Geographic priorities for research and development on dryland cereals and legumes

RESEARCH PROGRAM ON Dryland Cereals | RESEARCH PROGRAM ON Grain Legumes | CGIAR

ABSTRACT - Dryland cereal and legume crops have often received less attention than maize, wheat and rice in terms of research and development priorities. But these crops are important globally because they serve populations living in poverty and particular socioeconomic and environmental niches. Compared to other crops, less is known about the global distribution of dryland cereal and legume crops and the conditions where they are grown. This research reports on an international effort to compile geographic information on cereal and legume crops and the conditions under which they are cultivated.. The study suggested that dryland cereal and legume crops should be given priority in 18 farming systems worldwide, representing 160 million ha. The priority regions include the drier areas of South Asia, West and East Africa, Middle East and North Africa, Central America and other parts of Asia. These regions are prone to drought and heat stress, among other biotic and abiotic constraints. They represent 60% of the global poor and malnourished and make up half of the global population.

INTRODUCTION - The CGIAR (hereafter referred to as DCL) requested an analysis of the principal commodities of their proposed program and the farming systems in which they are found. The 12 priority crops of the Dryland Cereals and Legumes Agri-Food System research program are chickpea, common bean, cowpea, faba bean, groundnut, lentil, pigeon pea, soybean, barley, pearl millet, small millet and sorghum (DCL, 2015). The research builds on a global classification of farming systems, on maps of the spatial distribution of all 12 DCL crop commodities, on socioeconomic data on population, poverty, malnutrition, on market access, and on soil and climatic data.

The analysis identifies	The study examines	The analysis and resulting database provides
• Where these crops occur in the context of constraints and opportunities for their development • How can DCL technologies be geographically targeted for reducing poverty and malnutrition?	• The spatial extents of key con-straints to DCL crop production, using the most recent spatial data available	• The first global farming systems information resource for specifically evaluating priorities for DCL crop improvement and management

Figure 2. Once the database was organized we could graph relationships between variables, such as this comparison of rainfall and drought

Figure 3. All the data from the project was compiled and developed within an online Atlas (http://www.eatlasdcl.cgiar.org/) available for download.

MATERIALS AND METHODS - The present study uses a spatial overlay, biophysical and socioeconomic information are organized according to the 63 Dixon farming systems (Dixon et al., 2001) but with a focus on the 12 principal commodities and farming systems of DCL A key advantage of this research was that instead of analyzing crop information by country (250 in total), subnational estimates of crop distribution are generated based on pixel level data (Hyman et al., 2008). Spatial overlay was used to organize the data into spatial units according to farming system and combinations of farming systems and country. The result of the overlay procedure is a set of database files (dBase format) organized by farming system region and combination of farming system region and country. The process facilitated an analysis of DCL crops in 18 farming systems where these crops are concentrated.

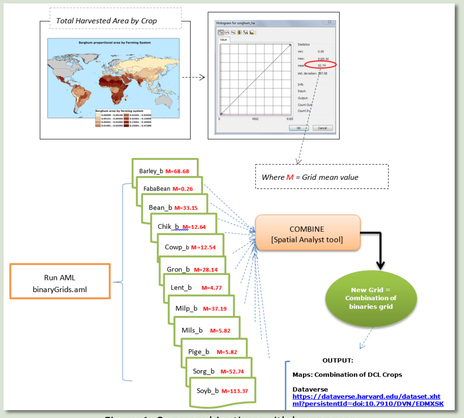

Figure 1. Crop combinations with larges areas

RESULTS

- DCL crops should be given priority in 18 farming systems worldwide where they cover 160 million ha.
- These dryland system areas are home to the majority of the world's poor and food insecure.
- The DCL crops are found in environment prone to heat and drought stress – two constraint key to crop improvement efforts.

FARMING SYSTEMS	REGION	2010 Population ('000)	2005 Population ('000)	2005 Rural Population ('000)	2005 Urban Population ('000)	Stunted Children ('000)	Stunting Prevalence	Poverty headcount (<$1day) ('000)	Poverty headcount (<$2day) ('000)	DCL Crop Area ('000 ha)
Cereal-root crop mixed	SSA	116,472	84,150	69,199	14,951	6,320	39	52,865	73,618	21,328
Maize mixed	SSA	125,279	96,684	72,837	23,847	6,314	41.1	51,310	68,988	7,607
Agro-pastoral millet/sorghum	SSA	70,806	54,864	37,892	16,972	3,133	37	30,899	40,999	18,691
Pastoral	SSA	51,662	39,705	29,677	10,027	3,228	35.5	13,369	20,871	10,808
Rice-wheat	SA	613,984	491,399	365,498	125,901	28,292	51.5	237,306	440,256	11,283
Rainfed mixed	SA	400,921	356,767	249,537	107,430	24,541	62.6	157,816	296,661	30,763
Dry rainfed	SA	47,017	45,600	33,544	12,056	3,610	65.5	18,074	32,620	8,685
Highland mixed	MENA	72,913	67,103	31,036	36,067	1,572	20.4	3,648	11,254	2,961
Rainfed mixed	MENA	47,798	38,815	13,852	24,963	499	16.3	1,666	6,415	1,589
Dryland mixed	MENA	56,966	47,224	18,093	29,132	750	18.7	1,128	4,380	3,841
Pastoral	MENA	38,441	33,845	16,798	17,047	1,668	21.9	988	4,444	1,001
Maize-beans (Mesoamerica)	LAC	88,137	76,106	28,686	47,420	2,838	35.9	4,684	9,278	1,750
Large scale cereal-vegetable	EECA	63,105	65,593	28,474	37,118	319	8.7	1,501	1,178	6,948
Small scale cereal-livestock	EECA	19,852	19,898	8,763	11,135	382	19.6	658	2,175	2,550
Extensive cereal-livestock	EECA	92,121	93,425	26,044	67,381	70	3.7	1,639	2,848	9,161
Lowland rice	EAP	851,260	785,701	496,073	289,627	13,360	31.8	117,021	264,030	8,778
Upland intensive mixed	EAP	501,857	502,323	358,539	143,783	15,427	33.6	84,484	190,653	7,869
Temperate mixed	EAP	285,014	260,574	138,989	121,585	2,594	21.6	36,416	82,927	6,539
TOTAL		3,543,606	3,159,775	2,023,332	1,136,441	114,917		815,472	1,546,593	162,152

FARMING SYSTEMS	REGION	DLC Crop Area (ha)	Potential Drought Impact Index	Temperature Change 2050
Cereal-root crop mixed	SSA	21,327,541	2,971,040	2.46
Maize mixed	SSA	7,606,508	1,592,730	2.47
Agro-pastoral millet/ sorghum	SSA	18,691,342	7,644,810	2.77
Pastoral	SSA	10,808,337	7,409,830	2.73
Rice-wheat	SA	11,282,838	4,431,820	2.83
Rainfed mixed	SA	30,763,078	7,556,180	2.46
Dry rainfed	SA	8,685,308	2,868,150	2.36
Highland mixed	MENA	2,961,344	98,050	3.01
Rainfed mixed	MENA	1,588,829	123,471	2.64
Dryland mixed	MENA	3,840,974	104,013	2.79
Pastoral	MENA	1,000,516	10,668	2.93
Maize-beans (Mesoamerica)	LAC	1,749,799	398,401	2.36
Large scale cereal-vegetable	EECA	6,947,991	86,502	2.82
Small scale cereal-livestock	EECA	2,550,258	1,849	2.82
Extensive cereal-livestock	EECA	9,160,822	17,198	3.31
Lowland rice	EAP	8,778,265	982,407	2.25
Upland intensive mixed	EAP	7,868,661	1,065,610	2.42
Temperate mixed	EAP	6,539,133	1,088,910	2.91

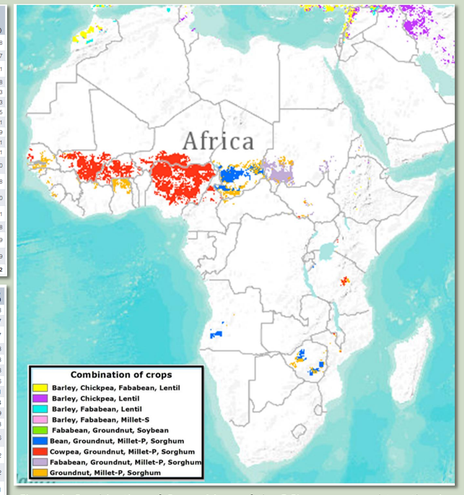

Figure 4. Combination of Crops. Many of the DCL crops around together in dryland áreas such as the Sahel. In this región, the research program can take advantage of economies of scale in carrying out R&D interventions

DISCUSSION

- South Asia and Sub-Saharan Africa are the most important regions for crop improvement and adapted crop management practices
- Adverse biotic and abiotic constraints and socioeconomic conditions set the context for research and development in these priority systems
- Future geographic research is needed to update maps to latest conditions, improve spatial resolution and carry out genotype-by-environment analysis.

REFERENCES – See our website at http://www.eatlasdcl.cgiar.org/, or our published paper: Hyman, G., Barona, E., Biradar, C., Guevara, E., Dixon, J., Beebe, S., Castano, S.E., Alabi, T., Gumma, M.K., Sivasankar, S. and Rivera, O., 2016. Priority regions for research on dryland cereals and legumes. F1000 Research, 5(885), pp.01-18. https://f1000research.com/articles/5-885/v2.

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CGIAR RESEARCH PROGRAM ON Grain Legumes

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IN PARTNERSHIP WITH CIAT — Centro Internacional de Agricultura Tropical / International Center for Tropical Agriculture; ICARDA — Science for Better Livelihoods in Dry Areas; IITA — Research to Nourish Africa

and public and private institutes and organizations, governments, and farmers worldwide

Leveraging legumes and dryland cereals to combat poverty, hunger, malnutrition and environmental degradation