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The Future of Agriculture in Malawi with Climate Change

Sustainability in agriculture: what does it really mean?

To an agronomist, it might refer to how nutrients and organic matter are being removed from the soil.

But to an economist, it is about whether expectations for the agricultural sector are more than it can deliver in the future.

What expectations?

- Food security, especially for subsistence farming households
- National food self-sufficiency
- Income growth
- Employment

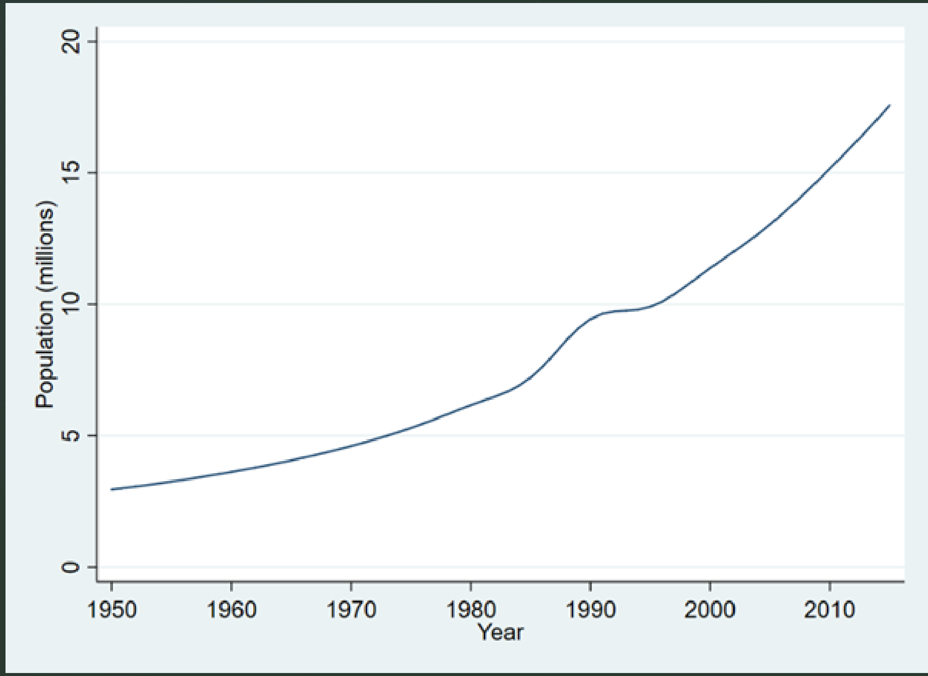
Importance of agriculture for economic development

World Development Indicators tell us that in Malawi

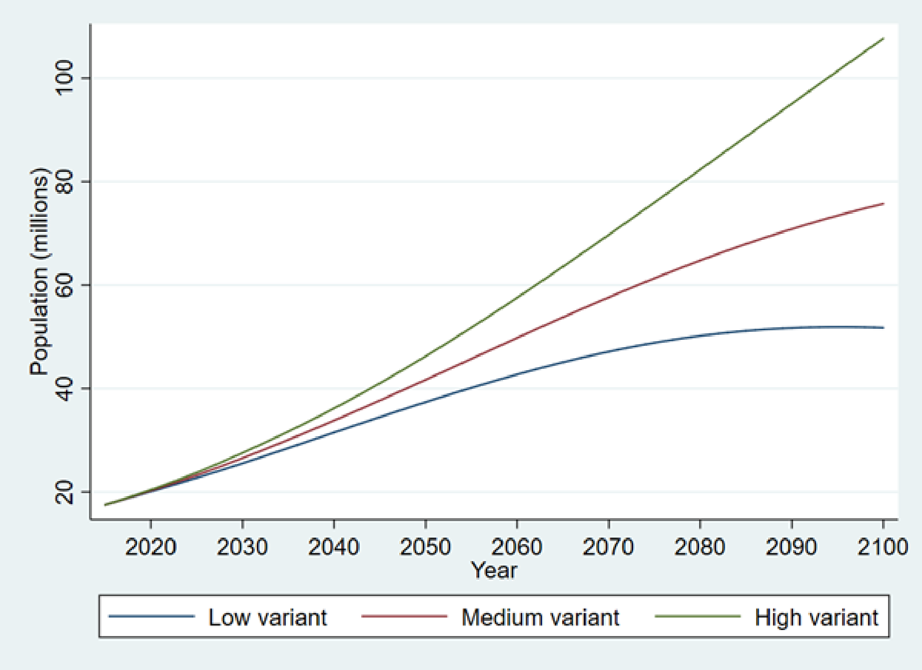
- Population is roughly 84% rural
- Agriculture contributes 31% to GDP
- 85% of employment is in agriculture

Population growth is a critical issue affecting the sustainability of agriculture

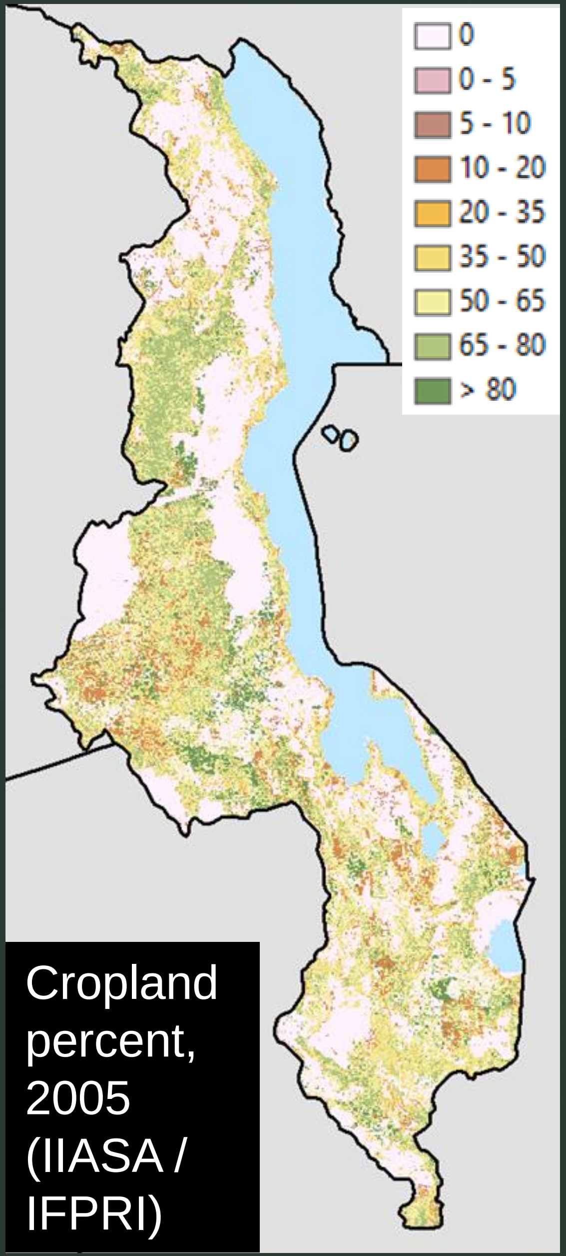
Population of Malawi, 1950-2015



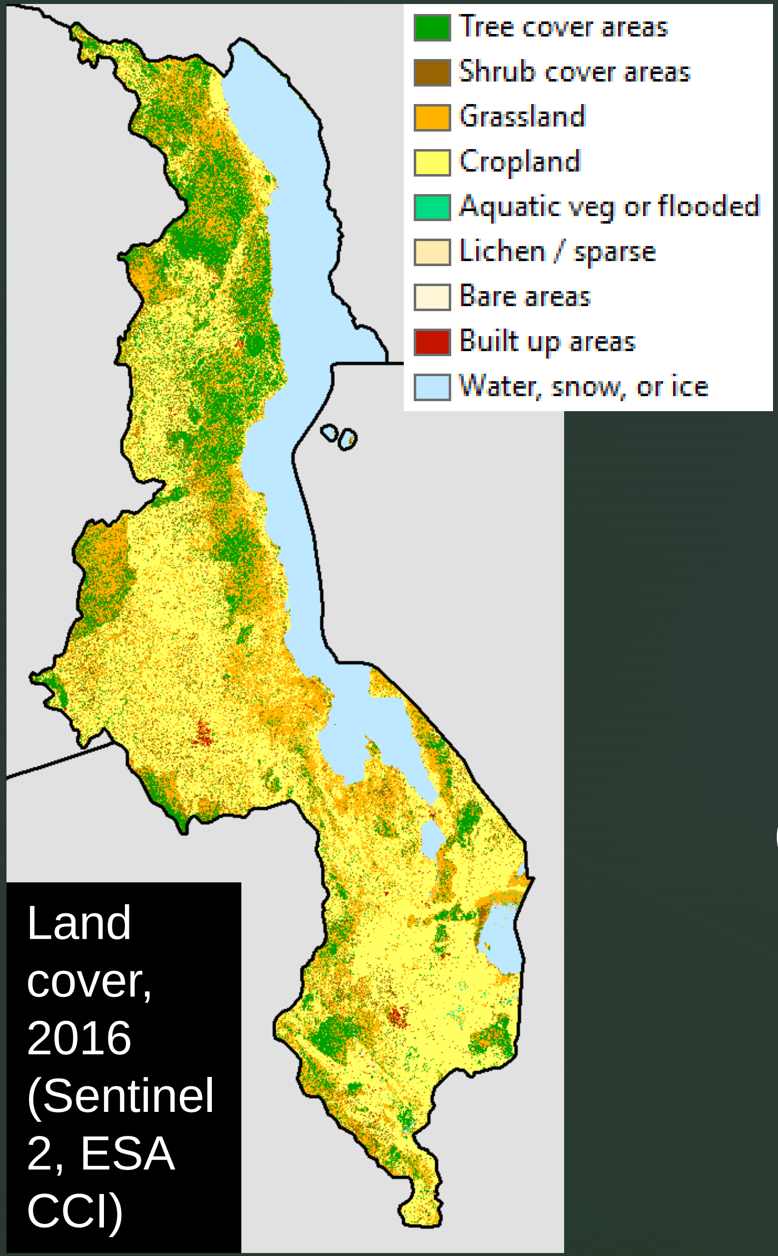
Population projections for Malawi, 2015-2100



Source: UN Population Division (2018).



Cropland percent, 2005 (IIASA / IFPRI)



Land cover, 2016 (Sentinel 2, ESA CCI)

Land uses and constraints

Can food production keep pace?

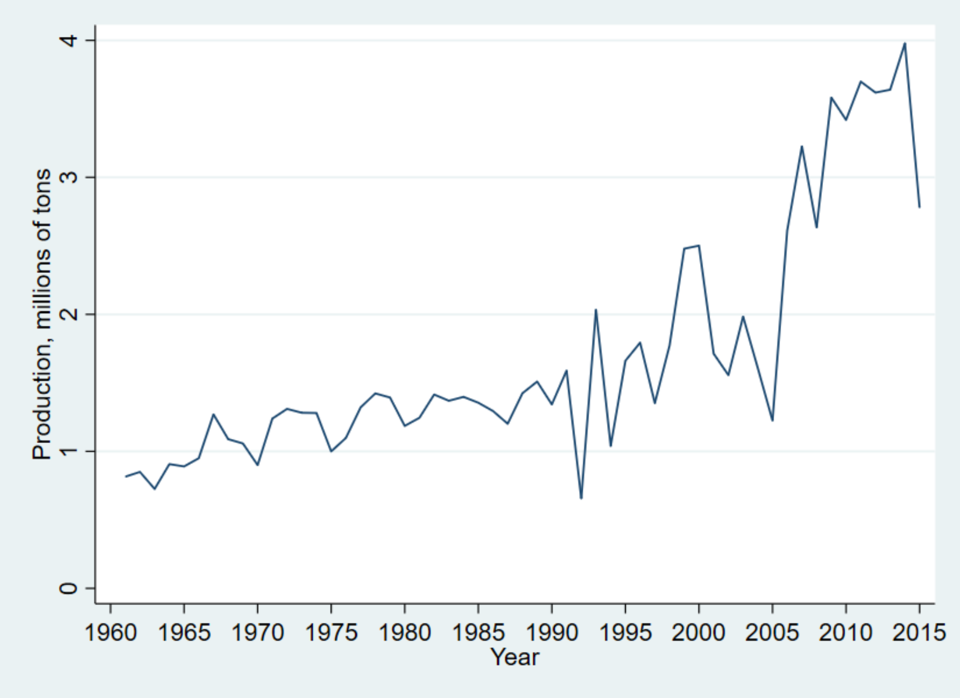
Top ten crops in Malawi by harvested area, average 2012-2015

Item	Hectares	Production	Yield (kg / hect)
Maize	1,676,875	3,503,241	2,089
Groundnuts	365,498	355,315	973
Beans	316,229	189,697	600
Pigeon peas	218,123	294,811	1,347
Cassava	217,926	4,878,877	22,396
Seed cotton	177,230	153,652	840
Potatoes	155,060	2,694,493	17,376
Soybeans	119,364	117,927	994
Chick peas	115,282	66,406	576
Tobacco	114,039	113,057	1,000

Source: FAOSTAT (2018)

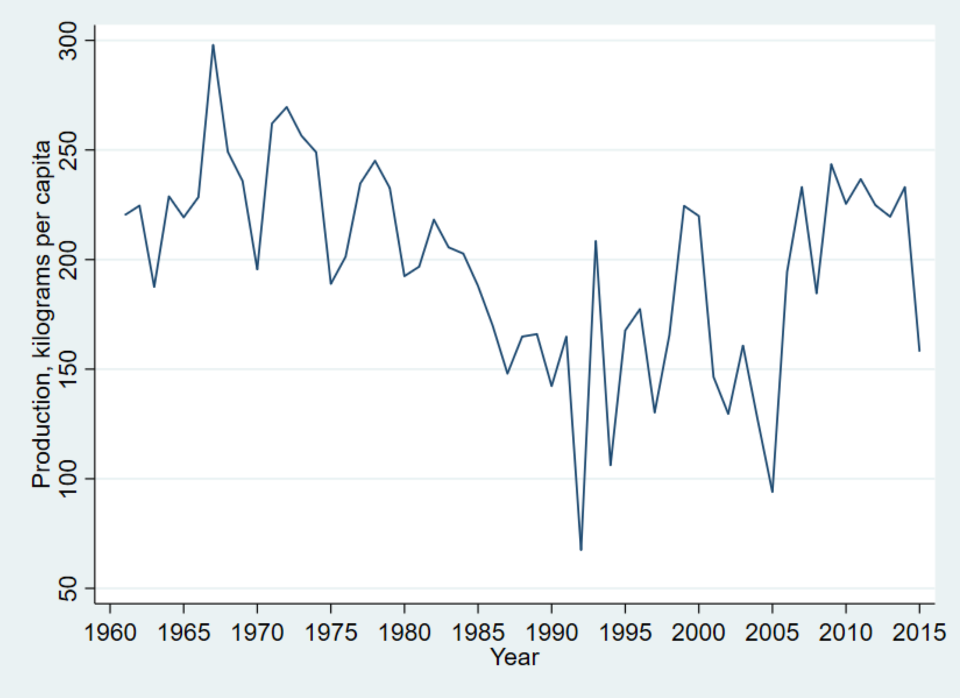
Has maize production kept pace?

Maize production, 1960-2015



Source: FAOSTAT (2018)

Maize production per capita, 1960-2015



Source: FAOSTAT (2018) and UN Population Division(2018)

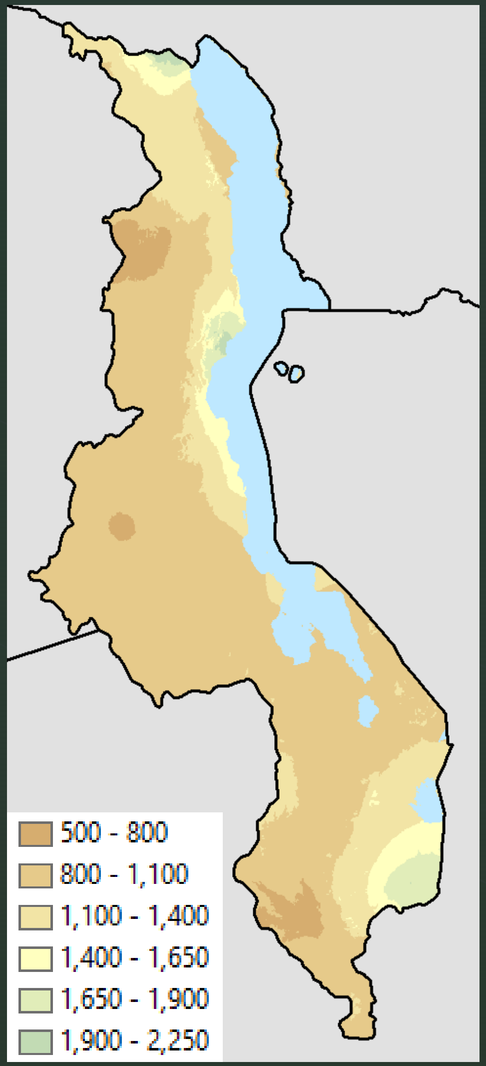
Looking deeper into recent cereal performance

	Annualized growth rates, 2002-2005 to 2012-2015		
	Produc-tion	Har-vested area	Yield
Sub-Saharan Africa	3.59	1.47	2.12
Eastern Africa	5.43	1.74	3.68
Ethiopia	7.80	1.75	6.05
Rwanda	9.40	3.10	6.30
Middle Africa	5.03	3.41	1.62
Southern Africa	2.62	-0.60	3.22
Malawi	7.79	1.06	6.73
Mozambique	3.30	0.95	2.35
South Africa	1.14	-2.71	3.86
Zambia	10.20	5.55	4.65
Western Africa	2.49	1.55	0.94

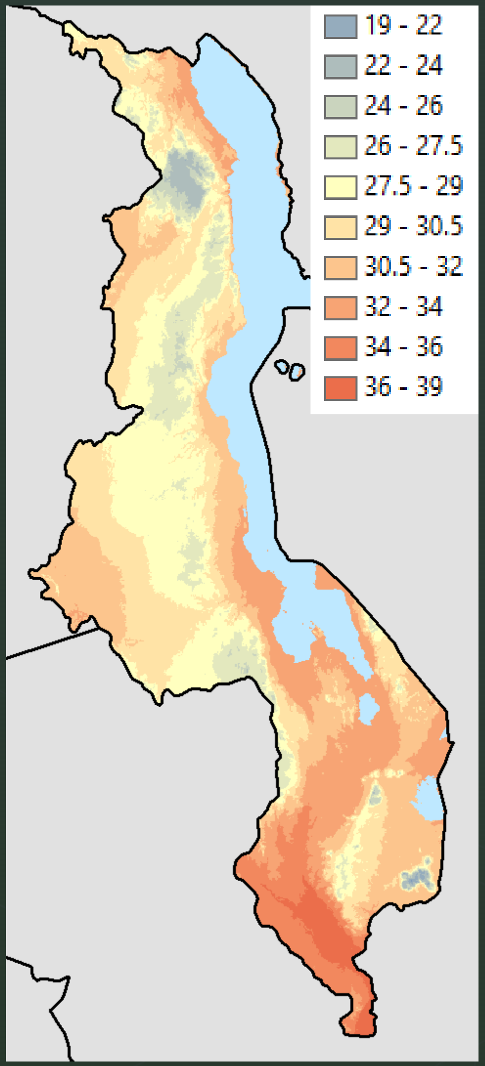
Source: FAOSTAT (2018)

Historical climate, 1960-1990

Mean annual precipitation, mm



Mean daily maximum temperature of the warmest month, ^0C

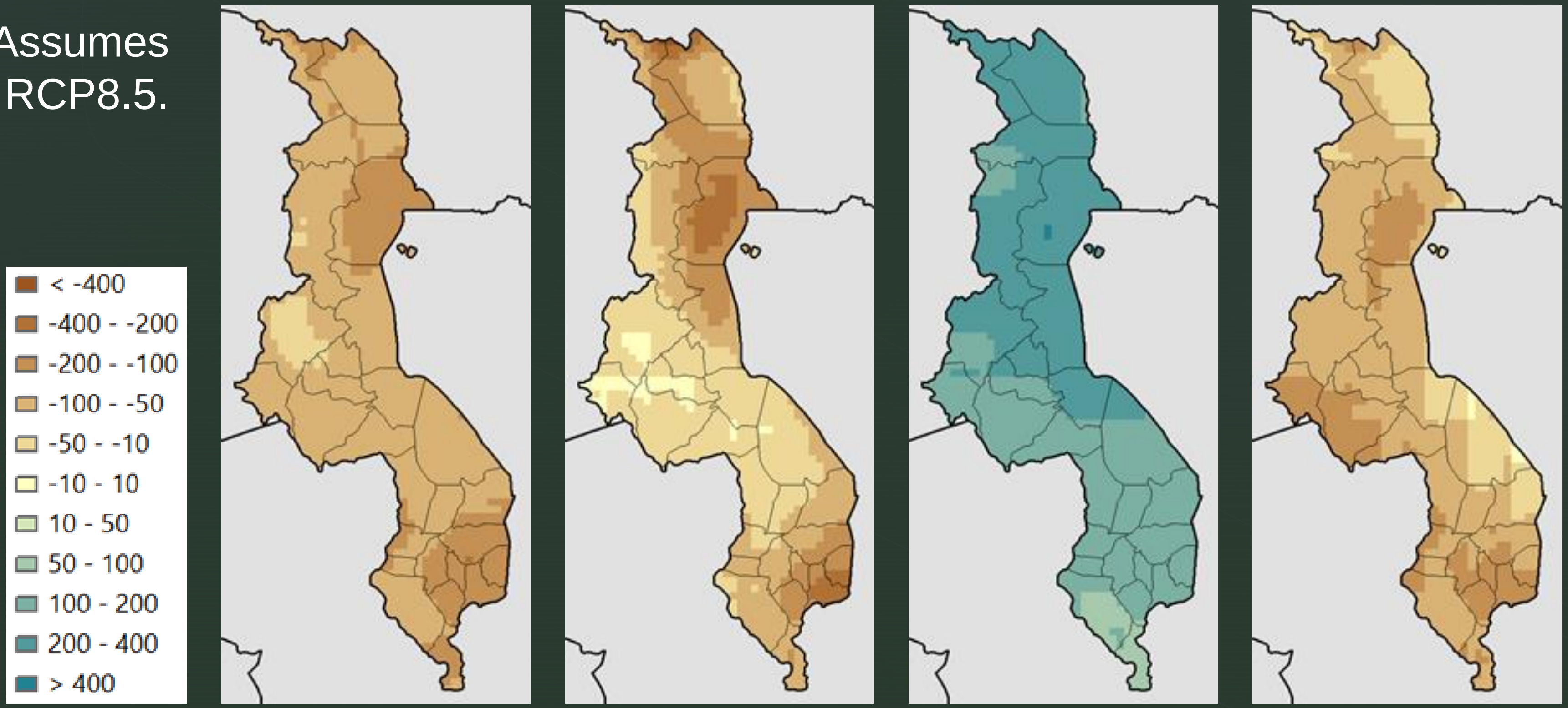


Source: WorldClim 1.4 (Hijmans et al.

Projections for precipitation change in Malawi, mm, from 1960-1990 period to 2050

GFDL-ESM2M | HadGEM2-ES | IPSL-CM5A-LR | MIROC-ESM-CHEM

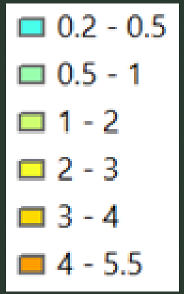
Note: Assumes RCP8.5.

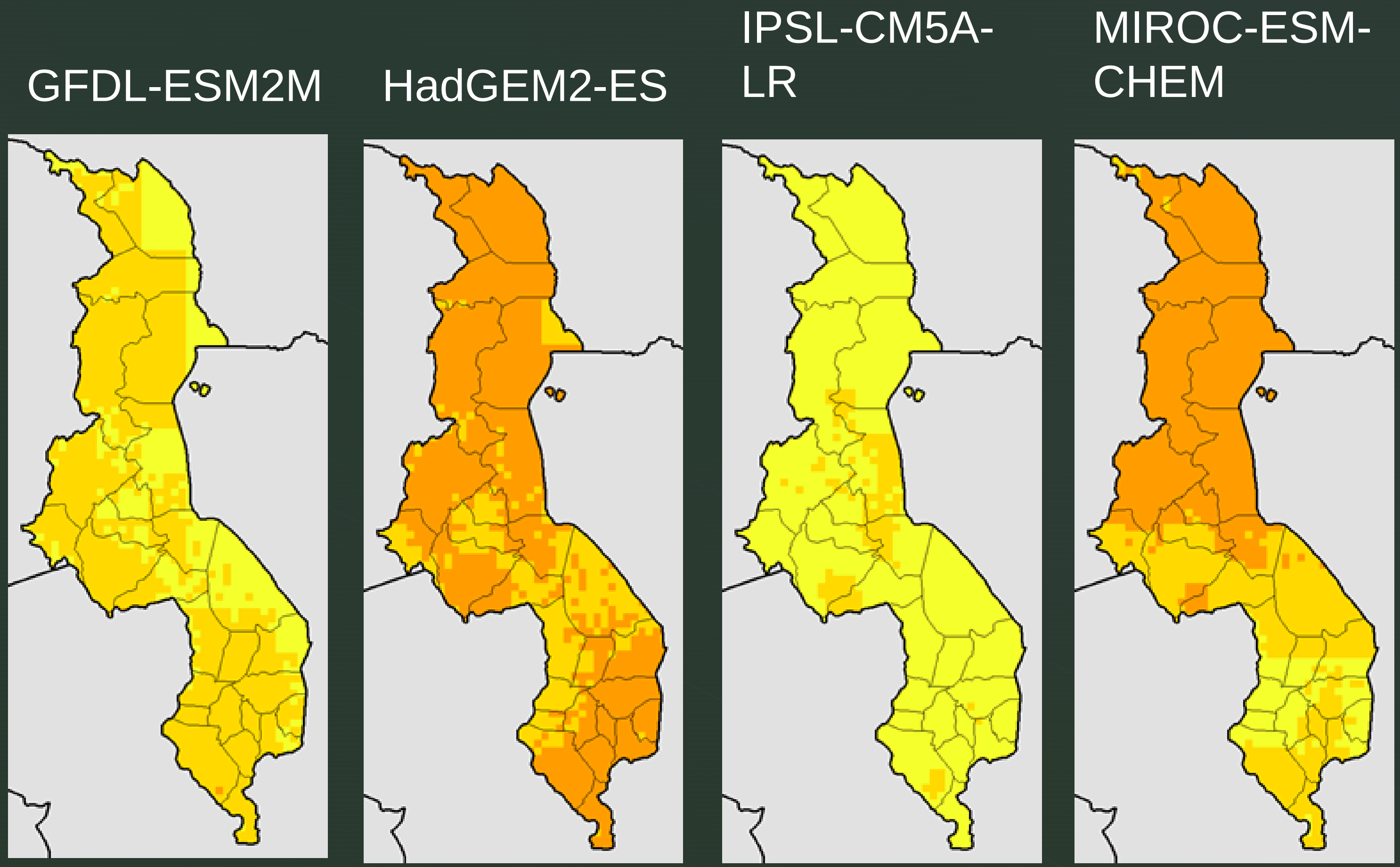


Source: Müller and Robertson (2014).

Projections for temperature change in Malawi, ^{0}C, from 1960-1990 period to 2050

Note: Temperature change is for mean daily maximum temperature of the warmest month. RCP8.5.





Source: Müller and Robertson (2014).

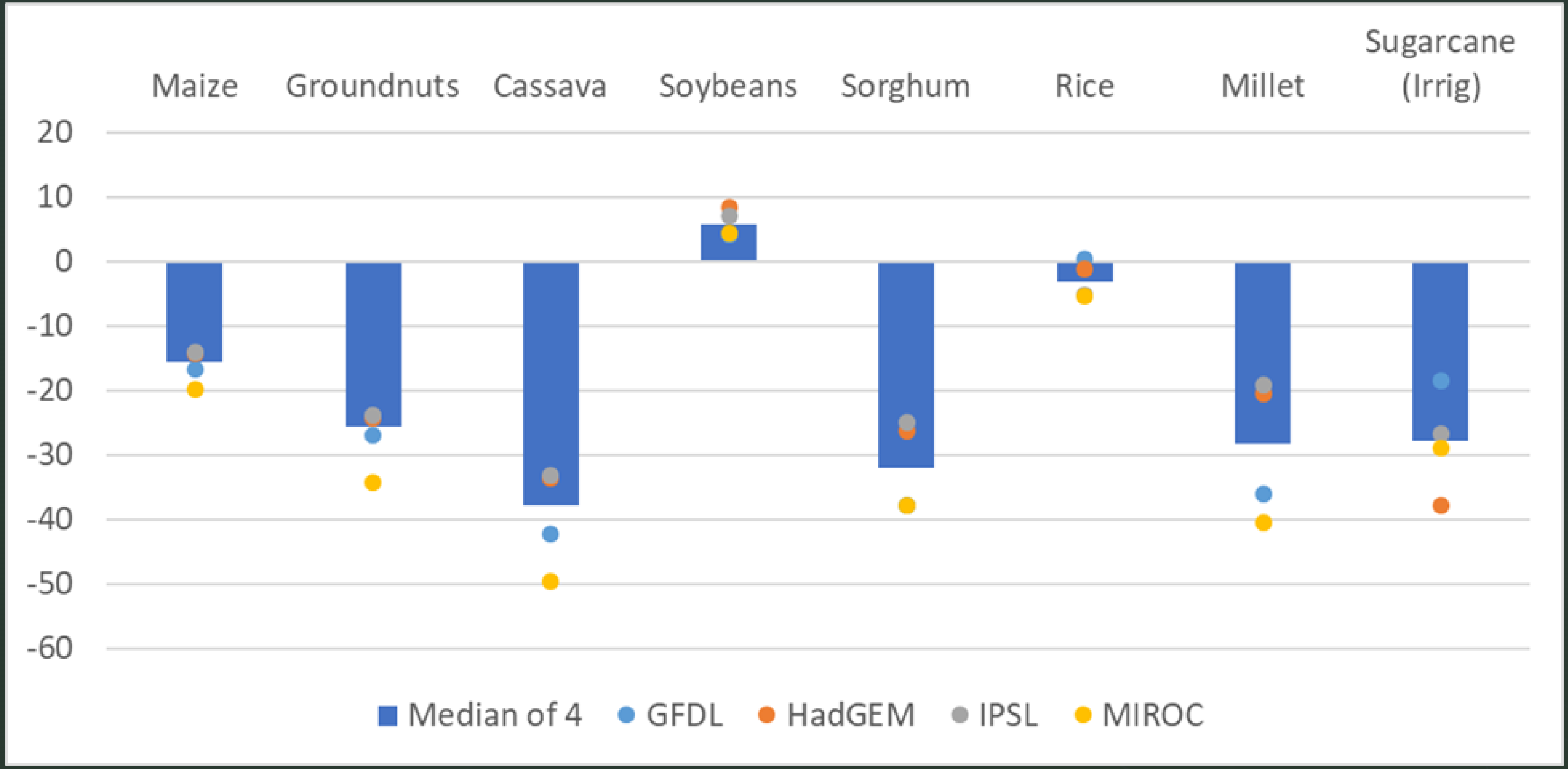
Distribution of climate change projections across 32 models, RCP8.5, baseline to 2050

Base (1960-1990)	Change in annual rainfall, mm, percentiles across 32 GCMs in average for 1960-1990 to 2050						
	0 (min)	10	25	50	75	90	100 (max)
1,089	-318	-177	-106	-53	22	61	333

Base (1960-1990)	Change in mean daily maximum temperature of the warmest month, ^{0}C, percentiles across 32 GCMs in average for 1960-1990 to 2050						
	0 (min)	10	25	50	75	90	100 (max)
30.7	1.8	2.9	3.1	3.3	3.8	4.3	4.8

Source: CCAFS/CIAT.

Crop models showing median yield change from baseline to 2050



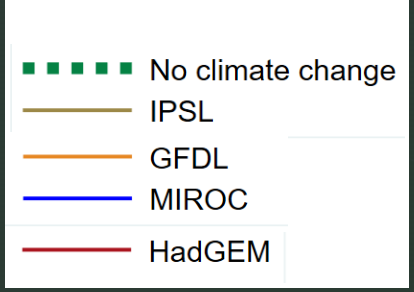
Source: Authors based on Rosenzweig et al. (2014) using weights from MapSPAM harvested area (You et al. 2014).

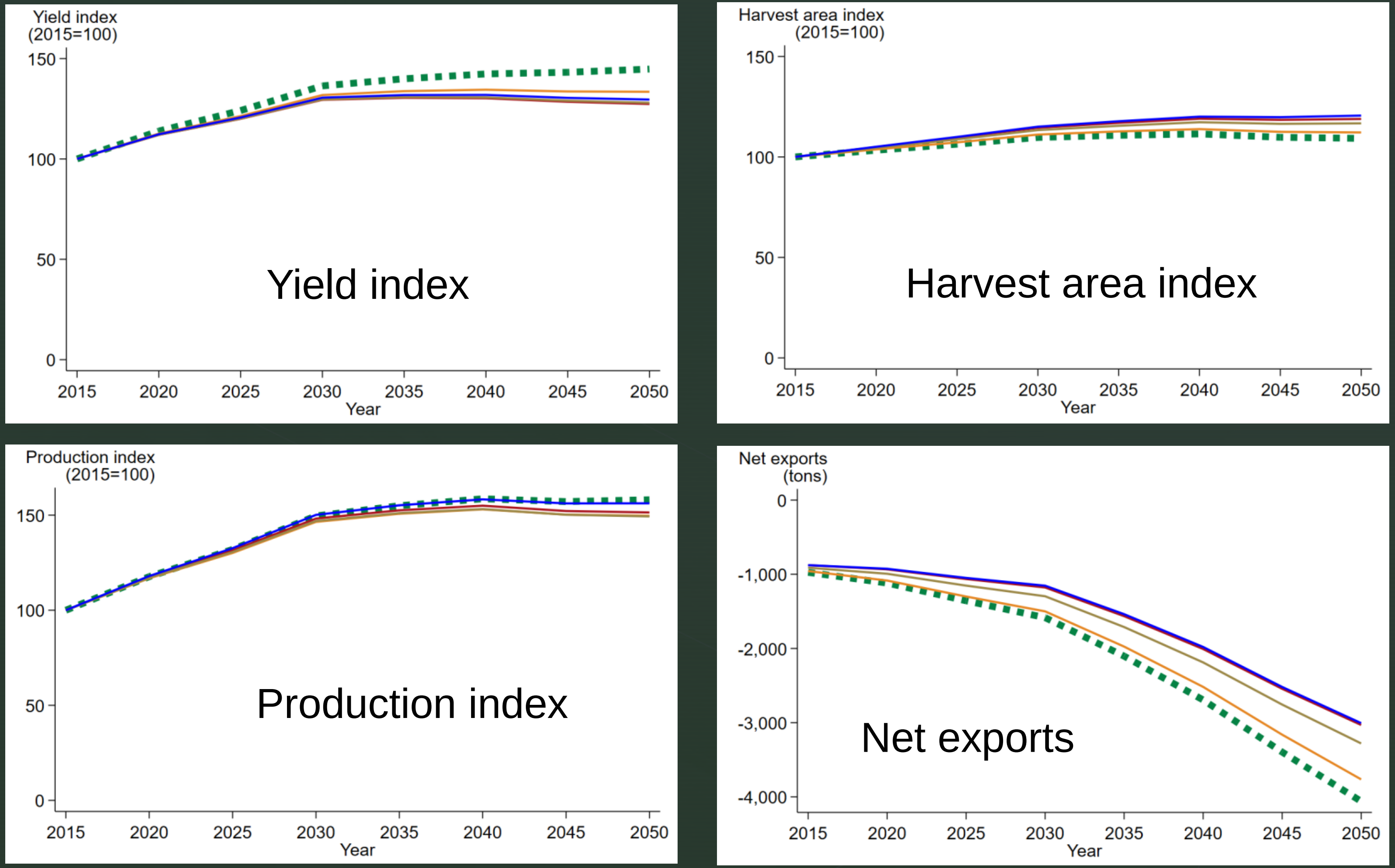
IMPACT Model

- Global model of food and agriculture
- Multi-market, partial equilibrium model

Geographic Scope	Commodity Scope	Time Scope	Linked Models and Modules
159 countries **154 water basins** **320 FPUs**	62 total 39 crops 6 livestock 17 processed	2005-2050	• Crop (DSSAT) • Food Security • Land-Use • Livestock • Value chains (processing) • Water • Welfare Analysis

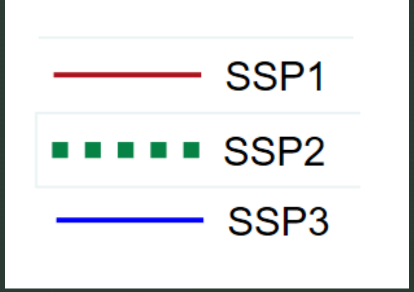
The future of maize in Malawi under climate change, 2005-2050

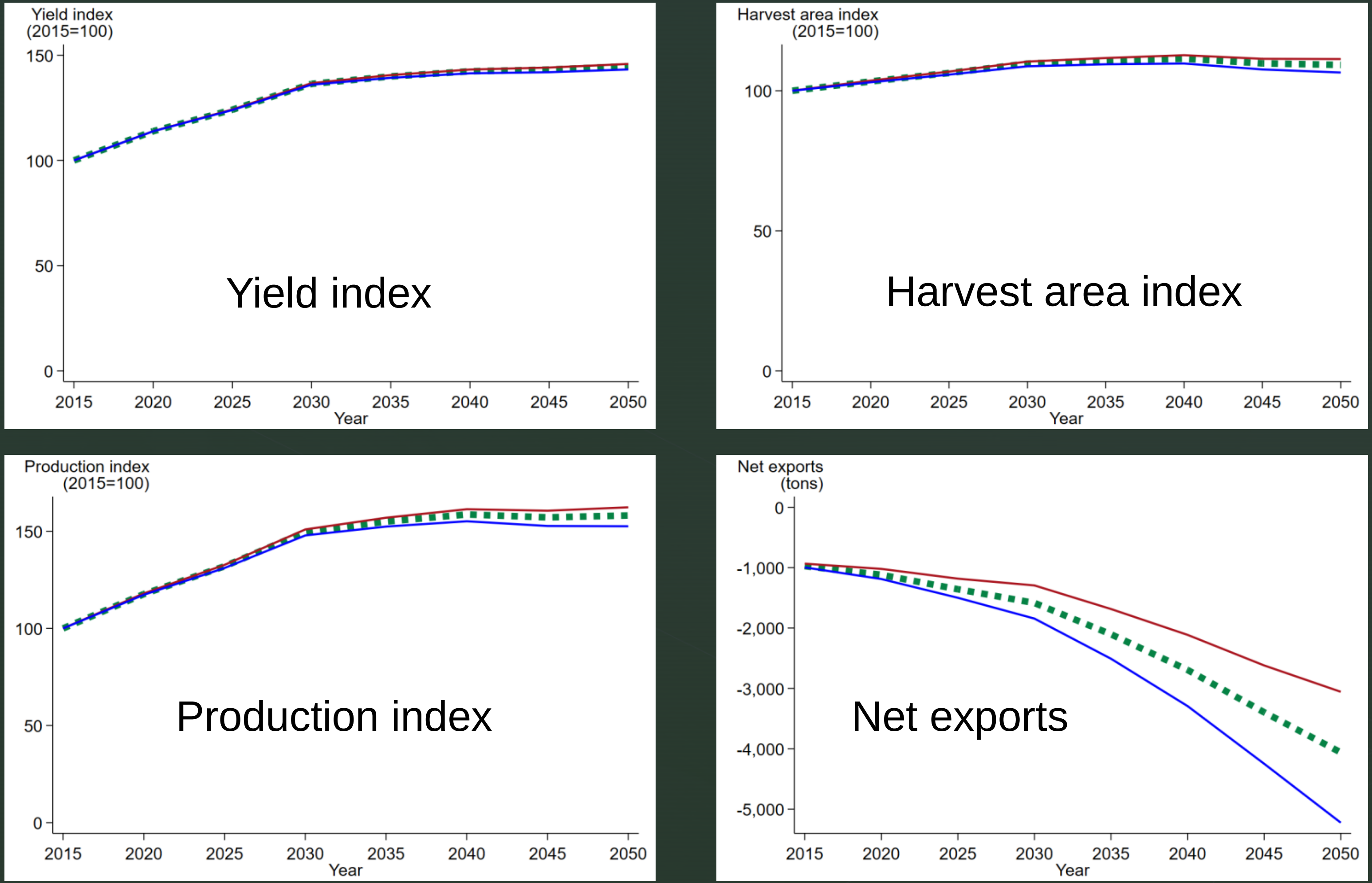




Source: IMPACT model baseline results (Sulser et al. 2015).

The future of maize in Malawi under different SSPs (growth scenarios), 2005-2050





Source: IMPACT model baseline results (Sulser et al. 2015).

Climate change effects on yield, area, and production of leading crops in Malawi, 2050, RCP8.5, SSP2

	Yield index			Area index			Production index		
Commodity	*No CC*	*Low CC*	*Hi CC*	*No CC*	*Low CC*	*Hi CC*	*No CC*	*Low CC*	*Hi CC*
CER-Maize	145	127	133	109	112	121	158	149	156
CER-Millet	218	201	226	188	170	209	410	359	466
COT-Cotton	160	149	157	142	138	144	228	206	227
OLS-Groundnut	115	90	101	139	143	159	160	129	156
OLS-Soybean	95	80	100	85	84	85	80	67	85
PUL-Beans	144	126	134	142	129	141	205	166	189
PUL-Chickpeas	156	136	146	137	131	137	214	177	198
PUL-Pigeonpeas	152	131	142	134	125	130	203	164	184
R&T-Cassava	120	114	119	135	132	135	162	150	159

Source: IMPACT model baseline results (Sulser et al. 2015).
Note: An index of 100 is the level calculated for 2010.

Climate change effects on net exports of leading crops in Malawi, 2050, RCP8.5, SSP2

	Change in net exports (tons)		
	No CC	*Low CC*	*Hi CC*
Commodity			
CER-Maize	-4,060	-3,764	-3,006
CER-Millet	24	6	47
COT-Cotton	180	157	179
OLS-Groundnut	-104	-130	-68
OLS-Soybean	-181	-180	-177
PUL-Beans	-200	-238	-203
PUL-Chickpeas	-32	-45	-35
PUL-Pigeonpeas	-14	-63	-36
R&T-Cassava	106	-147	121
SGR-Sugar	-311	-400	-267

Source: IMPACT model baseline results (Sulser et al. 2015).

Conclusions

- Population growth appears to be a bigger challenge to agricultural sustainability than climate change.
- Climate change will generally adversely affect agriculture, especially in 2050-2100.
- Economic models are required to fully understand the effect of climate change, since the changes in global food demand and supply occur simultaneously with climate change.

Conclusions (2)

- How to make agriculture sustainable in the light of rapid population growth requires more thought and bold action.
- Developing markets and assisting farmers to move into higher-value and labor-intensive crops is one solution.
- Expansion of irrigation could be very helpful in reducing year-to-year variability and increasing yields and should serve to reduce aflatoxin contamination in drier years.

Acknowledgments

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