Agriculture and Food Development Authority

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Professional Knowledge Network

The Signpost Series - *'Pointing the way to a low emissions agriculture'*

The Impact of Climate Change on Smallholder Food Production in the Tropics

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Self Help Africa

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- International development organisation dedicated to the vision of an **economically thriving and resilient rural Africa**.
- Offices in Dublin, Belfast, London, Shrewsbury, New York
- Currently working in Burkina Faso, Ethiopia, Eritrea, Kenya, Malawi, Togo, Uganda and Zambia.
- Part of the Gorta Group: Self Help Africa, TruTrade, Partner Africa

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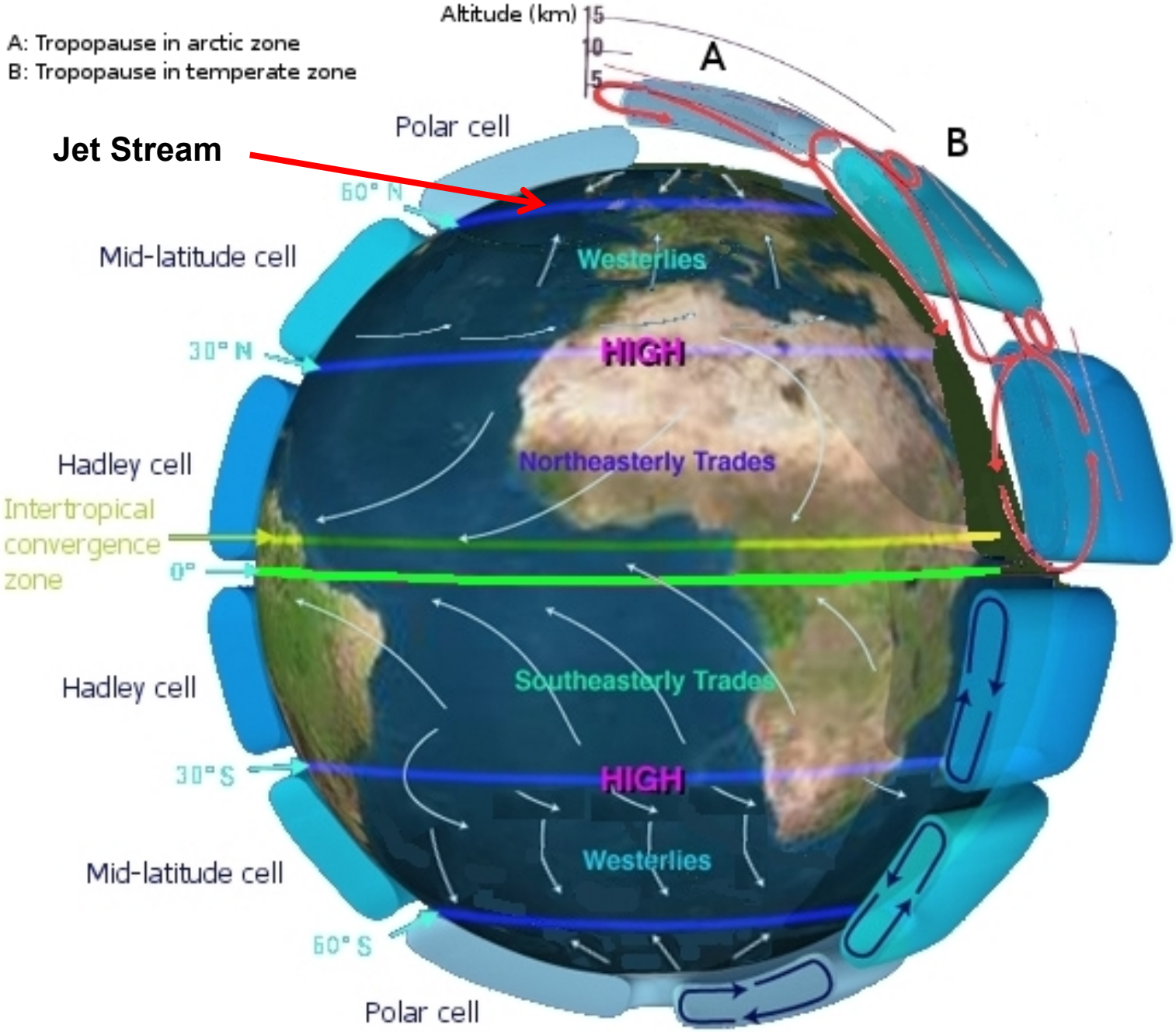
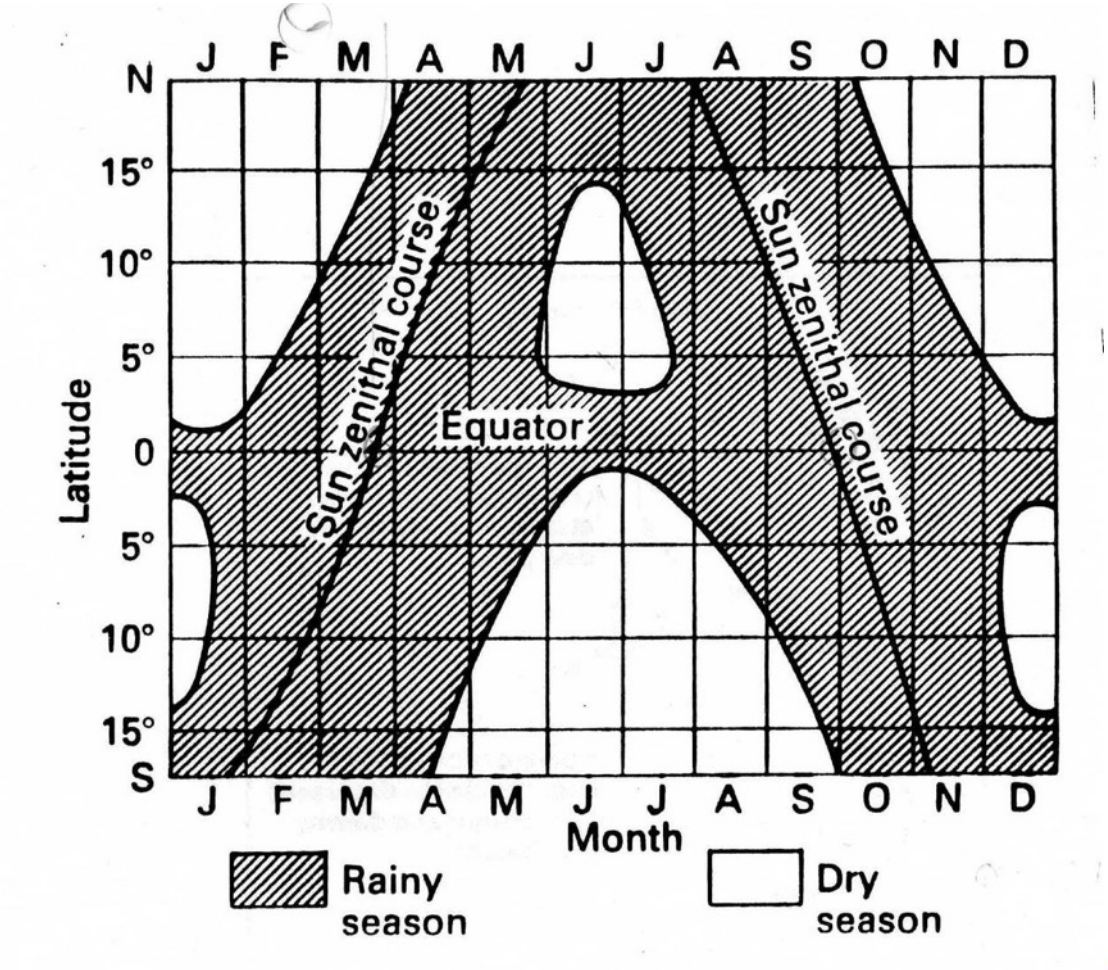

A: Tropopause in arctic zone
B: Tropopause in temperate zone
Altitude (km)
15
10
5
A
B
Jet Stream
Polar cell
60° N
Mid-latitude cell
Westerlies
30° N
HIGH
Hadley cell
Northeasterly Trades
Intertropical convergence zone
0°
Hadley cell
Southeasterly Trades
30° S
HIGH
Mid-latitude cell
Westerlies
60° S
Polar cell

Rainy Seasons in the Tropics



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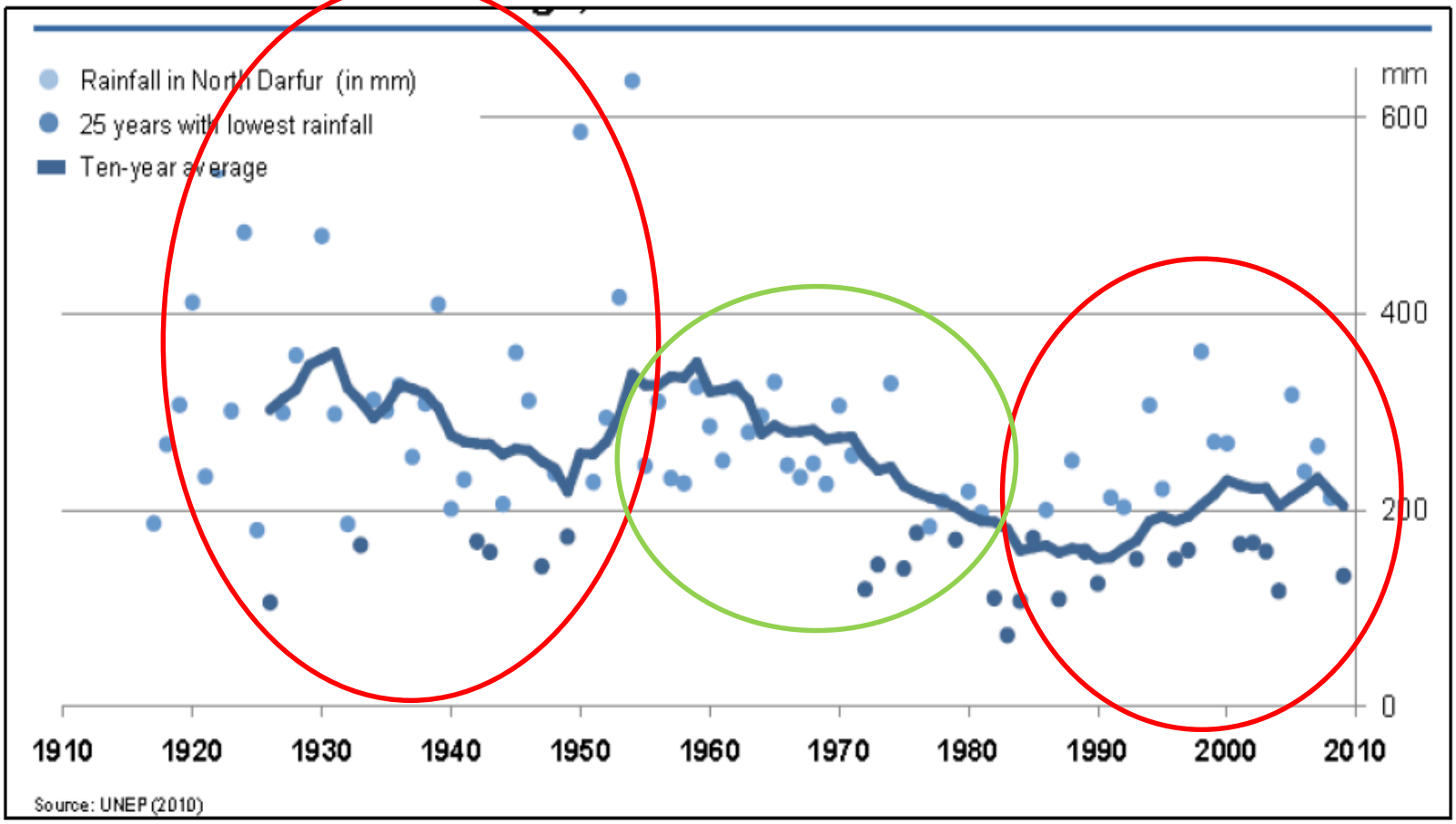
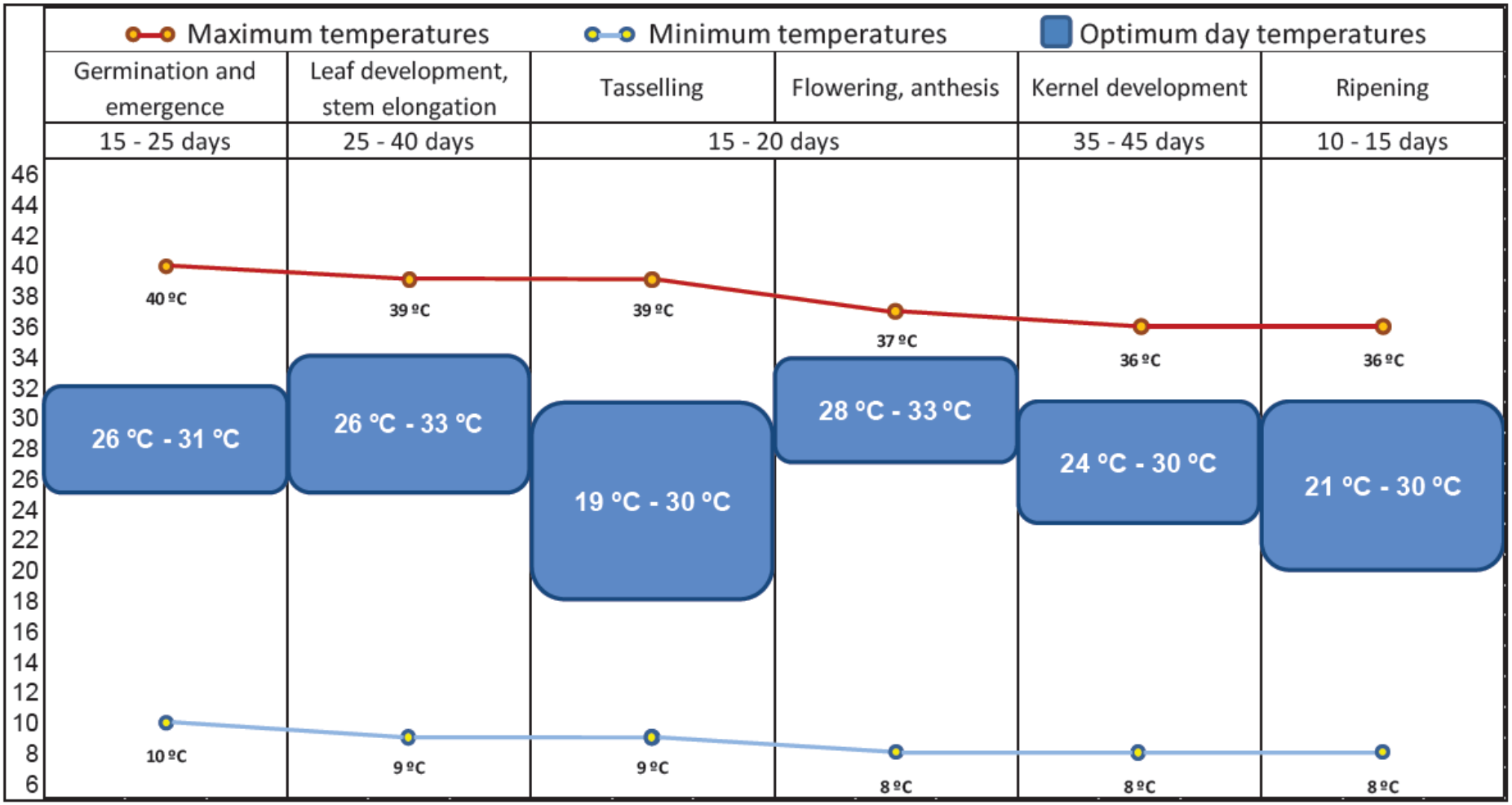
The Sahel: Climate Change or cycles of rainfall variability?



Rainfall data from Darfur.
There appears to be cycles of rainfall variability

Temperature effects on crop production



Maize

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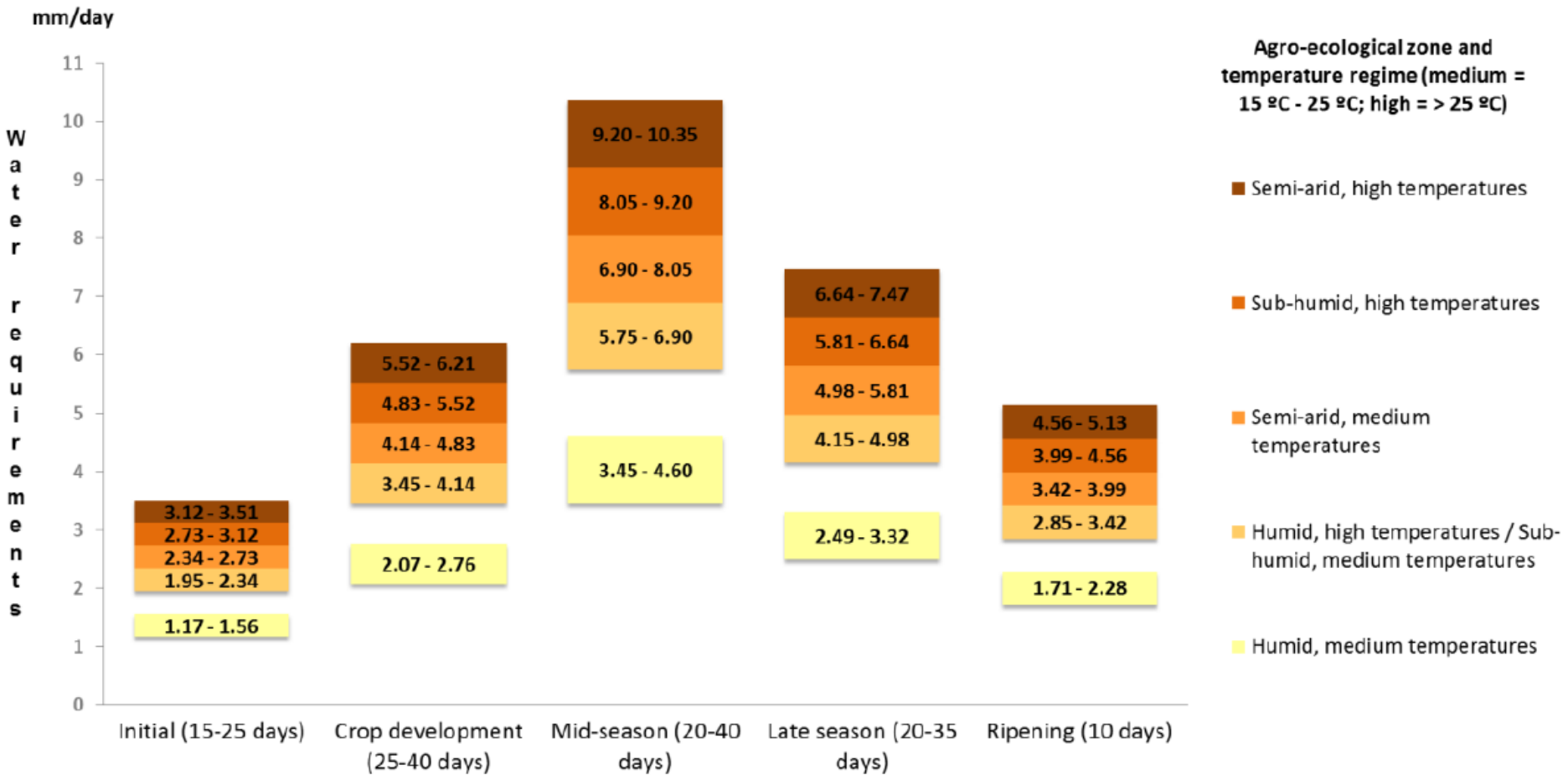
Reduced availability of water for crops



Maize

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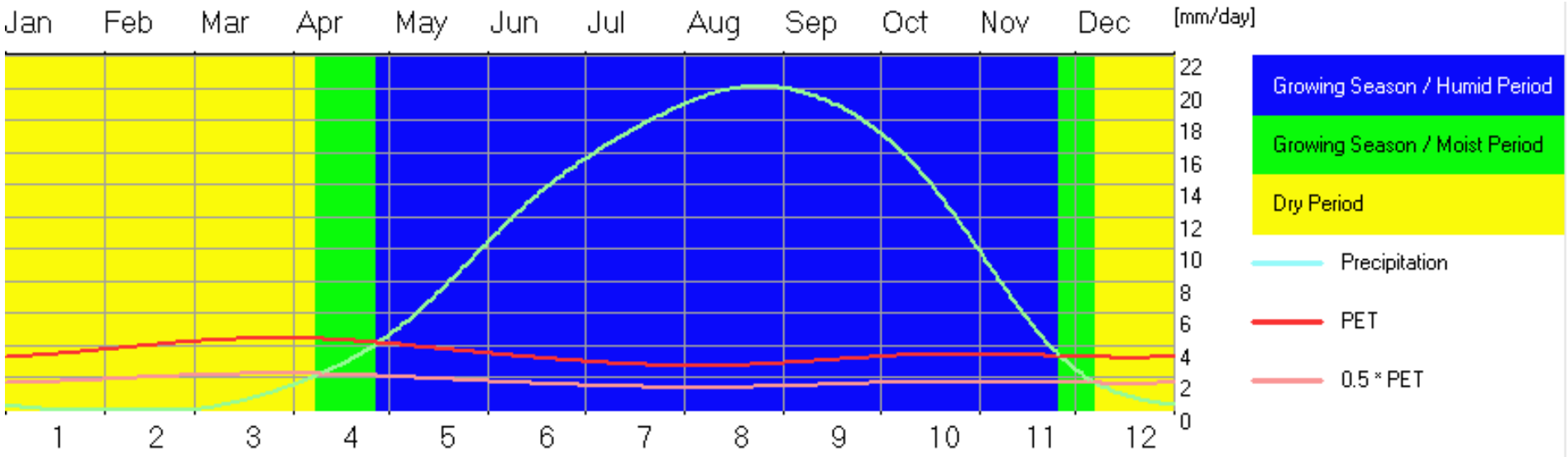
Growing Period, Magburaka, Sierra Leone



Nr.	Total	Type	Length	Begin	Begin	End	End	Humid 1	Humid 1	Humid 1	Humid 1	Humid 1
			Days	Date	Day	Date	Day	Length [Days]	Begin [Date]	Begin [Day]	End [Date]	End [Day]
1	1	3	243	8 APR	98	6 DEC	340	213	27 APR	117	25 NOV	329

FAO NewLocClim software

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Reduction in soil fertility

Increase in temperature will reduce soil moisture

Increase the rate of decomposition of organic material and oxidation of nutrients. Negative feedback loop.

Reduce the numbers of beneficial soil organisms.

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Increased incidence of disease & pest attacks

- Increase in temperature linked to proliferation of pests: faster metabolism + reproduction. Fall Armyworm 1-2 month life cycle.
- Increased rainfall will favour fungal disease
- Changes to vector behaviour: aphids, white fly.

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Impacts on Livestock Production

Heat stress: balance between heat dissipation and heat production.

Most livestock species thrive at “comfort zones” between 10 and 30° C. (25 °C for Friesian-Holsteins).

Above 30 ° animals reduce their feed intake by 3 to 5% for each degree of temperature rise.

There are important differences in how different livestock breeds respond to increased temperatures.

traditional cattle breeds crossed with Friesian Holsteins. Increase in milk production but the cross-bred animals need large quantities of water and are vulnerable to heat stress.

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Impacts on Fodder Production

- Changes in quantity and quality of feed and fodder, species composition of grasslands and digestibility and nutritional quality of forage.
- Elevated carbon dioxide levels, combined with increases in temperature, precipitation and nitrogen deposition, will result in increased primary productivity in pastures, with changes in species distribution and litter composition

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Distribution of vector-borne livestock diseases.

- These changes occur as a result of shifts in the geographical ranges of **ticks**, mosquitos, flies, …
- **Ticks**: East Coast Fever/ corridor disease (*Theileria parva)*, babesiosis (redwater), anaplasmosis (rickettsia bacteria)
- **Mosquitoes**: Rift Valley Fever (virus).
- **Tsetse Fly**: trypanosomiasis (protozoa).
- **Gastrointestinal nematodes (GINs)** in goats (Test and Selective Treatment, QUB).
- **African Swine Fever** in Europe. More juvenile boar surviving mild winters in Europe, boar populations soaring.

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Climate Change: increases in productivity

- Higher concentrations of atmospheric CO_2 will benefit many crops (CO_2 fertilisation).
- Potatoes: increased CO_2 increases the number and weight of tubers.
- Longer growing seasons in higher latitudes and altitudes (Ethiopia).
- Reduced frost risks allowing winter cropping in temperate areas (Nepal, Afghanistan, DPRK).

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Climate Change and Human Nutrition

- Reduction in dietary diversity. "*Higher long-term temperatures were found to cause a significant drop in overall child nutrition. Conversely, a year that sees higher-than-average levels of rainfall could lead to an increase in child nutrition in the following year*".
- Changes in crop nutrient levels
- C_4 plants concentrate CO_2 internally, so increased atmospheric levels have limited effects on C_4 plants.
- C_3 plants, except legumes, cannot extract enough N from the soil to maintain C:N ratios with higher photosynthesis rates.
- > CO_2 = increase in photosynthesis and carbohydrates in cereals.
- = increased demand for Phosphorus.
- > CO_2 = decrease in Zn, Fe and proteins in C_3 grains and legumes*.

*Myers et al, Increasing CO_2 threatens human nutrition, Nature Letters. 2014
Meredith T Niles *et al* 2021 *Environ. Res. Lett.* **16** 015010

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Climate Smart Agriculture

FAO definition of CSA:

1. Sustainably increasing agricultural productivity and incomes;
2. Adapting and building resilience to climate change;
3. Reducing and/or removing greenhouse gases emissions, where possible.

Details in the FAO CSA Sourcebook

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Examples of Climate Smart Agriculture

- Agroforestry
- Conservation Agriculture
- System for Rice Intensification
- Drought Tolerant crops/ varieties
- Quick Maturing/ drought avoiding varieties
- Flood tolerant crops/ varieties
- Salt Tolerant crops/ varieties
- soil and water conservation/ revegetation of degraded areas:
- Rainwater harvesting
- High Efficiency Irrigation
- Farmer / herder Managed Natural Regeneration
- Dryland/ drought tolerant Agro-forestry systems
- Soil fertility management
- Seed priming & Transplanting
- Coastal Protection
- Pastoralism
- Livestock breed conservation/ Livestock Diversity
- Rangeland Management
- Early Warning Systems
- Fuel Efficient stoves
- Power generation
- Biofuels
- Insurance

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Agroforestry: *Faidherbia albida*

Reverse phrenology: produces leaves in the dry season and sheds them in the rainy season

Nitrogen fixation: Zambia: maize yields were 3 tons ha-1 under F. albida canopies and only 2 tons ha-1 outside the canopies. GART (2008)

Senegal: yield of pearl millet was 2.5 times higher under the canopy of F. albida than outside the canopy (Charreau and Vidal, 1965).

Water Management

- World demand for freshwater will soon exceed supply.
- Agriculture is the largest user of freshwater.
- "**More crop per drop**"
- How can we do this?

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High Efficiency Irrigation

Drip irrigation

Simple pumps

High Efficiency Irrigation: Pakistan

Rain guns to irrigate wheat and chickpeas on edge of Thar Desert, South Punjab

Lining canals to reduce water loss.

Road run-off water harvesting ponds, Burundi

Irrigation channel

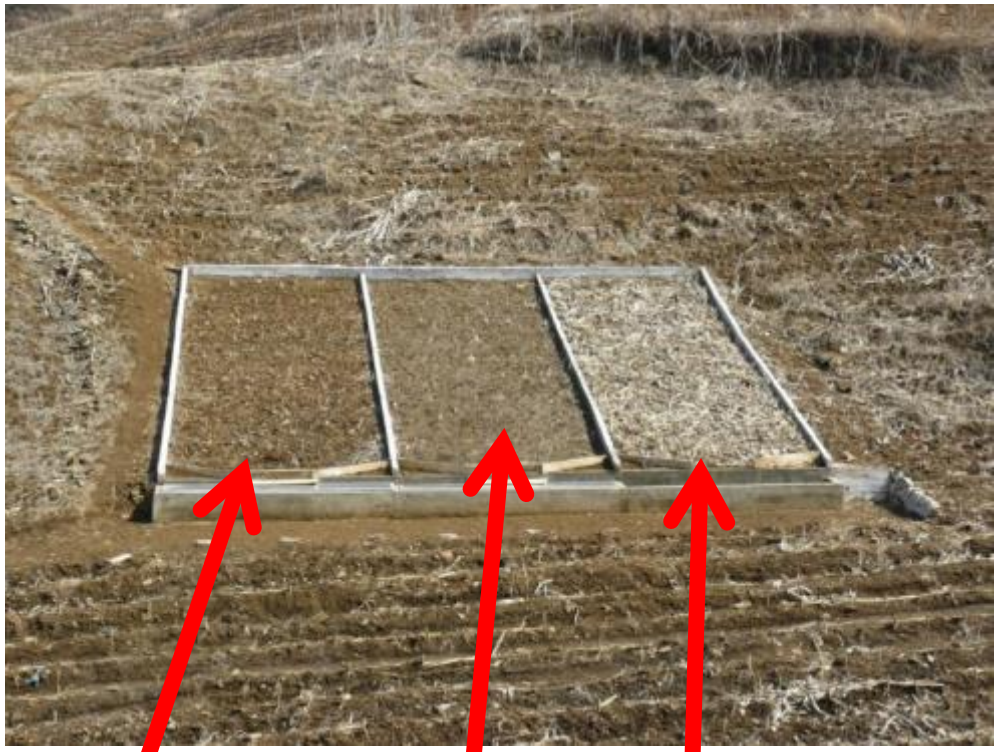
Fanya juu terracing

Soil and Water Conservation.
Conservation Agriculture, Dokryon Farm North Korea

Upper field under CA
Gully beginning to recover

Lower field, traditional agriculture
Stones visible in gully bed

Measuring reduction in soil erosion under CA, DPRK



Maize, traditional agriculture

Maize, CA, green mulch with Red Clover

Maize, CA, crop residue mulch

- Maize under traditional agriculture: soil loss = 8.7 tonnes/ha/year
- Maize intercropped with Red Clover: 8 tones/ha/year
- Maize under Conservation Agriculture: 7.7 tonnes/ha/year

Soil and water run-off collection

Crop and Variety Diversity

- By growing a range of crops farmers can hedge against climate risks, + increase dietary diversity + soil fertility.
- South Sudan: sorghum (*sorghum bicolor*) varieties: *cham*, early maturing, harvested in August; *alep cham*, second early; *unangjan*, maincrop; *maboior*, late maturing harvested in December
- Liberia: farmers plant 5-7 varieties of rice
- Niger: farmers mix sorghum and pearl millet, *Pennisetum glaucum*, seed.
- fields are scattered to take advantage of different soil types, seasonal opportunities and to spread risks.
- … But farmers with very small landholdings struggle to produce enough carbohydrate and are unable to allocate land for other crops.

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Livestock Diversity

- Some traditional breeds are already adapted to projected climate changes. Karakul sheep, Red Maasai sheep
- Cross-breeding risks, market pressures.
- Changes to herd structure: cows →camels, goats → sheep
- Not without risks: Kenya now the World's 3rd camel producer – MERS risks?

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Conservation Agriculture

- Avoid disturbing the soil (minimum mechanical soil disturbance): rippers, direct seeders, jab planters, zai holes.
- Keep the soil covered: mulch, cover crops
- Rotate the crops:
  - Malawi: maize ⟶ groundnuts/ peanuts (cash/ nutrition/ nitrogen) ⟶ soya (cash, tobacco substitute/ nitrogen).
  - Zambia: maize ⟶ groundnuts / Bambara nuts / cowpeas (cash/ nutrition/ nitrogen) ⟶ sunflower (cash)
  - Zimbabwe: maize ⟶ cowpeas ⟶ sorghum

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Ox-drawn Direct Seeders

Jab Planters

Fitarelli, Brazil

Li Seeders

By hand

Planting Basins / Zaï Holes, Zimbabwe

Mulched CA plots, Zambia, 2015

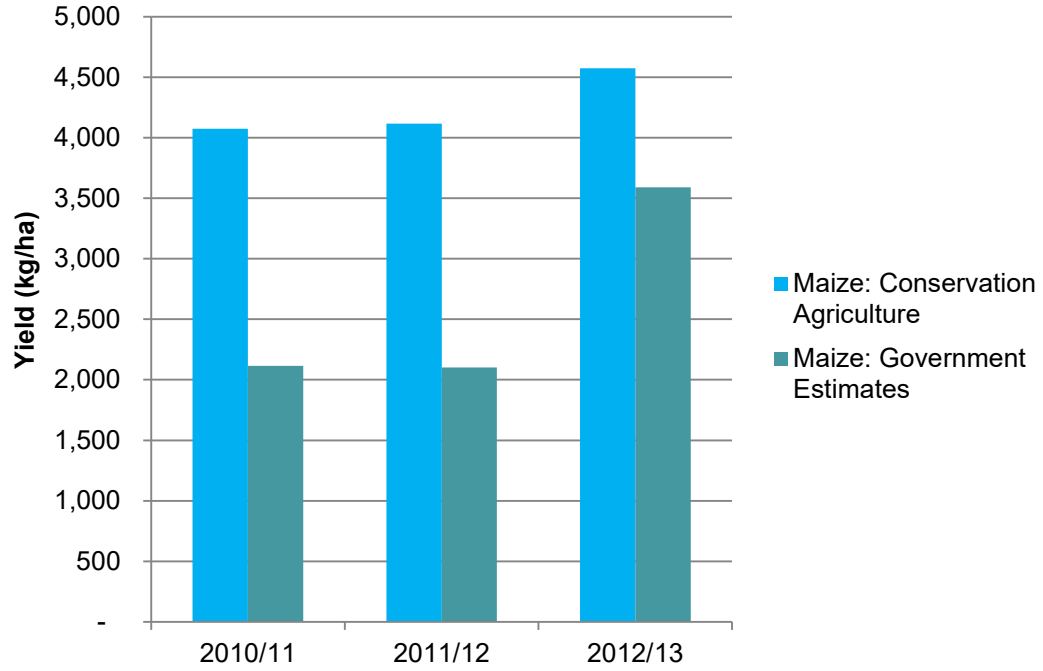
Cover Crops


Perennial Pigeon
Pea

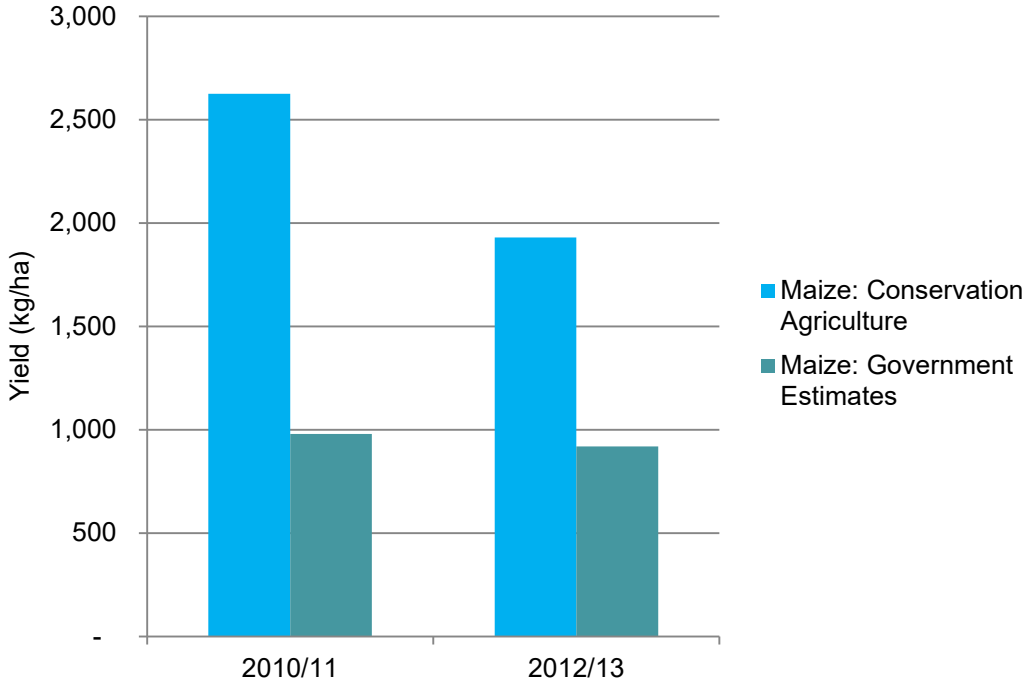

Velvet Bean
/ Mucuna


CA plot,Tz. Maize, grass mulch +
lablab as a green cover crop.
Lablab is too aggressive for the
maize.

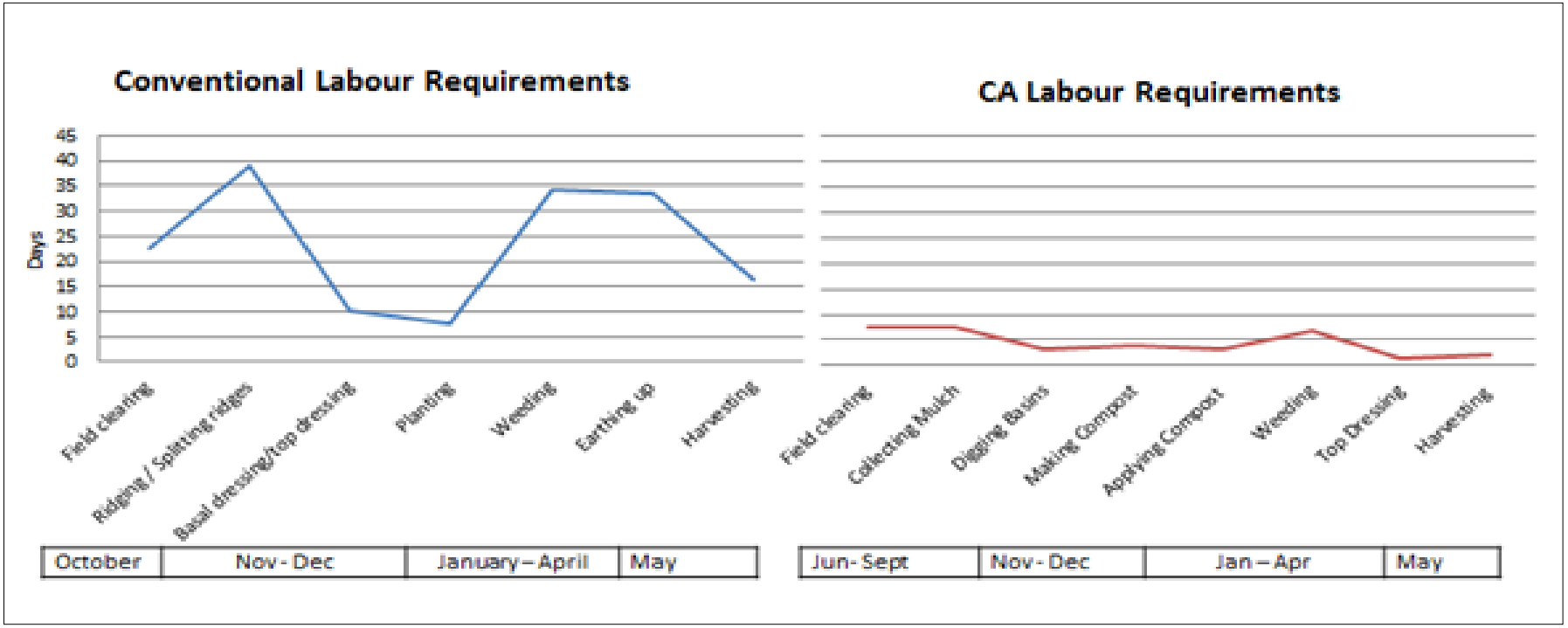
Maize yields in Malawi, 2010/11-2012/13



Maize yields in Zambia, 2010/11, 2012-13



Impact of CA on Women's workload in Malawi



	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
CA.	Planting		Wedding, Fertiliser			Harvesting			Land prep, mulching, making pits and compost			
Con.	Planting		Weeding, Fertiliser, Earthing up		Harvesting					Land preparation		

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