DCL AGRI-FOOD SYSTEMS

eAtlasDCL.cgiar.org

Geographic priorities for research and development on dryland cereals and legumes (DCL)

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CGIAR RESEARCH PROGRAM ON Dryland Cereals — LED BY ICRISAT — IN PARTNERSHIP WITH ICARDA — and public and private institutes and organizations, governments, and farmers worldwide — CGIAR RESEARCH PROGRAM ON Dryland Cereals and Legumes AGRI-FOOD SYSTEMS

Introduction

- Maps, geography and spatial analysis are increasingly important for developing R&D programs, priority setting, monitoring, impacts assessment and reporting.
- But the community of researchers working on this topics has perhaps been less organized to carry out this type of work.
- This initiative propose to develop an online Atlas for R&D among the DCL community with focus on Geo-spatial Science, Technology and Applications (GeSTA).

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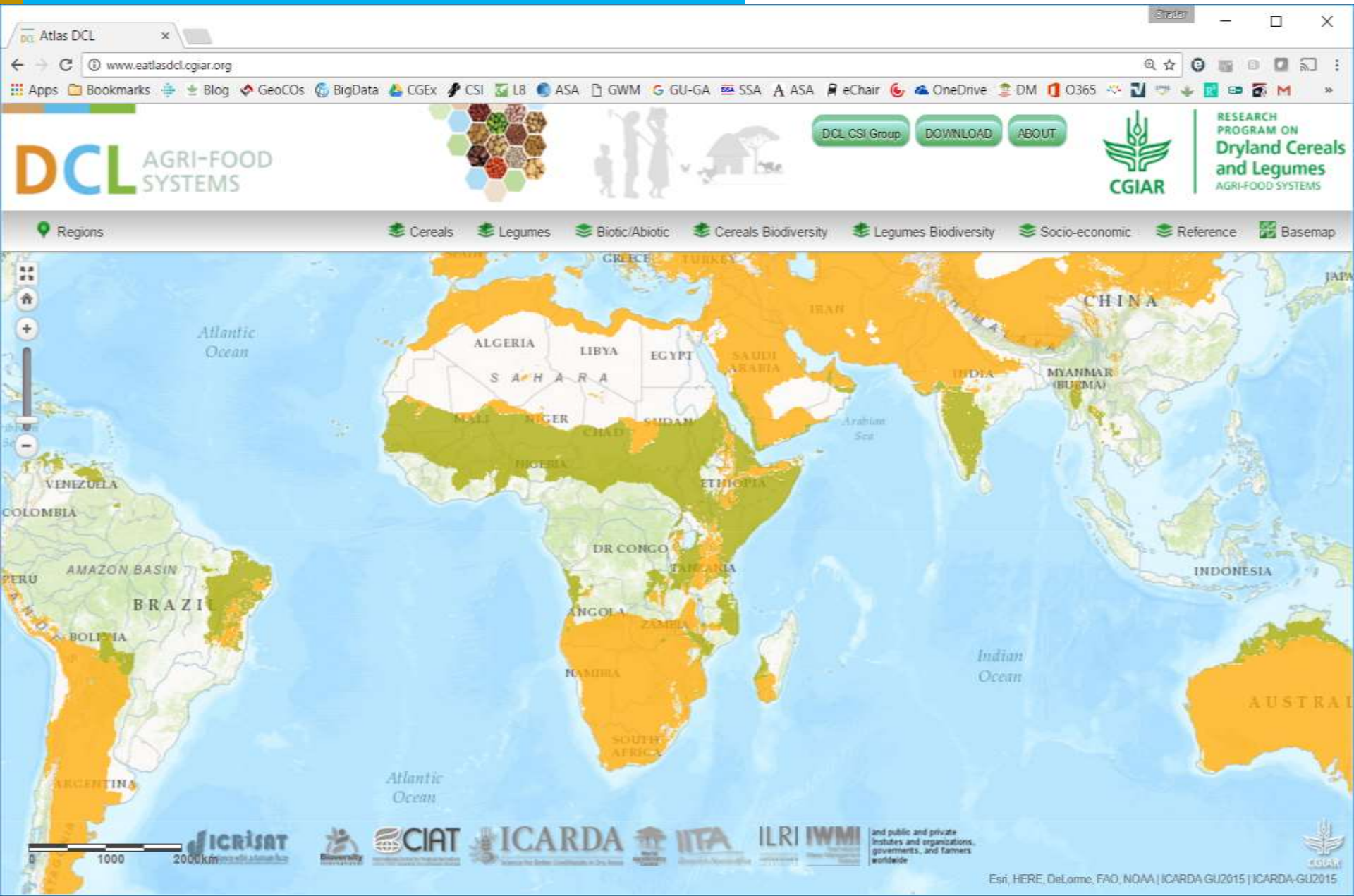
The DCL eAtlas www.eatlasdcl.cgiar.org



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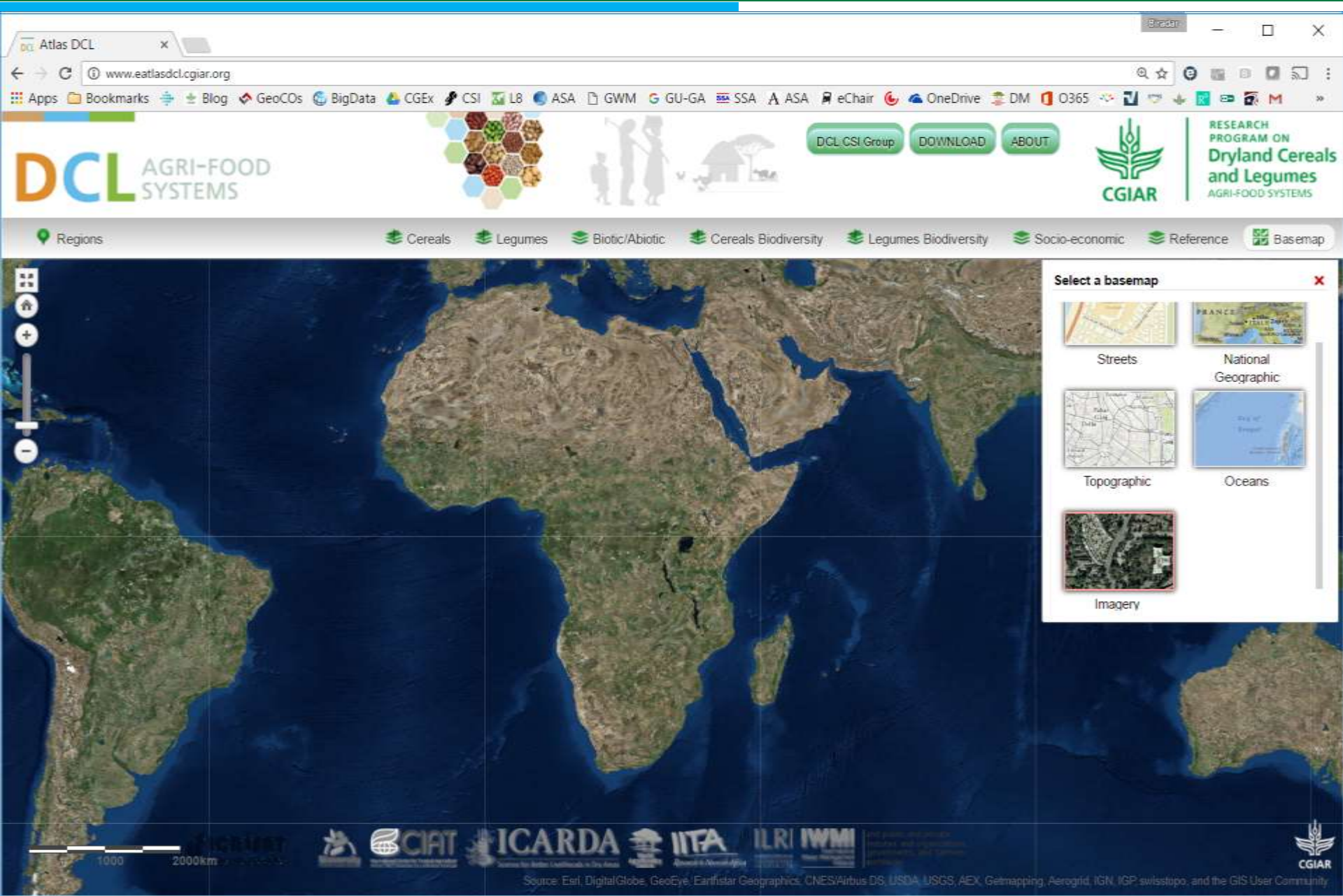


Methodology

Spatial overlays, zonal/geostats

Data sources

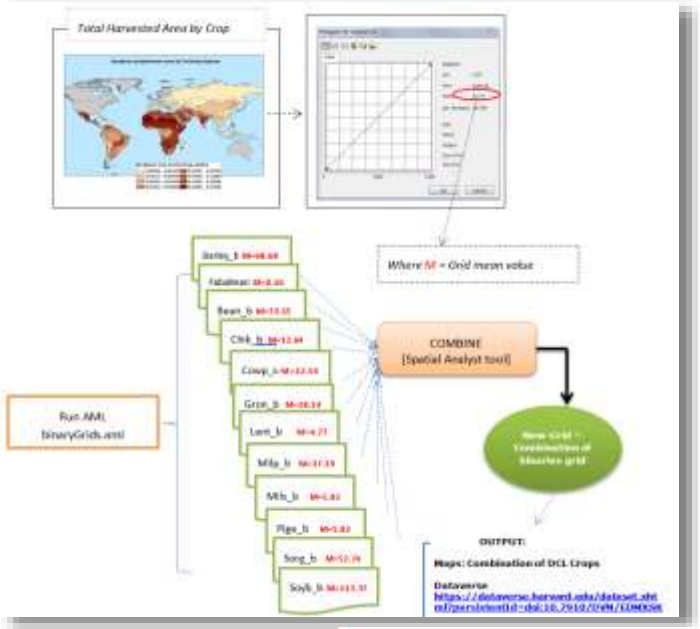
- CGIAR center GIS/Geo-informatics labs
- Public domain
- FAO farming systems

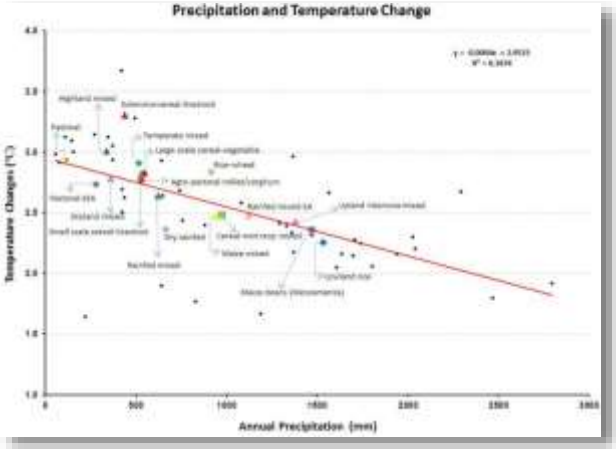
Spatial analysis

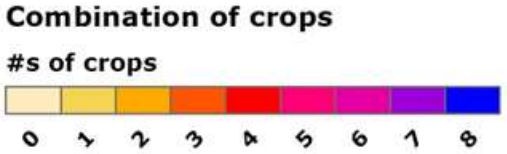
- Remote sensing and GIS
- Spatial overlay

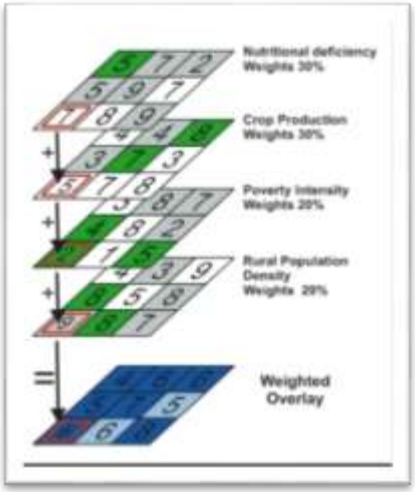
Determining priority regions

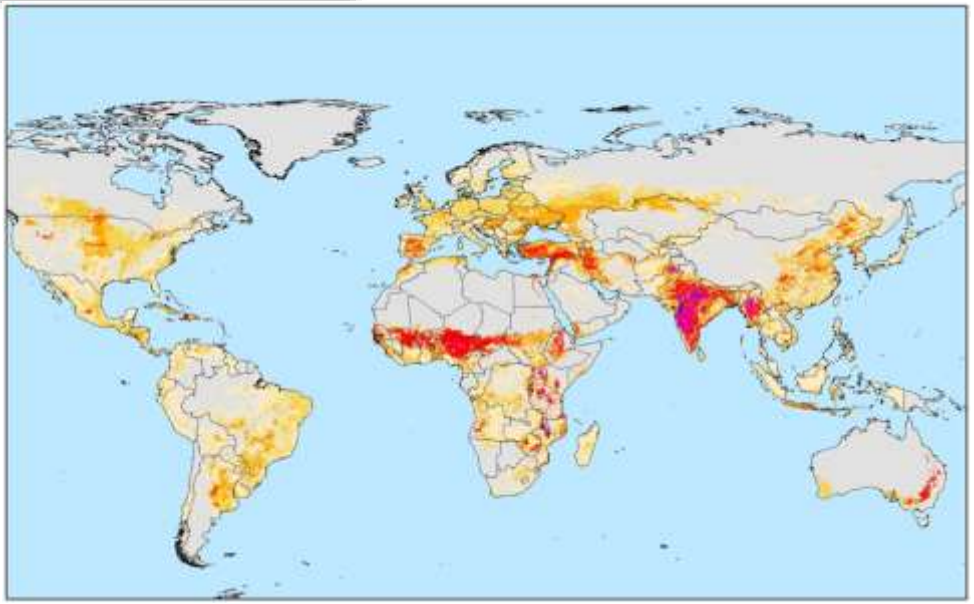
- Overlay of DCL crop distributions with FAO farming systems
- Analysis of biotic, abiotic, socioeconomic and management conditions by farming system.





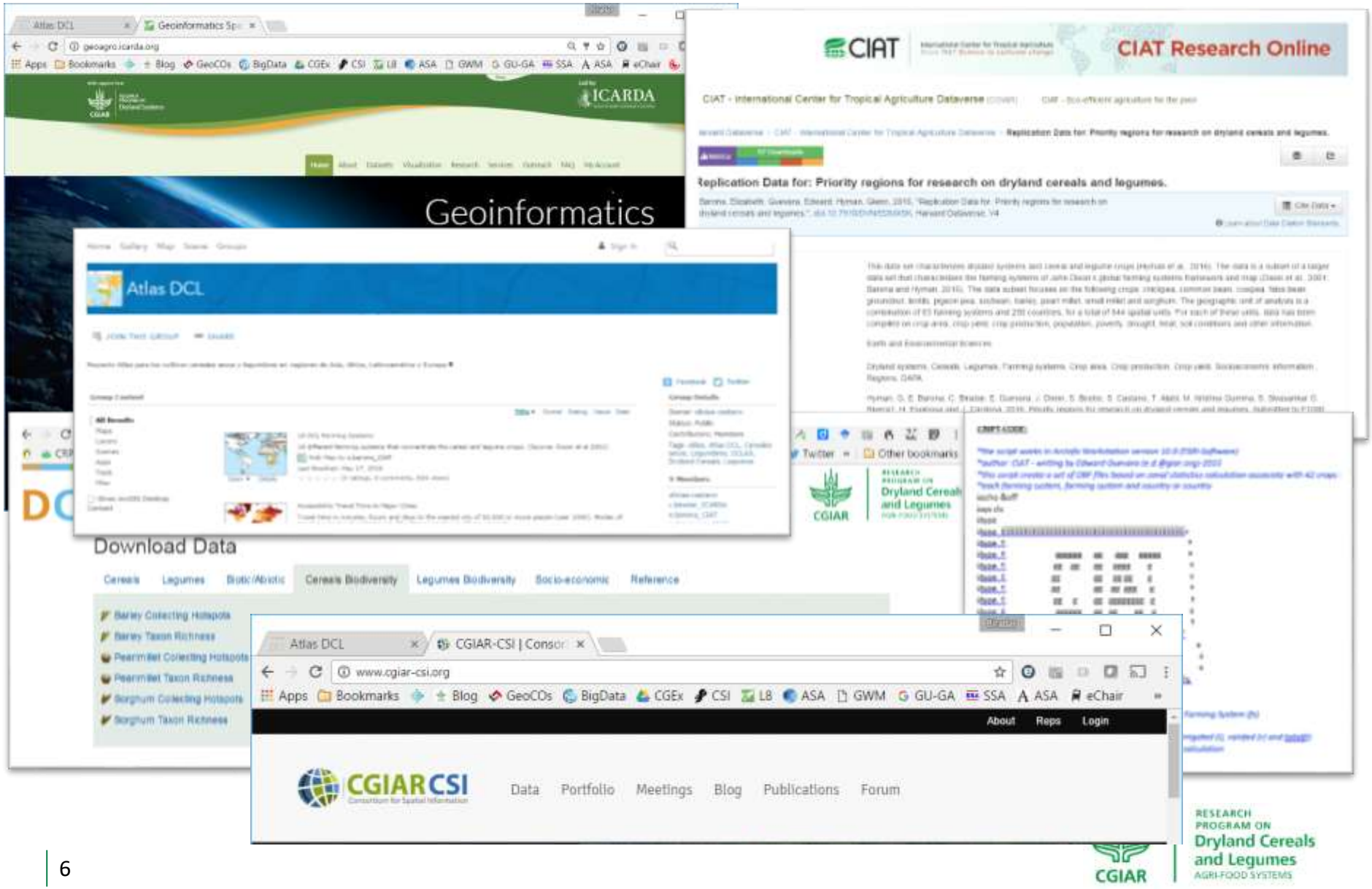






Methodology

Scripts, documentation and data all available online and cloud



Results

Major drylands farming systems and crop and regional dominance

Table 1. DCL crop area in '000's of hectares in 18 priority farming systems worldwide.

FARMING SYSTEMS	REGION	BARL	BEAN	CHKP	COWP	GRDN	LENT	PMIL	PSML	PPEA	SORG	SOYB	FABAB	TOTAL
Cereal-root crop mixed	SSA	26	573	32	2,983	2,949	1	4,649	128	78	9,594	295	19	**21,328**
Maize mixed	SSA	81	2,175	107	387	977	7	655	432	431	1,976	309	70	**7,607**
Agro-pastoral millet/sorghum	SSA	2	169	1	3,489	1,751	0	7,551	0	8	5,596	108	15	**18,691**
Pastoral	SSA	65	77	21	2,070	725	7	4,798	9	0	2,955	14	66	**10,808**
Rice-wheat	SA	461	1,575	1,966	0	277	977	4,012	144	543	966	362	0	**11,283**
Rainfed mixed	SA	161	3,951	4,062	4	4,014	595	2,628	1,697	2,149	4,226	7,276	0	**30,763**
Dry rainfed	SA	0	496	1,030	0	1,168	0	1,148	68	735	3,829	210	0	**8,685**
Highland mixed	MENA	1,704	83	524	0	1	189	1	67	0	291	75	28	**2,961**
Rainfed mixed	MENA	1,197	22	94	0	26	69	5	2	0	17	1	156	**1,589**
Dryland mixed	MENA	3,486	6	126	0	7	125	0	11	0	10	7	62	**3,841**
Pastoral	MENA	737	18	40	0	13	37	0	19	0	120	4	11	**1,001**
Maize-beans (Mesoamerica)	LAC	277	783	30	0	23	8	0	0	1	597	15	17	**1,750**
Large scale cereal-vegetable	EECA	5,927	44	2	0	0	1	0	309	0	30	634	1	**6,948**
Small scale cereal-livestock	EECA	2,057	59	235	0	6	181	0	2	0	0	0	9	**2,550**
Extensive cereal-livestock	EECA	8,322	5	12	0	0	6	0	535	0	22	250	6	**9,161**
Lowland rice	EAP	408	2,436	1	39	2,805	16	53	28	18	91	2,696	187	**8,778**
Upland intensive mixed	EAP	154	1,167	86	65	1,629	20	522	25	436	170	3,336	258	**7,869**
Temperate mixed	EAP	75	259	1	0	1,202	16	209	3	0	264	4,178	333	**6,539**
TOTAL		**25,141**	**13,899**	**8,371**	**9,039**	**17,576**	**2,257**	**26,233**	**3,477**	**4,399**	**30,754**	**19,770**	**1,236**	**162,152**

Results

Major drylands farming systems and crop and regional dominance

- Three farming systems in South Asia – ***rainfed mixed, rice-wheat*** **and** ***dry rainfed*** – make up about **one third** of the **162 million ha of DCL crops** in the 18 priority farming systems
- A second important region is **Sub-Saharan Africa**, where the cereal-root crop mixed system accounts for **21.3 million ha**, the **agro-pastoral millet sorghum** system accounts for **18.6 million ha**, the **pastoral system** accounts for **10.8 million ha** and the **maize mixed system has 7.6 million ha**
- In **Eastern Europe and Central Asia** more **than 15 million ha** are cultivated, with **barley** figuring prominently.
- In **East Asia over 22 million ha** are cultivated, with **groundnut and soybean** as the predominant crops.

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Results

Abiotic and biotic stress climate change and extreme events

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	2.48
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	2.48
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

The farming systems where dryland cereals and grain legumes are concentrated are particularly prone to high temperatures and drought and crop stress.

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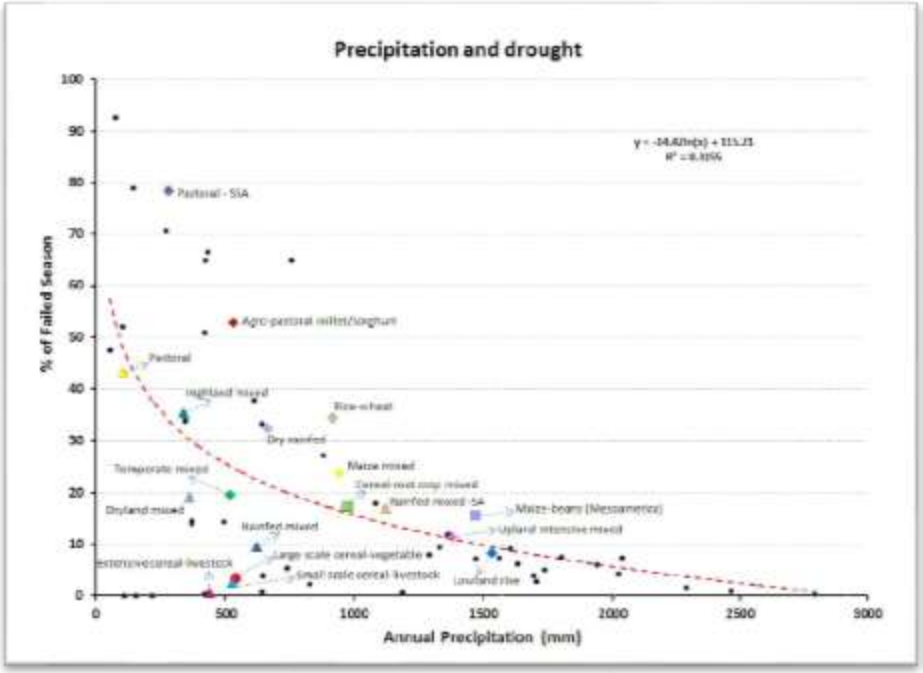
Results

Abiotic and biotic stress climate change and extreme events

These dryland systems, especially those with less than 1000 mm of annual precipitation, tend to have a higher probability of drought or a failed season, when precipitation does not meet crop requirements.

There is a general tendency of the drier farming systems having higher expected temperature changes between now and future climate scenarios (2050) and further decrease in precipitation



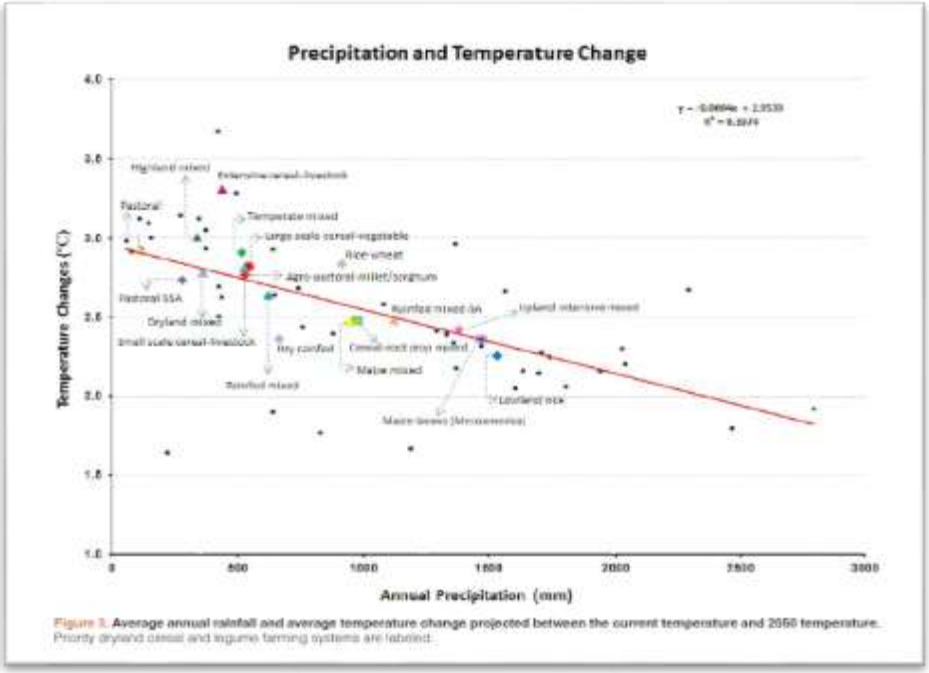


Figure 3. Average annual rainfall and average temperature change projected between the current temperature and 2050 temperature. Priority dryland cereal and legume farming systems are labeled.

Results

Abiotic and biotic stress climate change and extreme events

The soils of DCL priority farming systems present a number of abiotic constraints to DCL crop production.

Table 6. The percentage area of each of the 18 priority farming system with soil constraints.

FARMING SYSTEMS	REGION	Acid Soil constraints (MEAN % of farming system)	Soil > 3 months dry season (MEAN % of farming system)	Soil subject to waterlogging (MEAN % of farming system)	Soil with low moisture holding capacity (MEAN % of farming system)	Soil with Low nutrient availability (MEAN % of farming system)	Soil with Salinity constraints (MEAN % of farming system)
Cereal-root crop mixed	SSA	37	1	14	22	19	1
Maize mixed	SSA	27	4	7	14	35	1
Agro-pastoral millet/sorghum	SSA	15	4	8	38	7	3
Pastoral	SSA	5	20	4	30	2	6
Rice-wheat	SA	19	21	7	5	4	23
Rainfed mixed	SA	39	2	3	12	10	2
Dry rainfed	SA	14	0	2	1	1	2
Highland mixed	MENA	2	36	2	2	0	5
Rainfed mixed	MENA	25	13	3	3	0	2
Dryland mixed	MENA	7	38	1	5	0	5
Pastoral	MENA	1	42	1	10	0	8
Maize-beans (Mesoamerica)	LAC	30	1	3	3	14	0
Large scale cereal-vegetable	EECA	17	5	11	6	0	5
Small scale cereal-livestock	EECA	9	31	2	1	1	2
Extensive cereal-livestock	EECA	11	2	15	6	0	1
Lowland rice	EAP	22	0	35	5	30	2
Upland intensive mixed	EAP	23	0	10	1	35	1
Temperate mixed	EAP	10	1	35	2	0	18

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Results

Population and poverty

The key DCL farming systems are home to about one third of the global population, including an enormous number of people living in poverty.

FARMING SYSTEMS	REGION	2010 Population ('000)	2005 Population ('000)	2005 Rural Population ('000)	2005 Urban Population ('000)	Stunted Children ('000)	Stunting Prevalence	Poverty headcount (<$1/day) ('000)	Poverty headcount (<$2/day) ('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	249,337	107,430	24,541	62.6	157,816	286,661	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	193,653	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**

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Phase2 development and way forward

Potential additions to DCL Atlas Platform

- higher resolutions (space and time)
- crop types and granularity;
- similarity mapping and out scaling;
- tracking adoption of technologies;
- niche modelling and predictions;
- yield gap mapping across the scales
- carry out genotype-by-environment analysis;
- land potential for investment and implementation
- …

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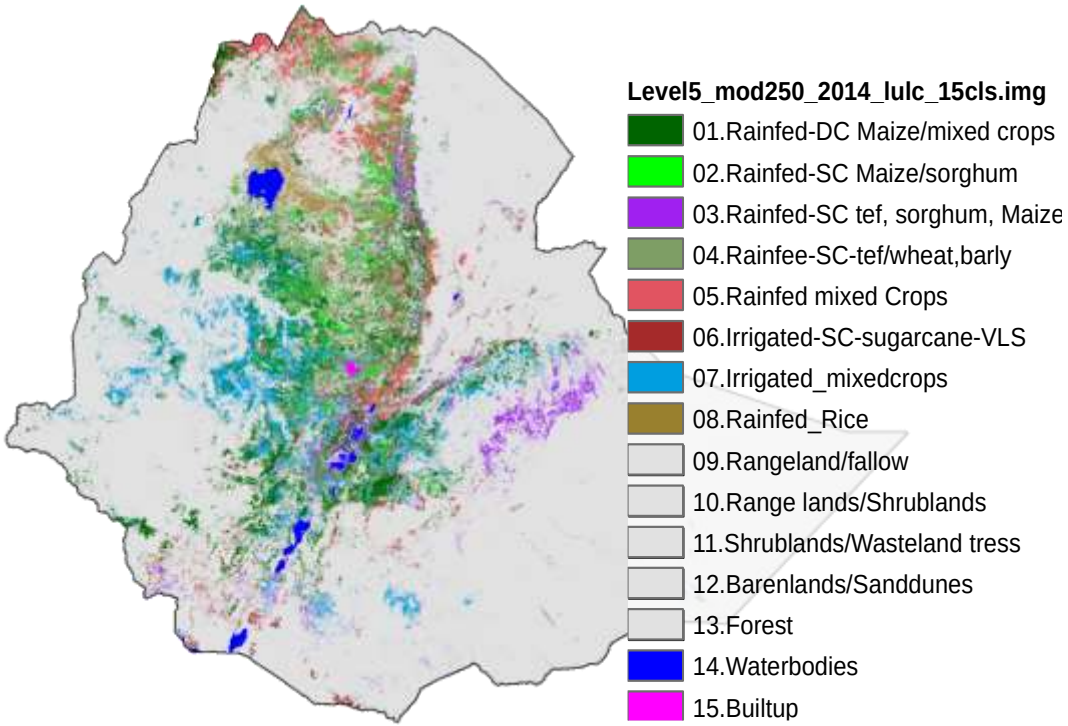
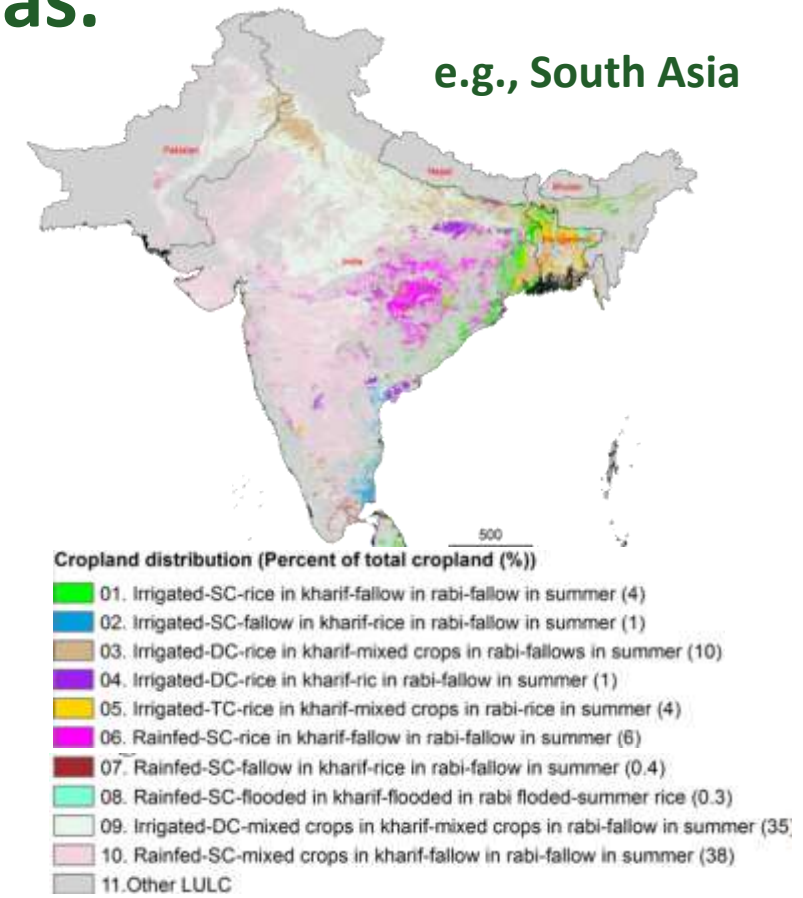
Crop types, pattern and phenology

Mapping crop land areas.

e.g., Ethiopia



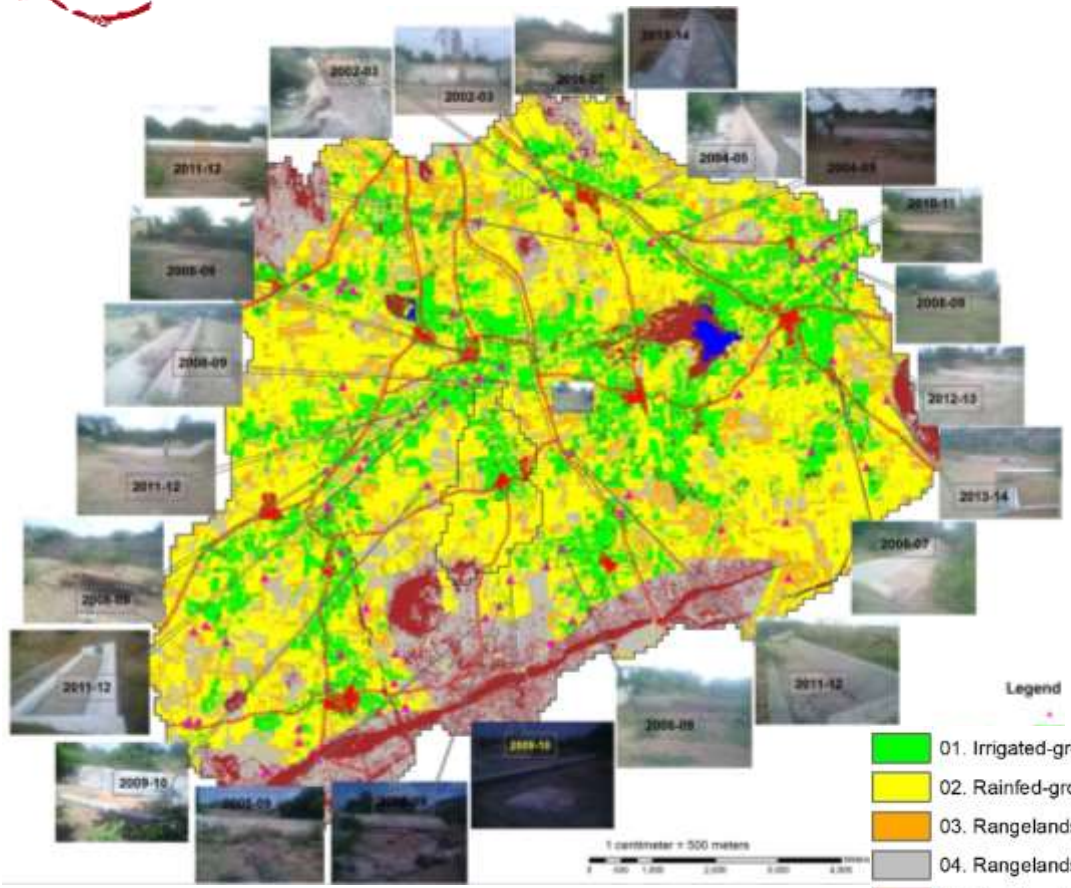
e.g., South Asia



Gumma et al., 2016. ICRISAT

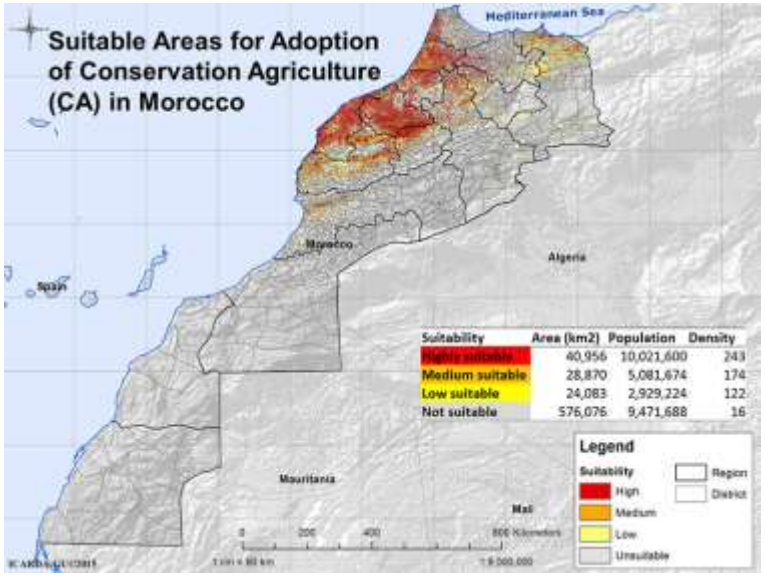
Tracking of technological adoption

Adoption of water harvesting structures, in Andra Pradesh



Ahmed, I. et al., 2016. ICRISAT

Adoption of conservation agriculture (zero tillage) in Morocco



Biradar, et al., 2015. ICARDA

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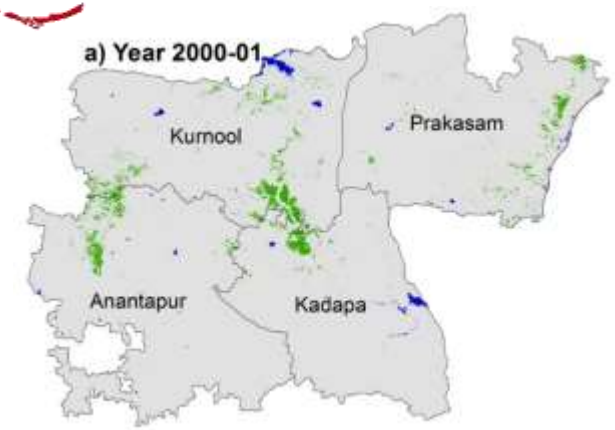
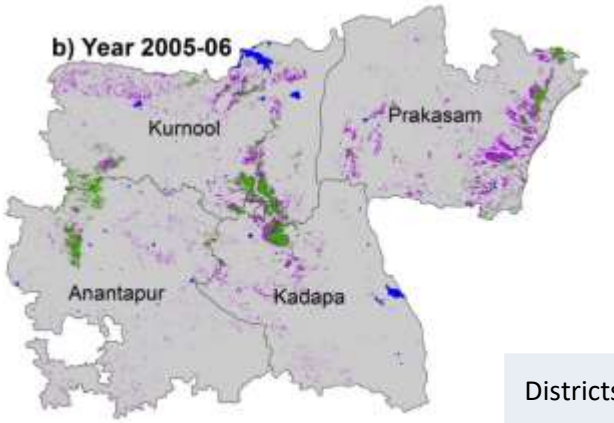
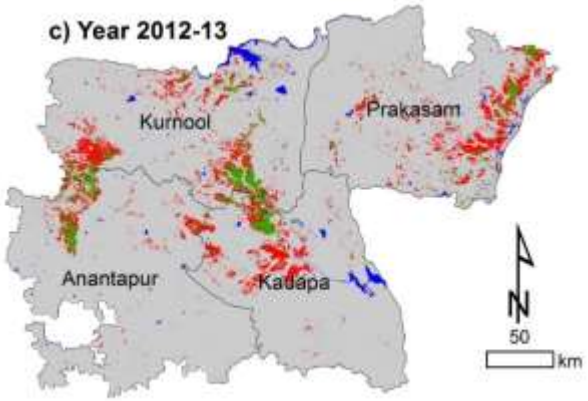
Tracking of technological adoption

Adoption of Chickpea

Links image analysis to field surveys







Districts	Area (ha)		
	MODIS-2000	**MODIS-2005**	**Modis-2012**
Anantapur	34777	51304	84493
Cuddapah	30343	69258	117903
Kurnool	68113	140511	196793
Prakasam	35129	128288	159524
	168362	389361	**558713**

Legend

- 01. Water bodies
- 02. Chickpea (2000-01)
- 03. Chickpea expansion (2005-06)
- 04. Chickpea expansion (2012-13)

Gumma et al., 2016. ICRISAT

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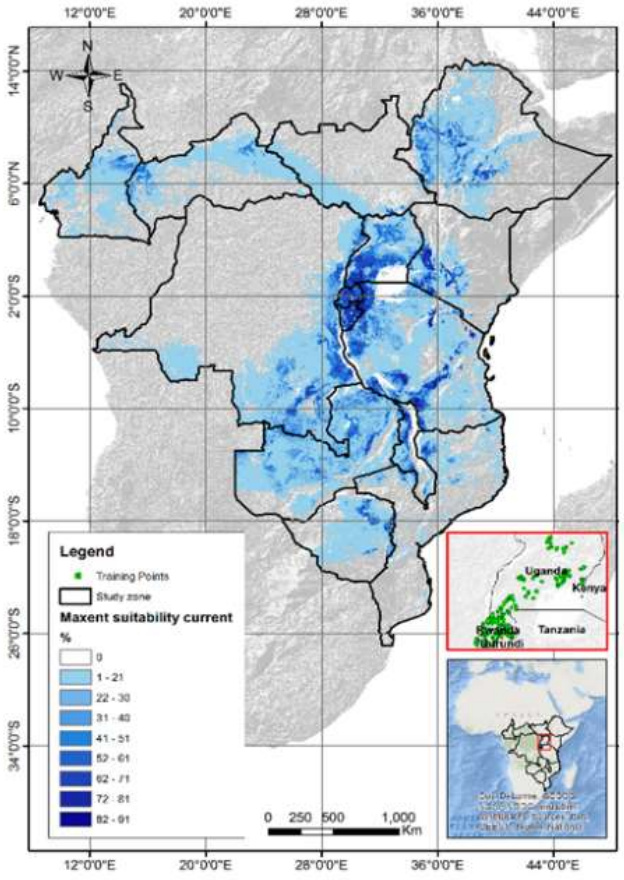
Niche modelling and distribution

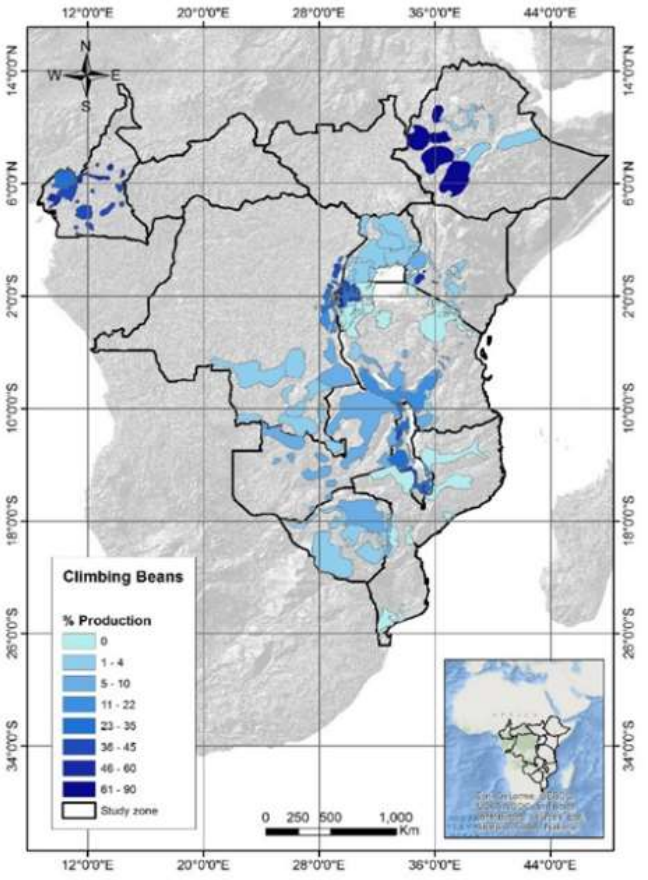
EXAMPLE

The current predicted distribution of climbing beans according to MaxEnt model and Africa Bean Atlas

Source: Glenn, CIAT



Current Climate



% of bean production that is climbing beans
From Atlas of Common Bean in Africa

CIAT

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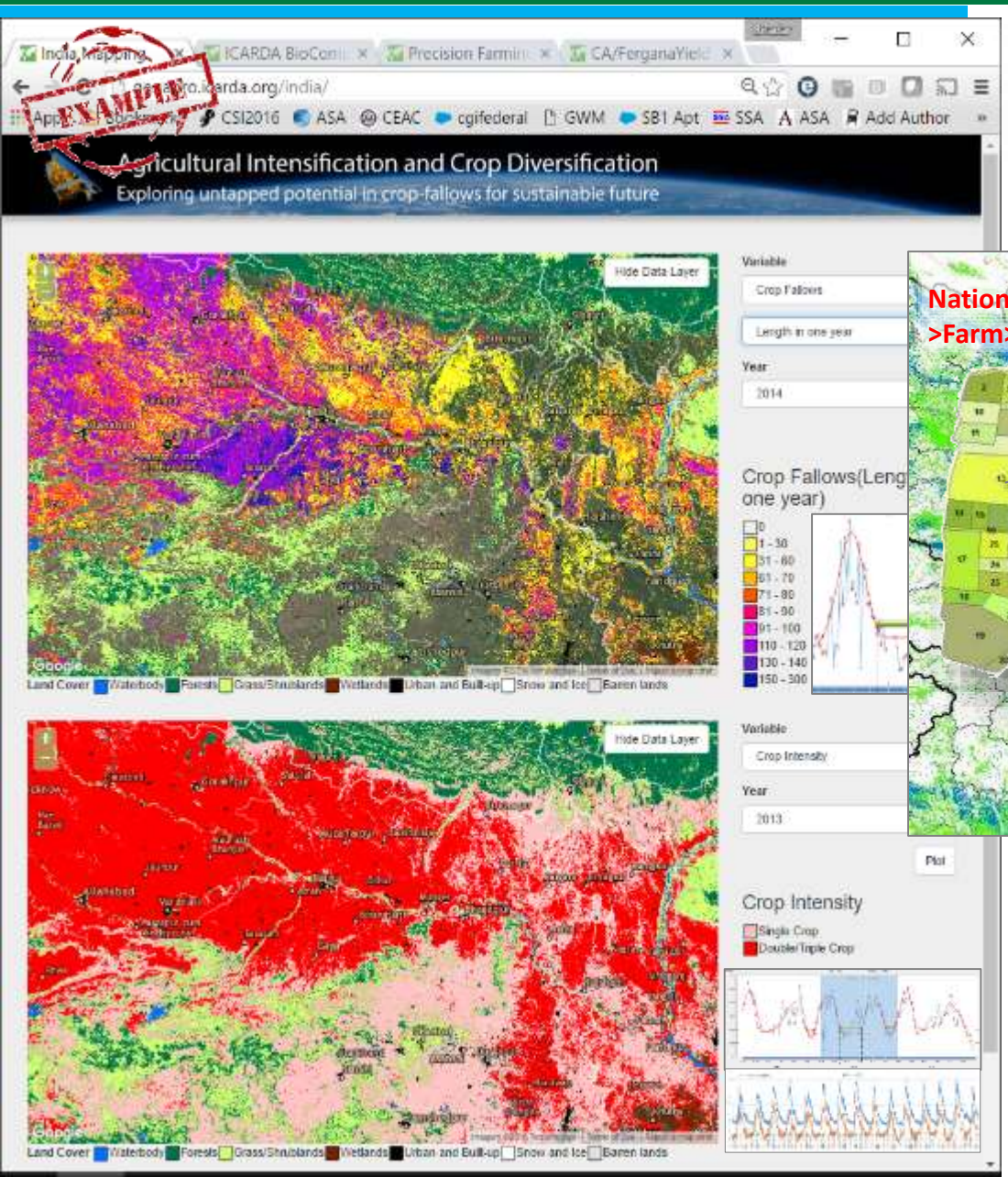
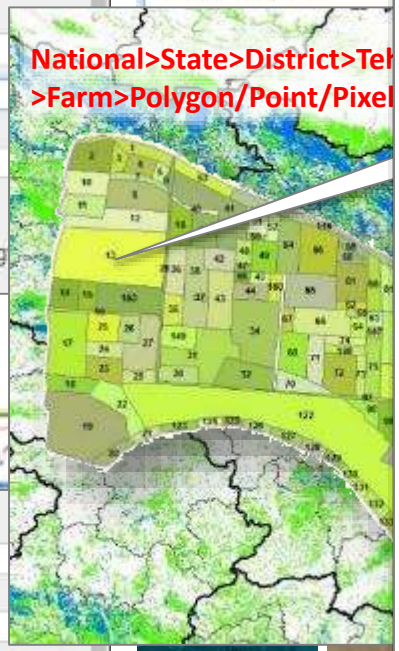
Crop Intensification & Diversification





Near real-ti
pixel to land

Variable

Crop Fallows

Lentil in Rice-b

Irrigated

Rice – EE Lentil

Rice – Relay E Lent

Cropping System
Crop Intensity
Crop Calendar
Crop Rotation
Cropped Area

Fallow Dynamics
-Fallow area
-Duration
-Start date
-End date

Yield Potential
-Current
-Achievable

Suitable Crop/Variety
-Legumes
-Oil Seeds

Soils
Soil Health (SHC)
Soil Moisture (SMAP)

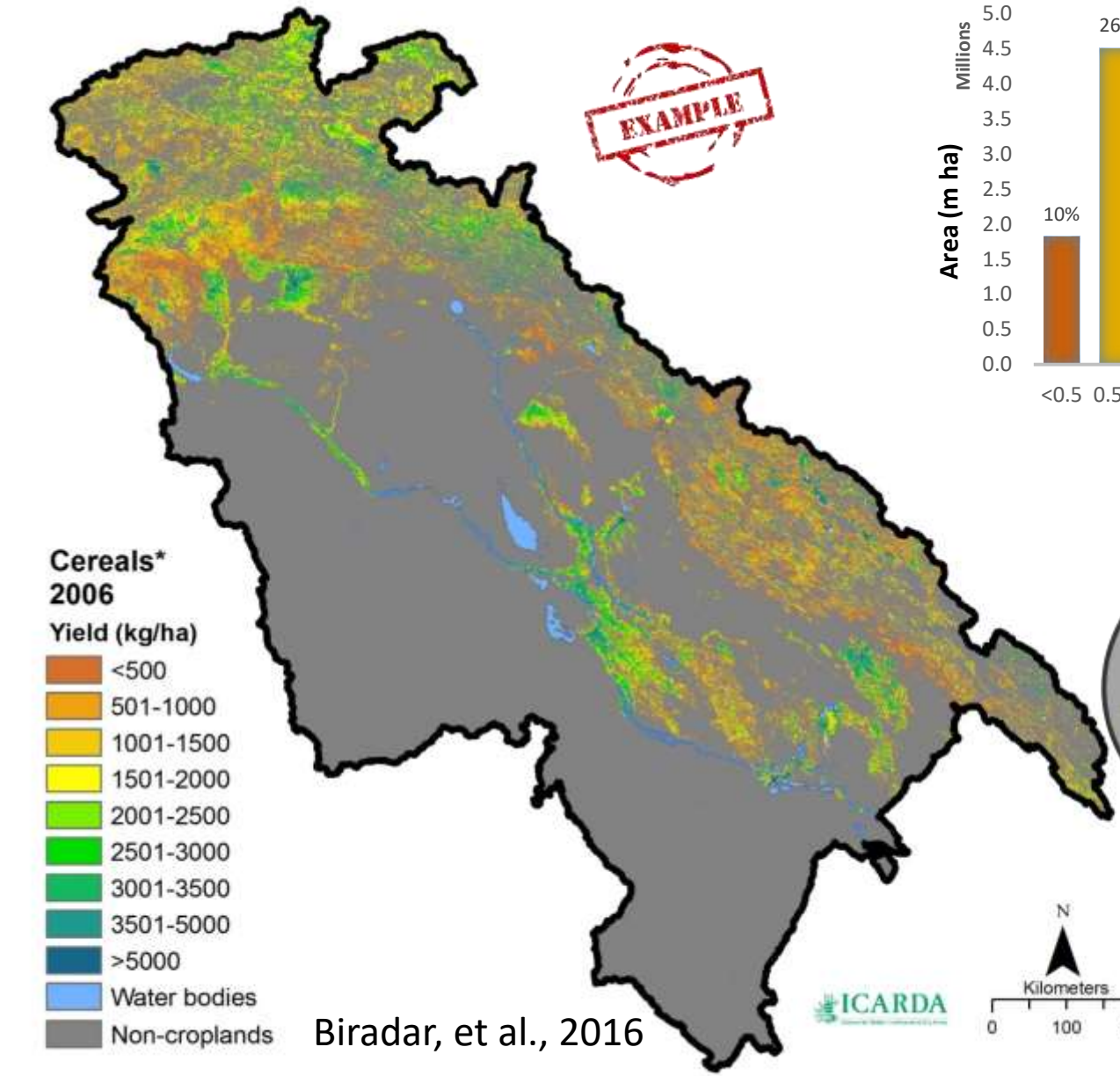
Water use
Evapotranspiration
Allocation/Irri. Sch.

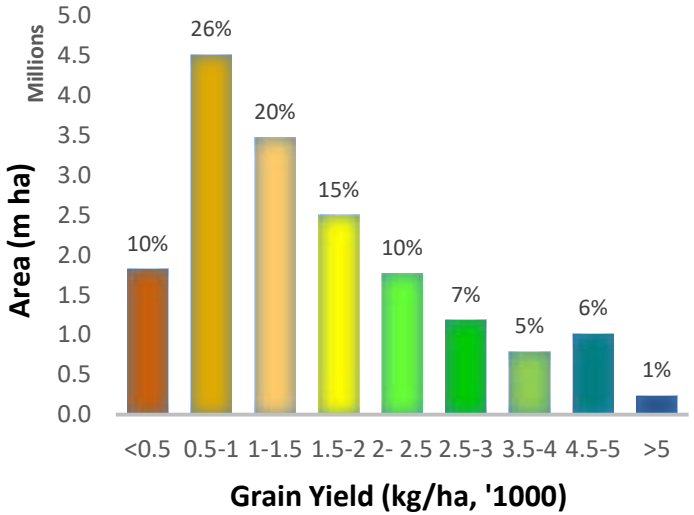
Markets
-ePlatform
-Ag Supply Chain
-Access (I/O)

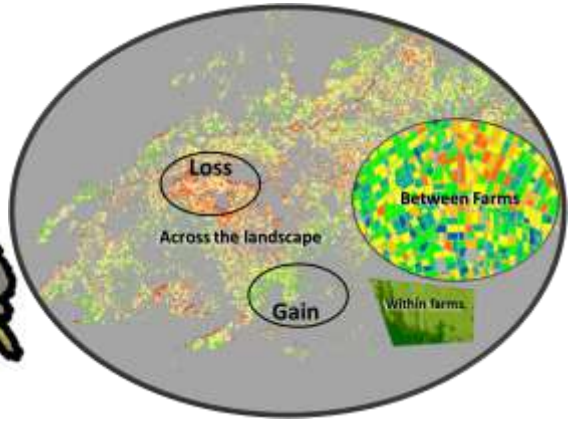
Monitoring
-Pest/Diseases
-Crop Stress

Citizen Science

Agricultural Productivity, Production and Dynamics







Biradar, et al., 2016

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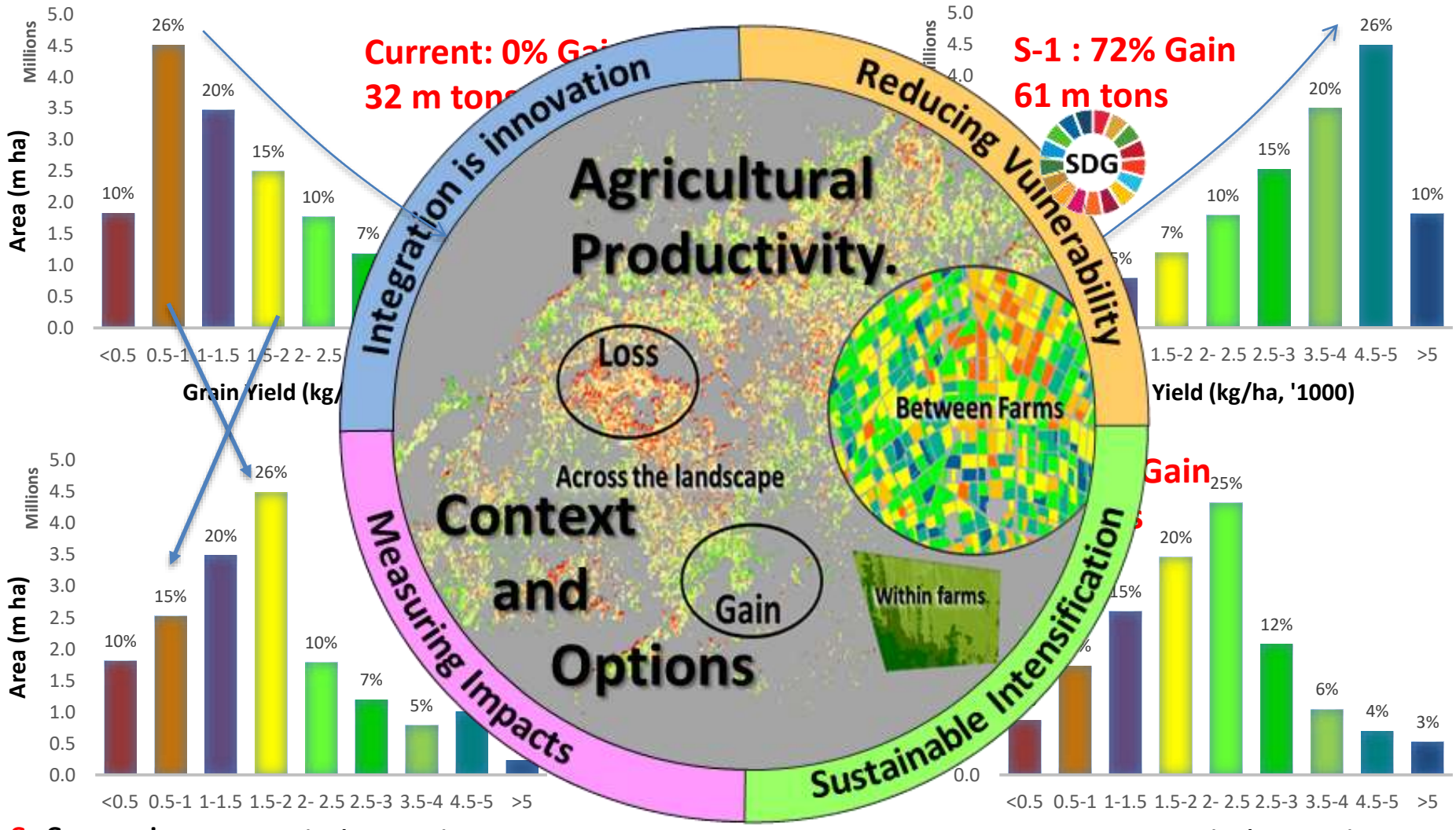
Dryland Cereals and Legumes
AGRI-FOOD SYSTEMS

Location specific Investment, Interventions and Impacts



S=Scenarios

Biradar, et al., 2016*

RESEARCH PROGRAM ON Dryland Cereals and Legumes AGRI-FOOD SYSTEMS
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in an inch of land and bunch of crop

avoid the unmanageable and
manage the unavoidable

-IPCC Confronting Climate Change:

Thank You

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