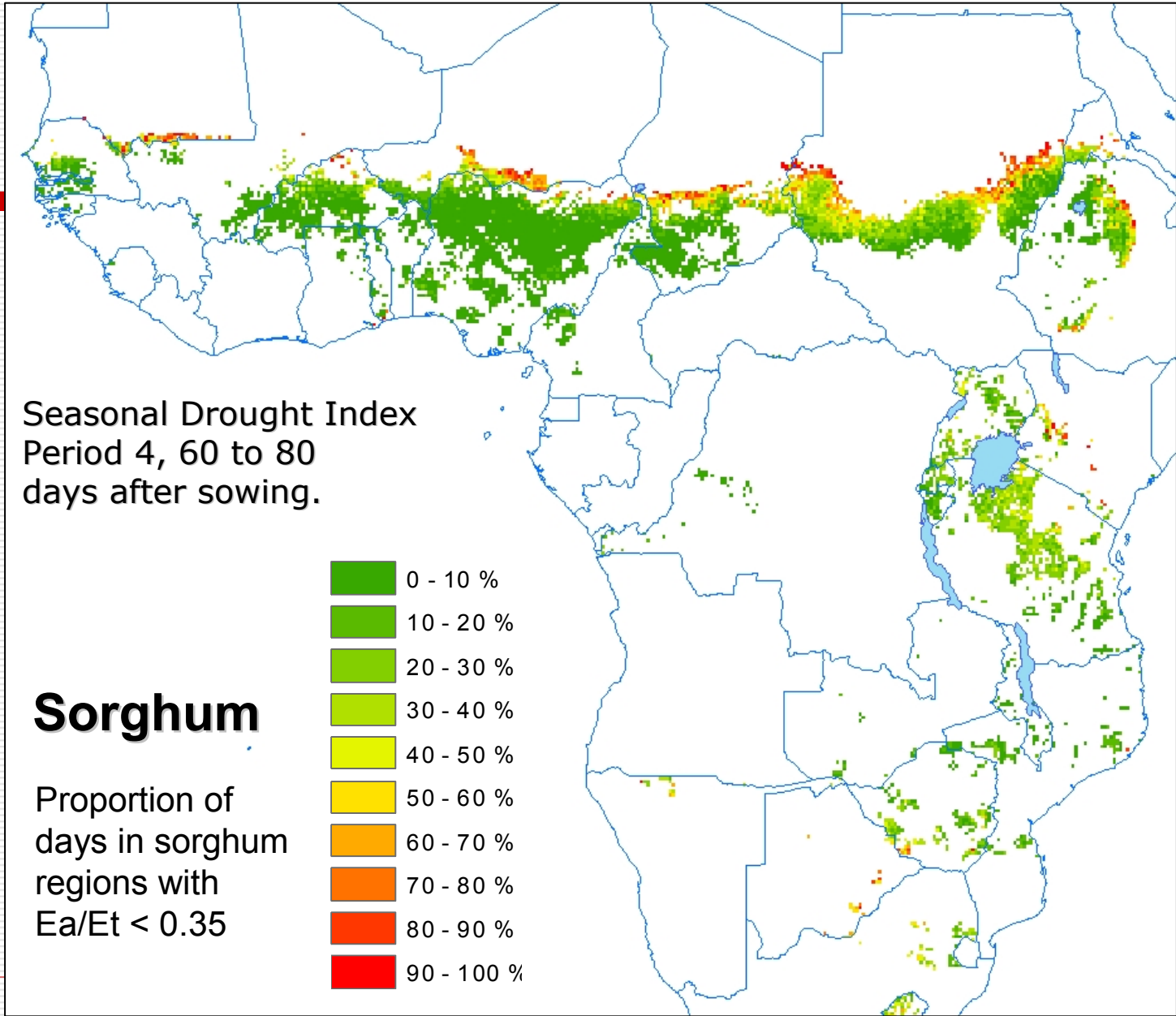
Seasonal Drought Index

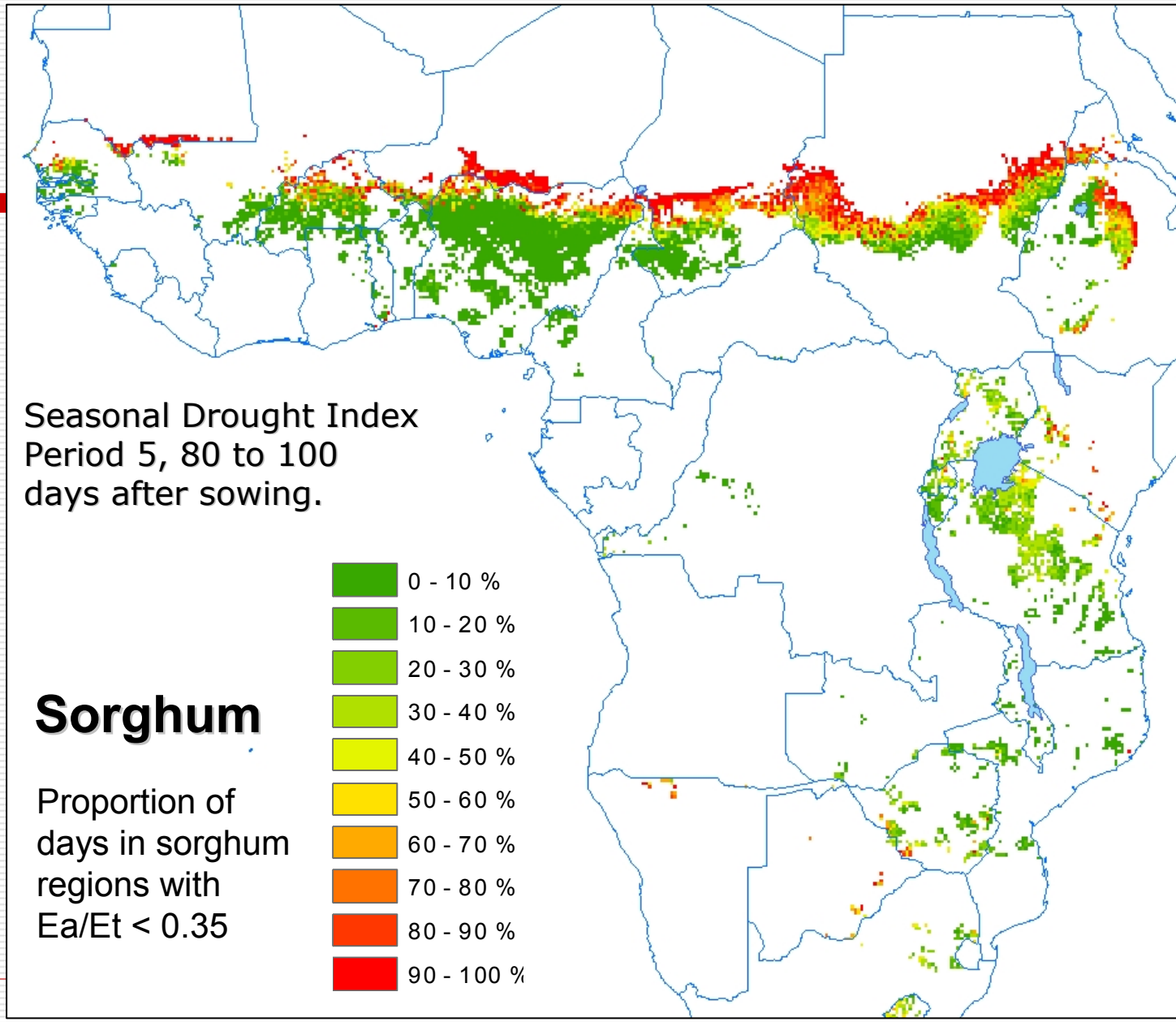
Sorghum in Sub Saharan Africa

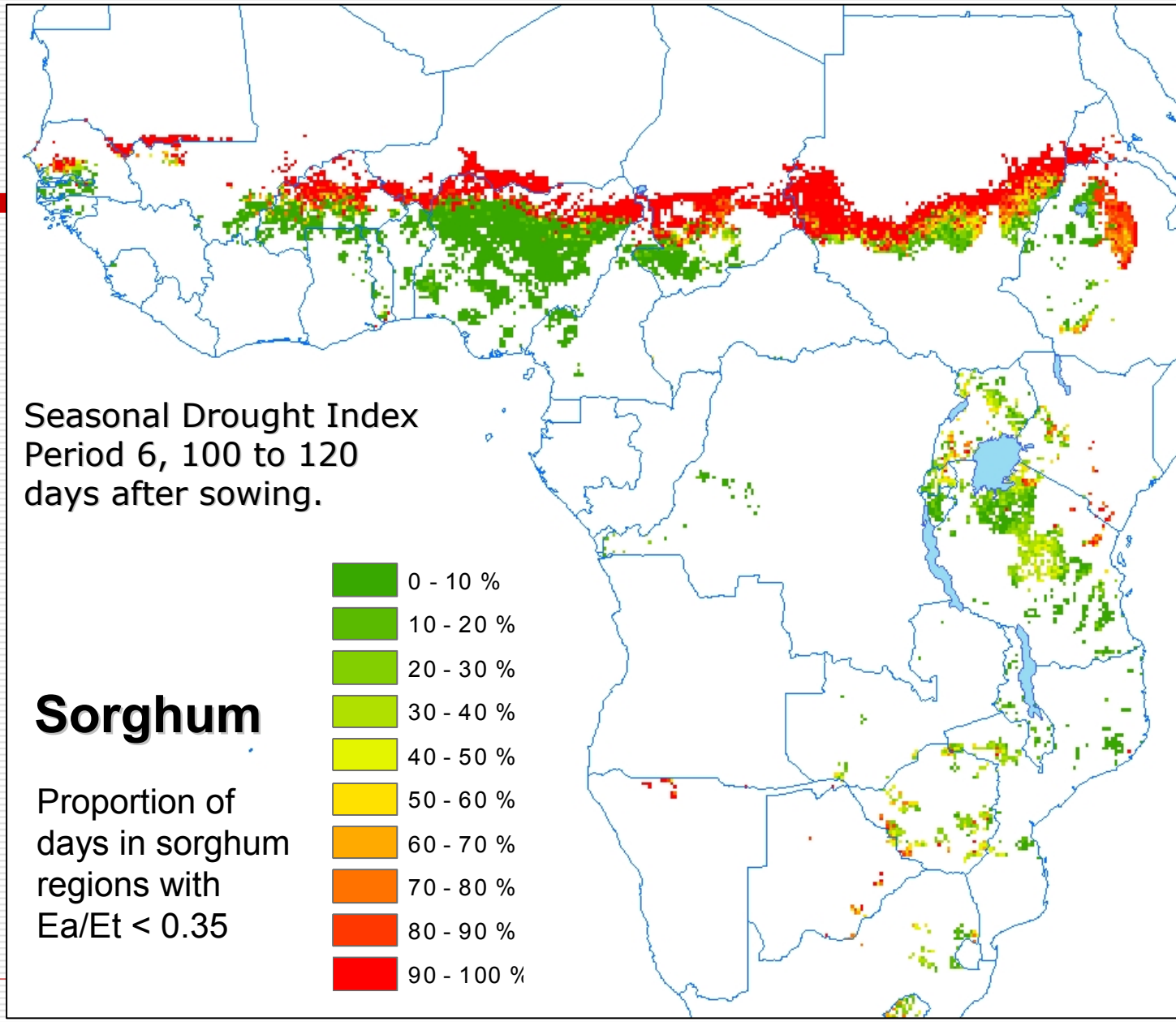


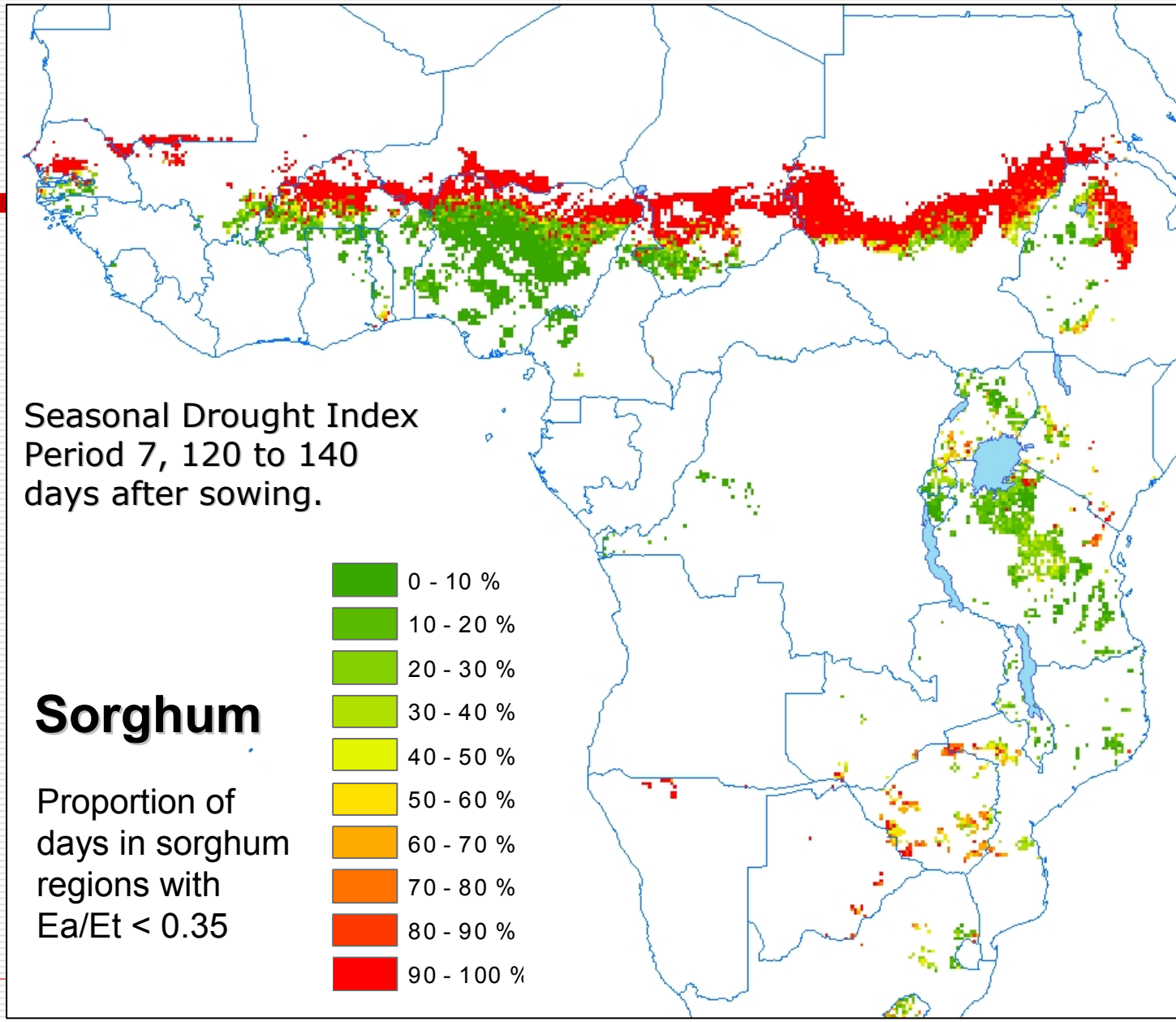












Complementary studies

- Getting the focus right: food crops and smallholder constraints
 - Expert survey
 - Information not found in typical surveys, including:
 - Biotic constraints, management and socioeconomic constraints

 - From Attractiveness to Feasibility: A Strategic Assessment of the Capacity to Develop, and Adopt GCP Technologies
 - Capacities of national programs for technology adoption
 - Country case studies in Mali, Burkina Faso, Nigeria, Tanzania and Indonesia
-



Generation Challenge Programme

CULTIVATING PLANT DIVERSITY FOR THE RESOURCE POOR

Selezione :

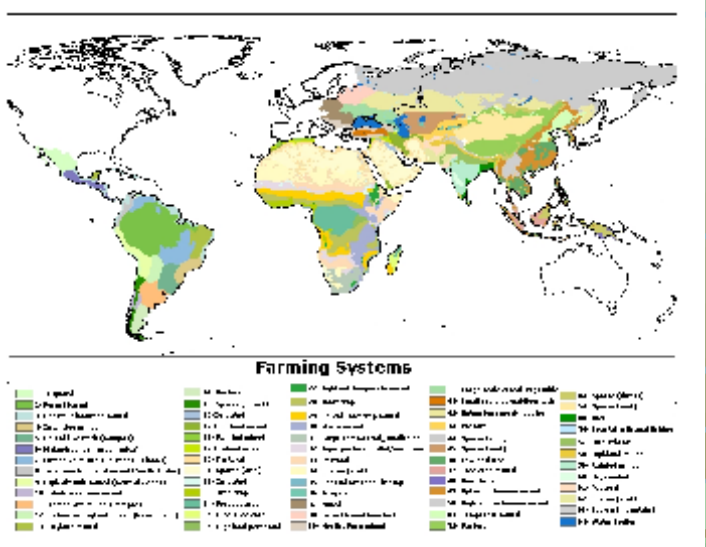
Country

Farming System

Variable

Display Data

End



Form View

What farming systems are found in a given country?

The screenshot shows a web application interface for selecting farming systems. The main area is a map of Africa with a dropdown menu for 'Country' set to 'Nigeria'. Below the map, there are three dropdown menus for 'Farming System' and 'Variable', and a 'Display Data' button. A list of farming systems is displayed, including 'Irrigated', 'Tree crop', 'Highland temperate mixed', 'Root crop', 'Cereal-root crop mixed', 'Agro-pastoral millet/sorghum', 'Pastoral', and 'Coastal artisanal fishing', all associated with 'SSA'.

Farming System within selected country	
Irrigated	SSA
Tree crop	SSA
Highland temperate mixed	SSA
Root crop	SSA
Cereal-root crop mixed	SSA
Agro-pastoral millet/sorghum	SSA
Pastoral	SSA
Coastal artisanal fishing	SSA

What countries make up a farming system?

Selection

GENTRY_NAME	FARMING_SY	Description	Unit	BANP	BARL	BEAN	CASS	COFF	COTT	GROU	MAIZ	MILL	OFIB	OOIL	OPU
Belize	Maize-beans (Mesos	Harvested Area Total	Ha	242	0	333	13	12	0	5	928	0	0	121	
Costa Rica	Maize-beans (Mesos	Harvested Area Total	Ha	35892	0	20143	2907	100423	171	88	6407	0	456	4329	
El Salvador	Maize-beans (Mesos	Harvested Area Total	Ha	5659	6	34262	489	66475	328	117	148291	0	1610	4382	
Guatemala	Maize-beans (Mesos	Harvested Area Total	Ha	11765	1289	98021	5605	146594	153	341	295755	0	122	32693	
Honduras	Maize-beans (Mesos	Harvested Area Total	Ha	30931	0	79643	2102	137514	130	408	317263	0	4	2632	
Mexico	Maize-beans (Mesos	Harvested Area Total	Ha	18252	123186	625241	497	281186	17507	35124	3514130	0	21510	67005	56310
Nicaragua	Maize-beans (Mesos	Harvested Area Total	Ha	2109	0	112190	1134	61958	129	2119	62545	0	322	1218	
Panama	Maize-beans (Mesos	Harvested Area Total	Ha	3291	0	1131	560	3108	0	0	6429	0	0	749	62
__Latin America and C	Maize-beans (Mesos	Harvested Area Total	Ha	108142	124481	970963	13307	797270	18418	38202	4351749	0	24023	113129	5693

End Export Data

start U... S... 5 M... W 2 M... 2 C... F... Desktop Google 100% 1:14 PM

What other countries have similar environments (spillover)?

Selection

ENTRY_NAME	FARMING_BY	Description	UNIT	BHP	BML	BNH	BZS	COFF	COTT	CSOU	HWZ	NLL	OFFB	OOL	IFI
Algeria	Agri (domestic)	Production	Ton	13775	0	2778	188000	773	2777	2000	100770	5706	776	6735	1
Algeria	Agri (domestic)	Production	-	0	0	0	0	0	0	0	2	0	0	1	1
Algeria	Agri (domestic)	Production	Ton	6700	0	1010	26777	0	-1307	79011	970	71006	0	700	1701
Algeria	Agri (domestic)	Production	-	44870	0	8782	7718	2777	28152	11528	14105	28174	0	78	18
Algeria	Agri (domestic)	Production	Ton	0	10018	1000	0	0	0	0	0075	-001	0	700	277
Algeria	Agri (domestic)	Production	-	7	17000	1050	1	577	0	188	79800	8577	778	147	257
Algeria	Agri (domestic)	Production	Ton	0	0	0	0	0	0	0	0	0	0	0	1
Algeria	Agri (domestic)	Production	-	38620	1088	1	11782	-00	1818	1178	17080	1782	1287	788	882
Algeria	Agri (domestic)	Production	Ton	0	1	0	0	0	6070	17007	2670	5777	68	600	10077
Algeria	Agri (domestic)	Production	-	0	27	0	0	0	0	178	784	588	0	0	780
Algeria	Agri (domestic)	Production	Ton	1707	0	-807	0700	1	6700	6007	1700	6003	0	10007	11707
Algeria	Agri (domestic)	Production	-	42888	0	4	885115	815	777	88525	88710	118814	172	82120	4842
Algeria	Agri (domestic)	Production	Ton	11	111	0	0	0	18	36	111	30	0	37	7
Algeria	Agri (domestic)	Production	-	0	0	0	11517	0	12870	79825	7988	8880	0	578	7800
Algeria	Agri (domestic)	Production	Ton	0	0	0	0	0	0	0	0	0	0	0	1
Algeria	Agri (domestic)	Production	-	11574	0	578	2881	0	27	251280	10578	18781	0	8778	788
Algeria	Agri (domestic)	Production	Ton	600	7	100	0707	36	0	388	-160	108	700	77	27
Algeria	Agri (domestic)	Production	-	0	0	27	-77	0	17715	2481	4782	25778	1	2108	2478
Algeria	Agri (domestic)	Production	Ton	0	0	707	0	0	807	78	7407	7800	0	7	6
Algeria	Agri (domestic)	Production	-	0	88	0	2708	887	0	887	17782	888	0	487	1
Algeria	Agri (domestic)	Production	Ton	0	0	0	0	0	0	0	0	0	0	0	1
Algeria	Agri (domestic)	Production	-	112882	7888	7104	1075700	1284	25884	197817	187820	78878	288	14712	88218

End Report Data

Focus crops of the Generation Challenge Program

Table 4

Fifteen farming systems with over 2.5 million stunted children and showing the main crops of the systems

Farming system ^a	Stunted children ('000s)	Crops ^b
SA rice-wheat	28,310	<i>Rice</i> , pulses (<i>chickpea</i>) <i>millet</i> , <i>wheat</i> , <i>maize</i> , <i>bean</i>
SA rainfed mixed	24,547	Rice, millet, <i>sorghum</i> , chickpea, bean, <i>groundnut</i> , maize, wheat
EAP upland intensive mixed	15,435	Maize, rice, wheat, <i>sweet potato</i> , <i>potato</i> , bean
EAP lowland rice	13,368	Rice, maize, wheat, <i>sweet potato</i> , <i>groundnut</i>
SA rice	11,668	Rice, pulses (<i>chickpea</i>)
SSA cereal-root	6319	<i>Sorghum</i> , millet, <i>pulses (cowpea)</i> , maize, <i>groundnut</i> , <i>cassava</i>
SSA maize mixed	6318	Maize, <i>cassava</i> , <i>sorghum</i> , pulses, <i>groundnut</i> , millet, bean, <i>sweet potato</i>
SA highland mixed	5162	Rice, maize, wheat, potato, <i>groundnut</i> , pulses (<i>chickpea</i>)
SSA root	4989	Maize, <i>cassava</i> , rice, <i>sweet potato</i> , <i>cowpea</i> , <i>sorghum</i> , <i>groundnut</i> , bean
SA dry rainfed	3610	<i>Sorghum</i> , millet, chickpea, <i>groundnut</i> , bean
SSA agro-pastoral millet/sorghum	3135	Millet, <i>sorghum</i> , pulses <i>groundnut</i> , maize
LAC maize-beans	2837	Maize, bean, <i>sorghum</i>
SSA highland temperate mixed	2761	Maize, wheat, <i>sorghum</i> , <i>barley</i> , millet, pulses
EAP temperate mixed	2596	Maize, wheat, potato, <i>groundnut</i> , millet
EAP highland extensive mixed	2537	Rice, maize, wheat, potato, <i>groundnut</i> , pulses

^a SA, South Asia; SSA, sub-Saharan Africa; LAC, Latin America and the Caribbean; EAP, East Asia and the Pacific.

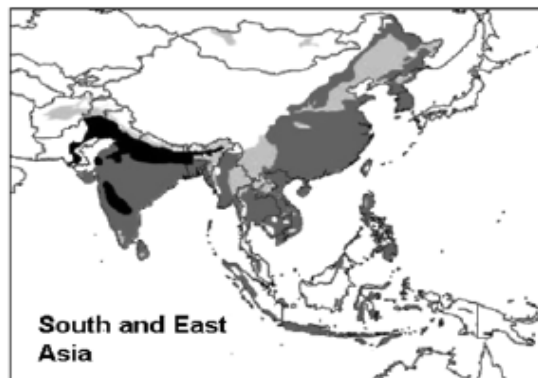
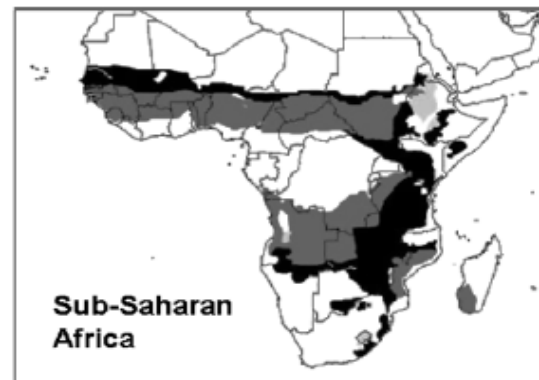
^b Crops appearing for the first time in the list are in italics.

Potential drought impact index (PDDI)

$$\sum_{i=1}^n (A * F)$$

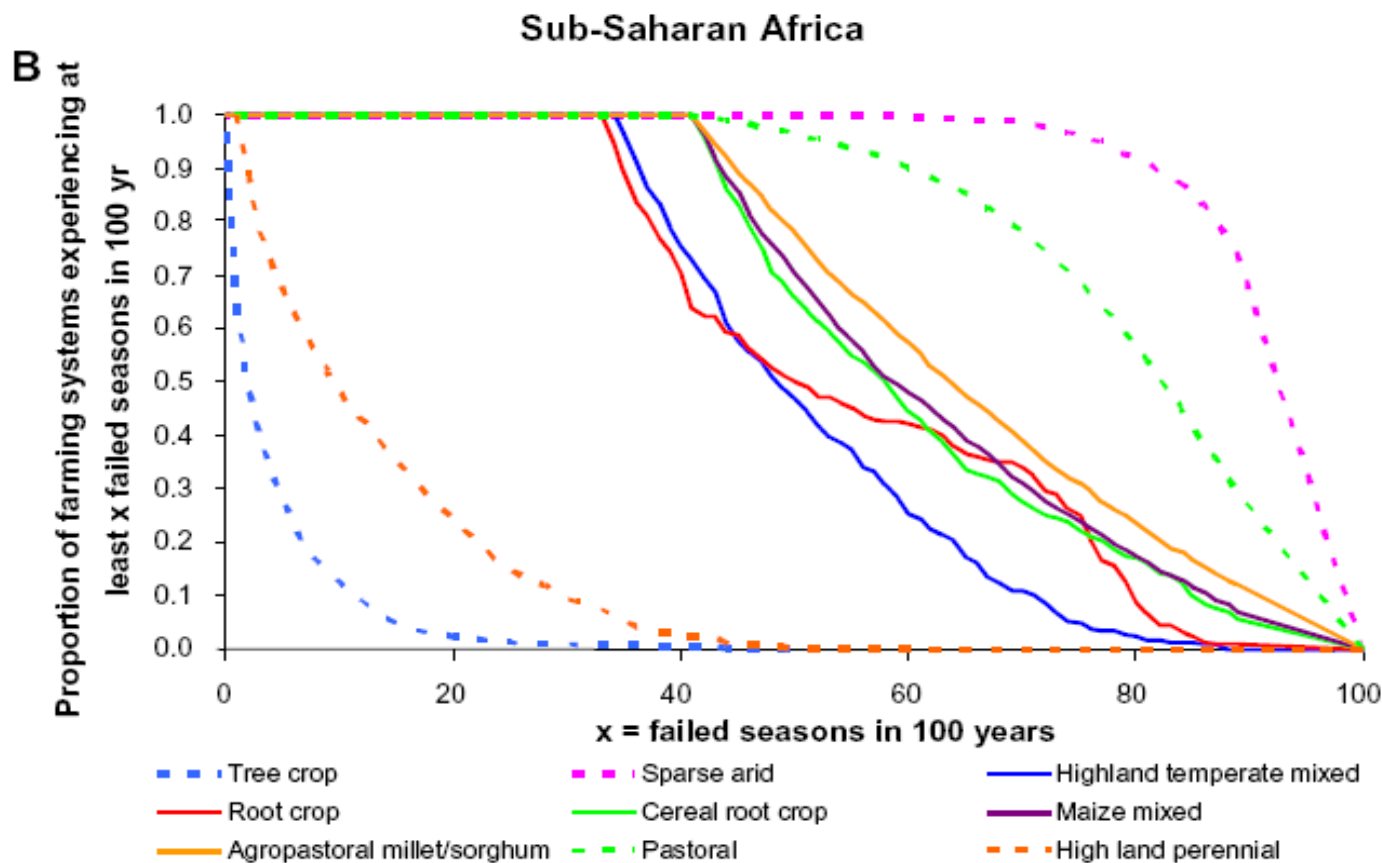
where A is the non-irrigated area harvested and F is the probability of a failed season for each grid cell. The index accounts for the extent of staple food crop production weighted by the probability of a failed season.

Focus regions for the GCP



- High drought intensity, high PDI
- Moderate drought intensity high PDI
- Moderate drought intensity, moderate PDI

The proportion of area within each farming system experiencing at least a given number of failed seasons in a 100-year period for sub-Saharan Africa. Systems represented by solid lines are among the 15 systems of the world with more than 2.5 million stunted children.



Results

- ❑ Farmers in drought prone areas largely depend on 12 staple crops
 - ❑ 15 farming systems in poor, drought-prone areas account for 70% of all stunted children
 - ❑ Farmers grow a diverse set of crops in these rainfed mixed cropping systems
-

Discussion

- ❑ Information resources used for making research investment decisions
- ❑ Better global crop maps needed
- ❑ Complementary studies to fill gaps
- ❑ Climate change considerations need to be incorporated
- ❑ Need to develop cultivar-specific analyses

Thank you