Climate Change & Drought

The Impact on the Invisible 60% of Africa's Population

Kenneth Strzepek
MIT Jameel Water and Food Systems Lab
International Food Policy Research Institute
Industrial Economic, Inc

Revd. Len Abrams
Church of England
Development Consultant

Timothy S. Thomas,
Senior Research Fellow,
International Food Policy Research Institute (IFPRI),
Washington, DC, USA.

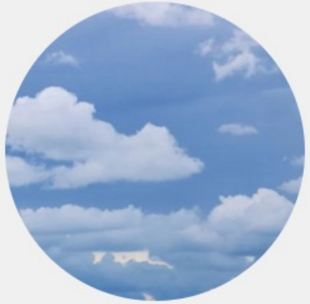
Drought

- Defining drought can be difficult. ...
- So if we say that a drought is when there isn't enough water,
- what does "enough" mean? And enough for what or whom?

- That is why scientists describe drought
    - *conceptually*, as an idea or concept; and
    - *operationally*, *by* how drought functions or operates in ways that can be measured.

Types of Drought

To help with drought classification and monitoring, scientists have defined several types of drought:

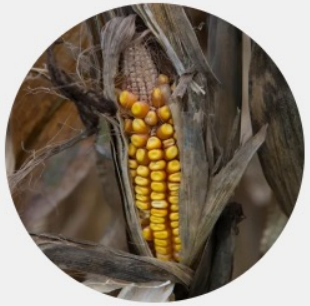


Meteorological Drought

When dry weather patterns dominate an area.

Hydrological Drought

When low water supply becomes evident in the water system.



Agricultural Drought

When crops become affected by drought.

Socioeconomic Drought

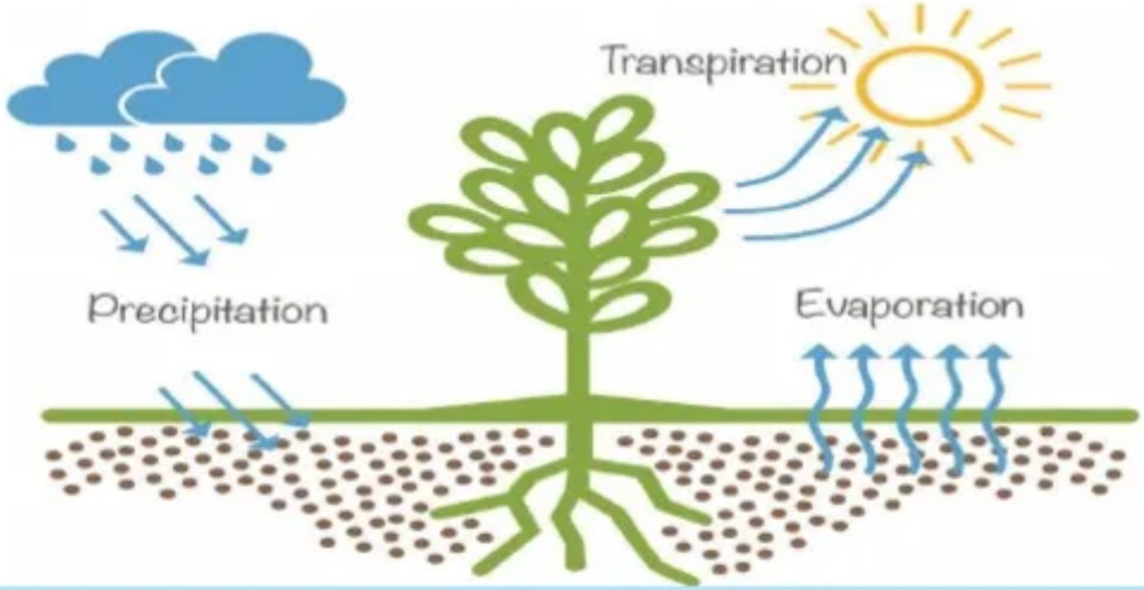
When the supply and demand of various commodities is affected by drought.

Ecological Drought

When natural ecosystems are affected by drought.

AGRICULTURAL DROUGHT IS ABOUT SOIL MOISTURE

- Water required to meet the demand of evapo-transpiration and metabolic activities of the crop together is known as consumptive use of water.



CLIMATE CHANGE THREAT

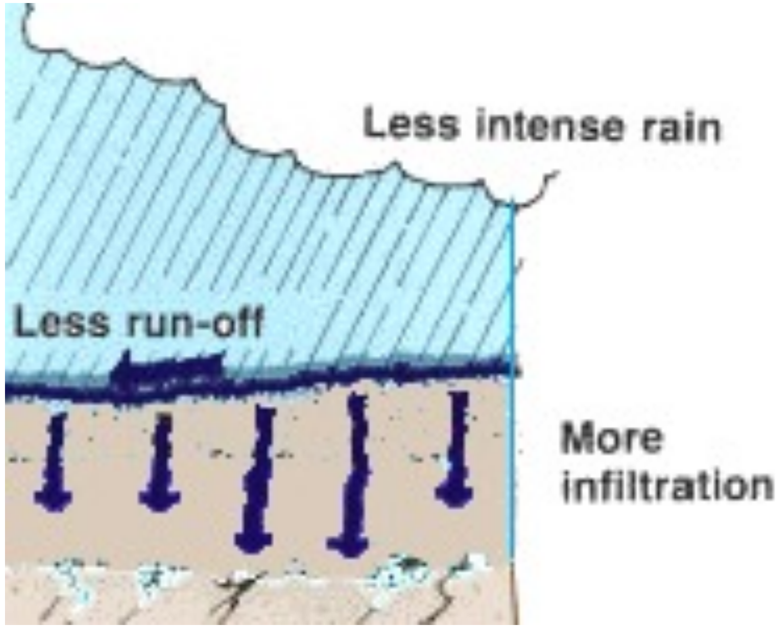
- Increased Temperature increase in PET
- Changes in Growing Season Precipitation
- Change in Intensity of Rainstorms – less infiltration

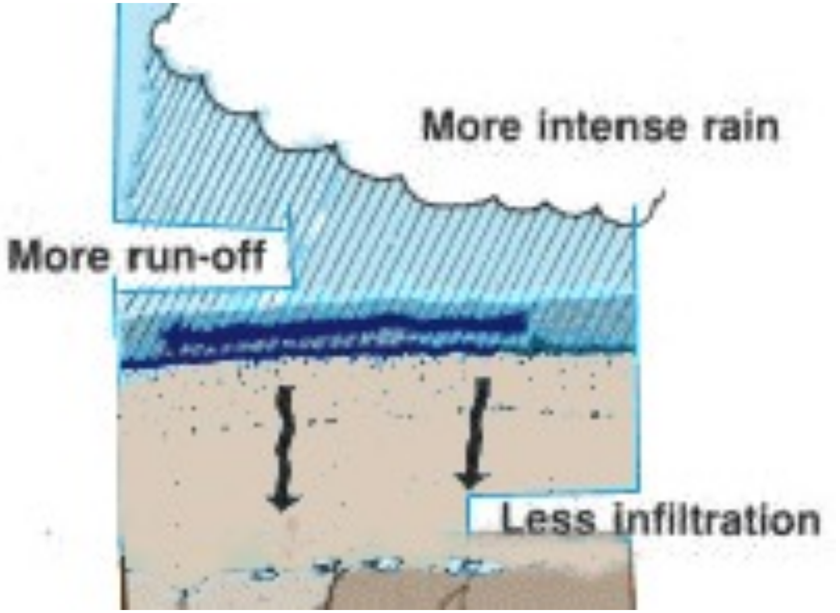
CLIMATE CHANGE IS DRIVING INCREASES IN VARIABILTY and EXTREMES

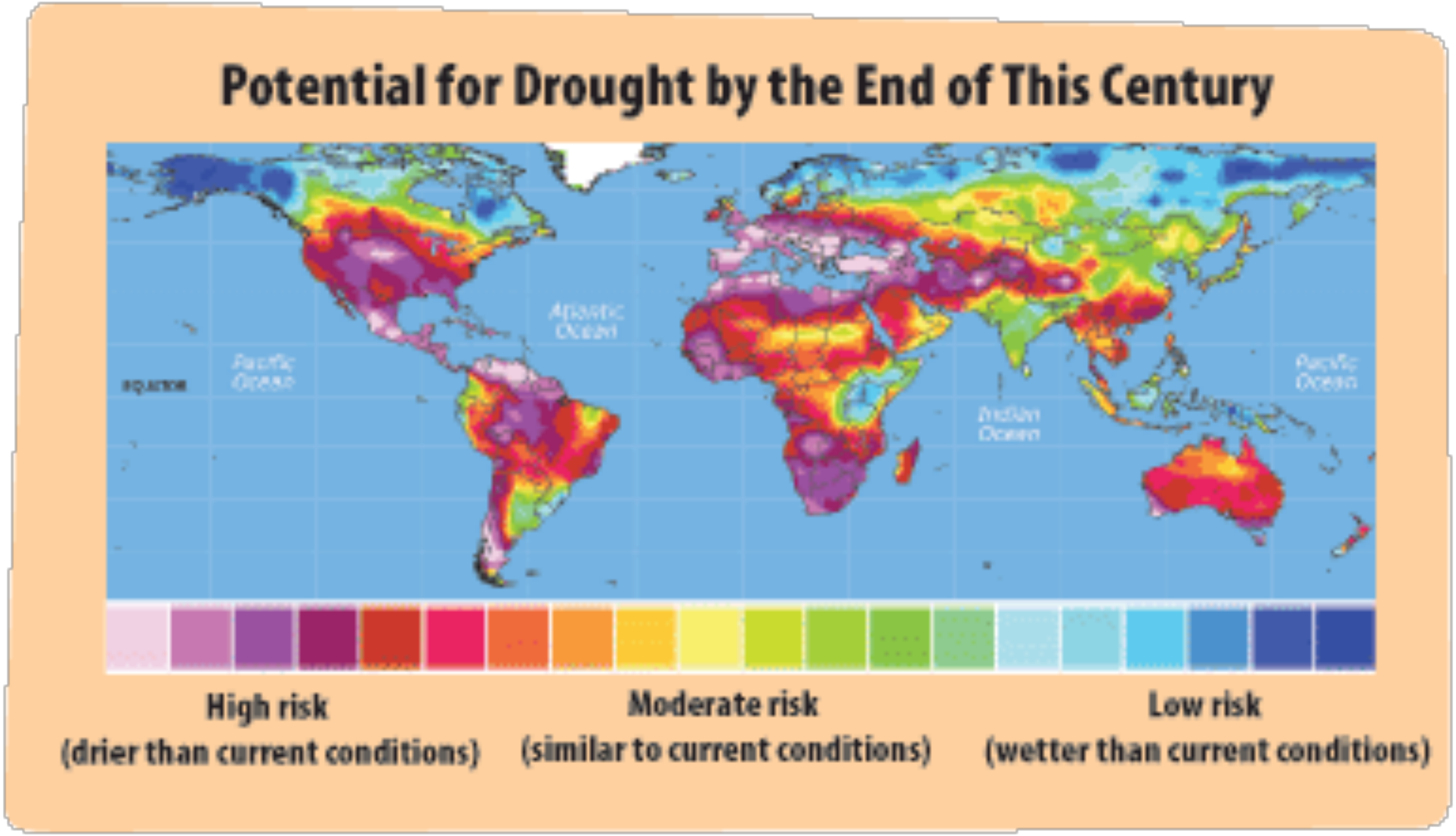
- AGRICULTURAL DROUGHTS WILL BE WORST UNDER CLIMATE CHANGE
- THE MAGNITUDE OF DROUGHTS INCREASE WITH GHG EMISSION

WHY?

- TEMPERATURE AND CROP WATER REQUIREMENT GOING UP
- PRECIPITATION EVENTS WILL BECOME LESS FREQUENT BUT MORE **INTENSE**
- MORE **INTENSE** RAINFALL CANNOT INFILTRATE AS WELL AND BECOMES RUNOFF (FLOODS) AND DOES NOT BECOME SOIL MOISTURE





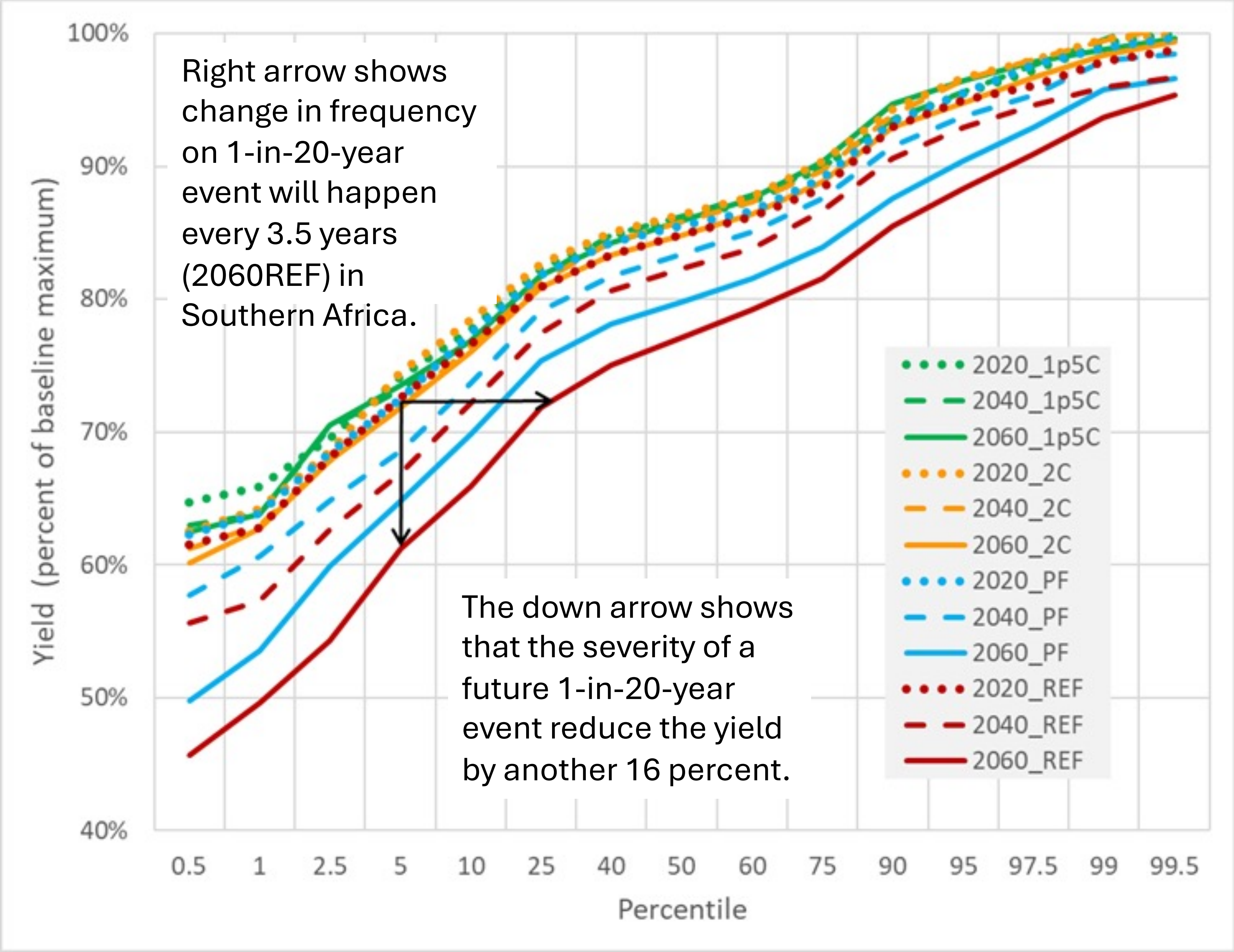


Dai, A. 2010. Drought under global warming: A review. Wiley Interdisciplinary Reviews: Climate Change 2:45–65. http://onlinelibrary.wiley.com/doi/10.1002/wcc.81/pdf.

Shifting means and rising uncertainty increase frequency of adverse climate and agricultural events

RESULTS FROM A JOINT IFPRI/MIT STUDY OF CLIMATE CHANGE , DROUGHT AND CROP YIELD IN SOUTHERN AFRICA

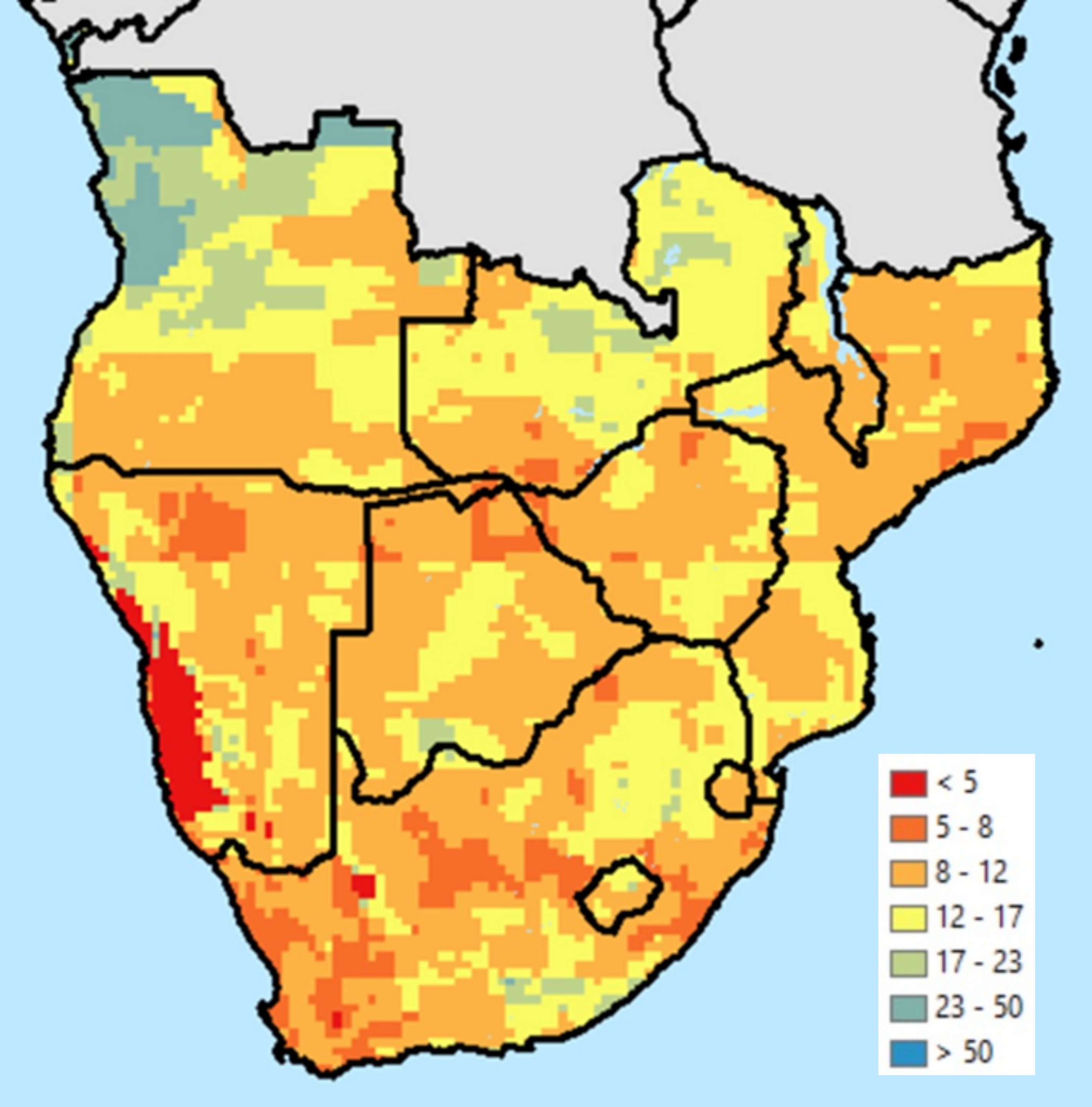
Foresight and Metrics to Accelerate Food, Land and Water Systems Transformation



Foresight and Metrics to Accelerate Food, Land and Water Systems Transformation

Equivalent views: greater losses in “bad” years AND higher frequency of adverse events

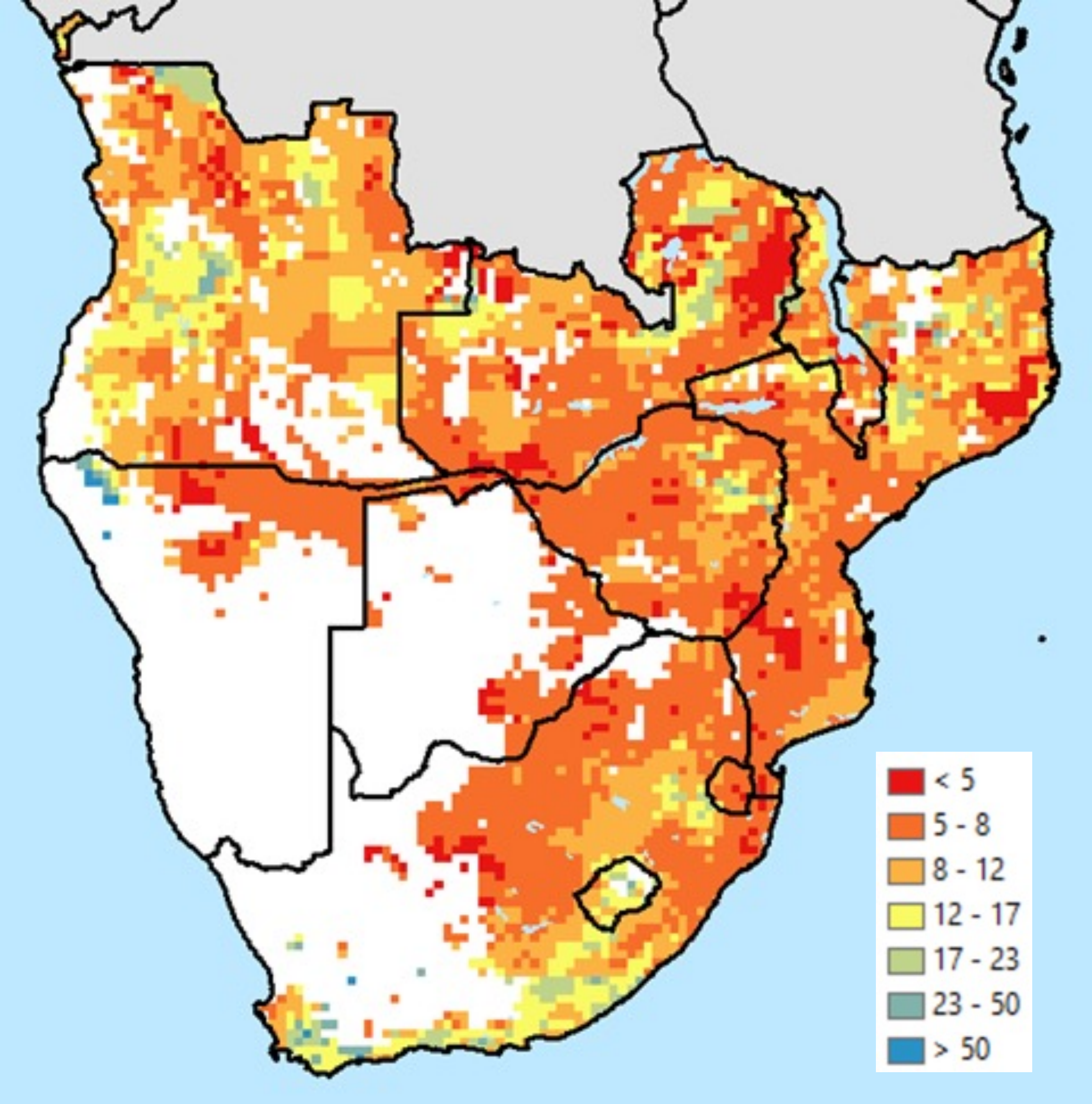
Source: Thomas TS, Robertson RD, Strzepek K and Arndt C (2022) Extreme Events and Production Shocks for Key Crops in Southern Africa Under Climate Change. Front. Clim. 4:787582



Foresight and Metrics to Accelerate Food, Land and Water Systems Transformation

Frequency of 1-in-20-year low rainfall events in Southern Africa: comparing level of the 2020s to the 2060s under the high emissions scenario

Source: Thomas TS, Robertson RD, Strzepek K and Arndt C (2022) Extreme Events and Production Shocks for Key Crops in Southern Africa Under Climate Change. *Front. Clim*. 4:787582



Frequency of 1-in-20-year low maize yield events in Southern Africa: comparing level of the 2020s to the 2060s under the high emissions scenario

Source: Thomas, TS, Robertson RD, Strzepek K, and Arndt C. (2022) Extreme Events and Production Shocks for Key Crops in Southern Africa Under Climate Change. *Front. Clim.* 4.

WHO CAN COPE WITH THESE TRENDS?

GENERALLY, COMMERICAL FARMERS WITH ACCESS TO RESOURCES:

Financial,
High Input Seeds,
Fertilizers,
Govt Information,
Forecast,
Irrigation,

What about the rest?

Foresight and Metrics to Accelerate Food, Land and Water Systems Transformation
CGIAR

SMALL HOLDER/SUSISTENCE FARMERS

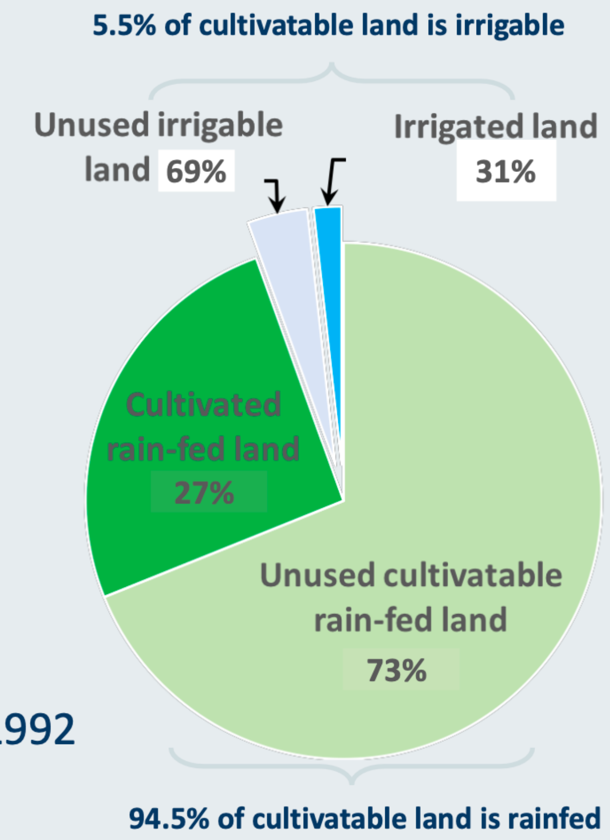
- The vast majority of farms (84%) are less than 2 ha in size (Lowder et al., 2021).
- Smallholder farmers produce around a third of the world’s food
- Smallholder farmers are responsible for about 80% of the food produced in Asia and sub-Saharan Africa (SSA) (Lowder et al., 2021).

THE INVISIBLE 60% OF AFRICA POPULATION

Over view of the situation

- Only 5.5 %of cultivatable land in Africa is irrigable – a natural phenomenon
- 94.5% of cultivatable land is therefore rainfed
- 65% of the population is employed directly or indirectly in agriculture
- 80% of all agricultural activity is on smallholder rainfed farms
- Africa has the lowest crop yields and agricultural productivity in the world
- In 2016 Africa had 218 million undernourished population, up by 44 million from 1992
- **60% of the world's unutilised arable land is in Africa**

AND Africa is importing food @ $35 billion per year which is expected to increase to $110 billion



WHY ARE THEY THE INVISIBLE ?

- THE INVISIBLE 60% ARE GENERALLY NOT ACCOUNTED FOR IN OUR ECONOMIC MODELS OF CC OR WORST ARE VALUED BY THEIR GDP/CAP.

- THEY ARE REGARDED AS A NET DRAIN ON THE ECONOMY.

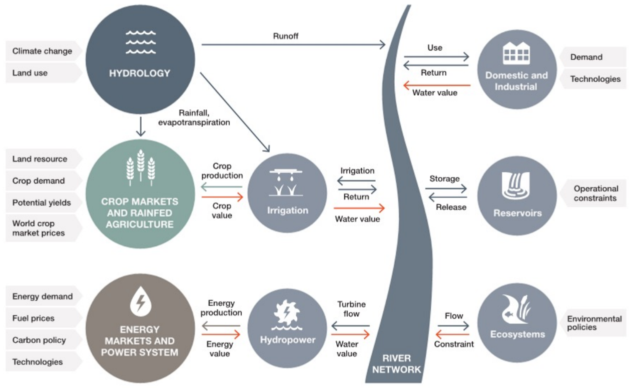
- OUT-OF-SIGHT AND OUT-OF-MIND, THEY ARE LEFT TO FEND FOR THEMSELVES WITH MINIMUM ALLOCATIONS OF PUBLIC EXPENDITURE.

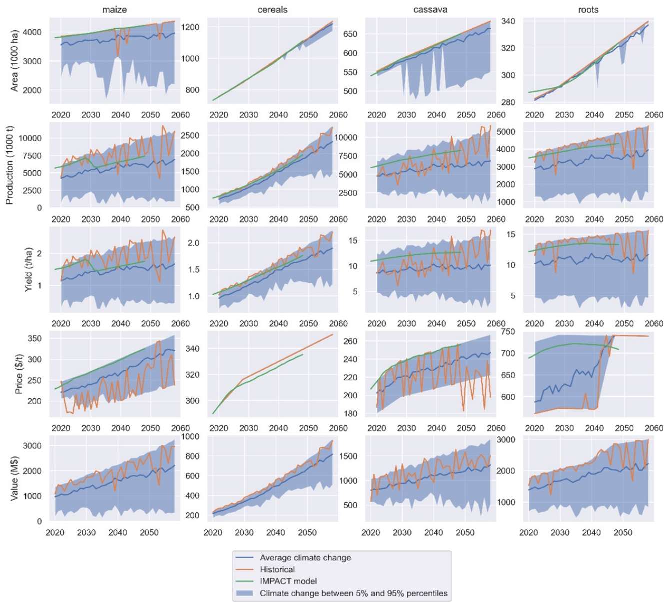
- EXCEPT WHEN DROUGHTS OCCUR AND ALL THEIR COPING STRATEGIES ARE EXHAUSTED, UNTIL THEY ARE FURTHER IMPOVERISHED AND THEY NEED TO BE FED.

- REACTIVE FOOD IMPORTS COST SUB-SAHARAN AFRICA 35-42 $ BILLION PER YEAR. THIS IS PART OF THE COST OF DOING NOTHING – FOR DECADE UPON DECADE

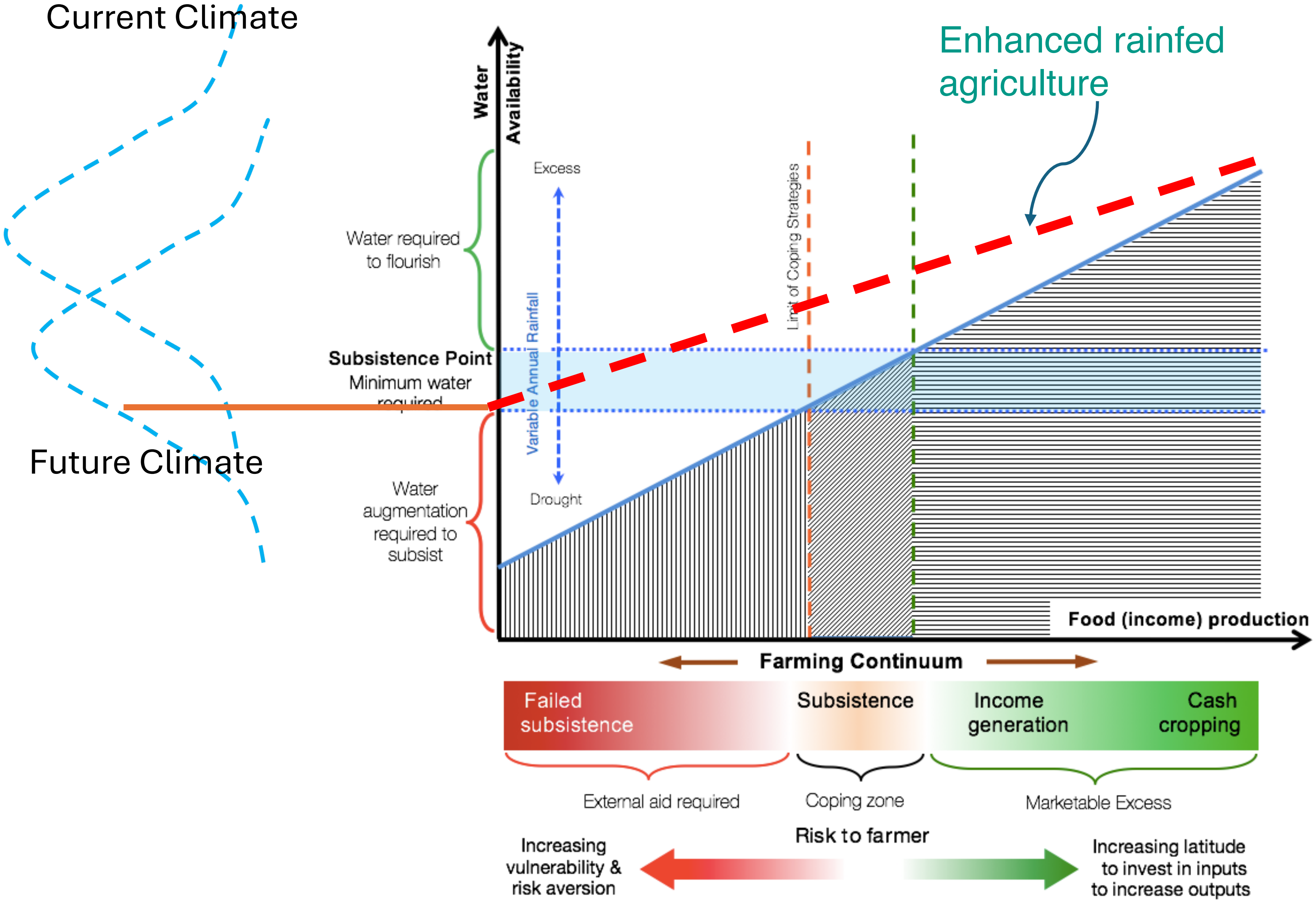
- WE NEED PROACTIVE INVESTMENTS TO MAKE THE 60% RESILIENT TO CLIMATE EXTREMES

AGRO - ECONOMIC MODELING OF CC IMPACT IN SOUTHERN AFRICA





WHY ARE THEY VULERNABLE?



- Enhanced rainfed farming has the highest potential to improve food production and reduce poverty, enabled through managing green water in the vast tracts of rainfed cultivable land in Africa.

WHAT CAN WE DO TO MAKE SMALL HOLDER /SUBSISTENCE FARMER MORE RESILIENT

- LET’S TAKE A LOOK AT HISTORY ACROSS THE MEDITERRANEAN

NILE RIVER IRRIGATION

VOL. 4, NO. 5 WATER RESOURCES RESEARCH OCTOBER 1968

Noah, Joseph, and Operational Hydrology

BENOIT B. MANDELBROT

JAMES R. WALLIS

International Business Machines Research Center
Yorktown Heights, New York 10598

Dedicated to Harold Edwin Hurst

. . . were all the fountains of the great deep broken up, and the windows of heaven were opened. And the rain was upon the earth forty days and forty nights. *Genesis, 6,* 11-12

. . . there came seven years of great plenty throughout the land of Egypt. And there shall arise after them seven years of famine . . . *Genesis, 41,* 29-30

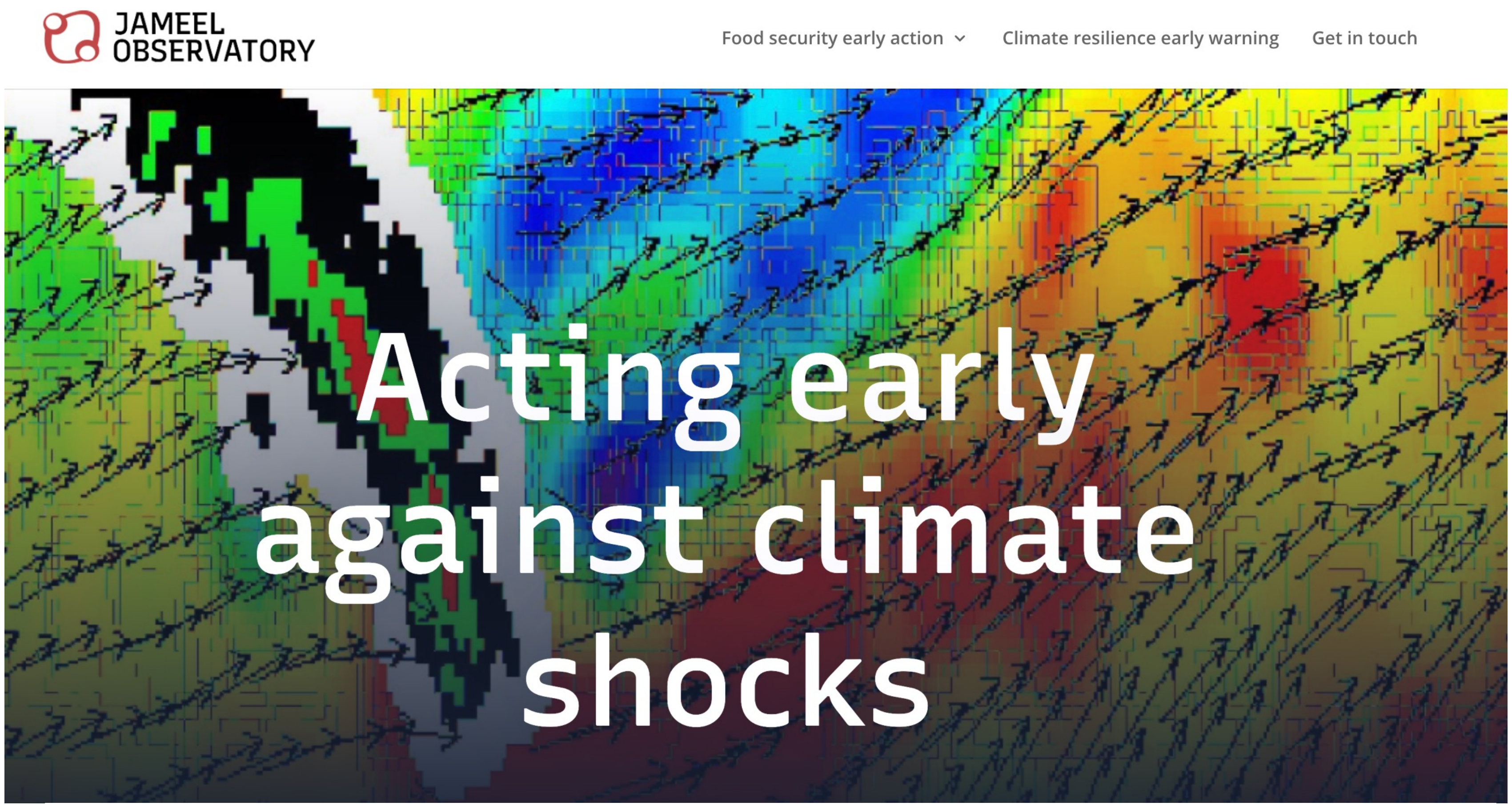
Abstract. By 'Noah Effect' we designate the observation that extreme precipitation can be very extreme indeed, and by 'Joseph Effect' the finding that a long period of unusual (high or low) precipitation can be extremely long. Current models of statistical hydrology cannot account for either effect and must be superseded. As a replacement, 'self-similar' models appear very promising. They account particularly well for the remarkable empirical observations of Harold Edwin Hurst. The present paper introduces and summarizes a series of investigations on self-similar operational hydrology. (Key words: Statistics; synthesis; time series)

Benoit B.[n 1] **Mandelbrot**[n was a Polish-born French-American mathematician and polymath and is recognized for his contribution to the field of fractal geometry,

Genesis 41: 28 -53 Lesson From the Nile Drought on Developing Resilience

- **Forecasting :** God has shown Pharaoh what he is about to do. Seven years of great abundance are coming throughout the land of Egypt, but seven years of famine will follow them.
- **Developing a plan** The plan seemed good to Pharaoh and to all his officials
- **Developing Institutions** “Pharaoh appoint commissioners over the land to take a fifth of the harvest of Egypt during the seven years of abundance.
- **Developing Infrastructure** In each city he put the food grown in the fields surrounding it.
- **Implementing the Plan** Joseph stored up huge quantities of grain, like the sand of the sea; it was so much that he stopped keeping records because it was beyond measure.
- **Success needs resources** Then Pharaoh took his signet ring from his finger and put it on Joseph’s finger.

DROUGHT FORECASTING



THE UNIVERSITY of EDINBURGH

Massachusetts Institute of Technology

Community Jameel

DROUGHT FORECASTING

FEWS NET
Famine Early Warning Systems Network

COUNTRIES & REGIONS DATA TOPICS OUR SERVICES ABOUT US

About FEWS NET

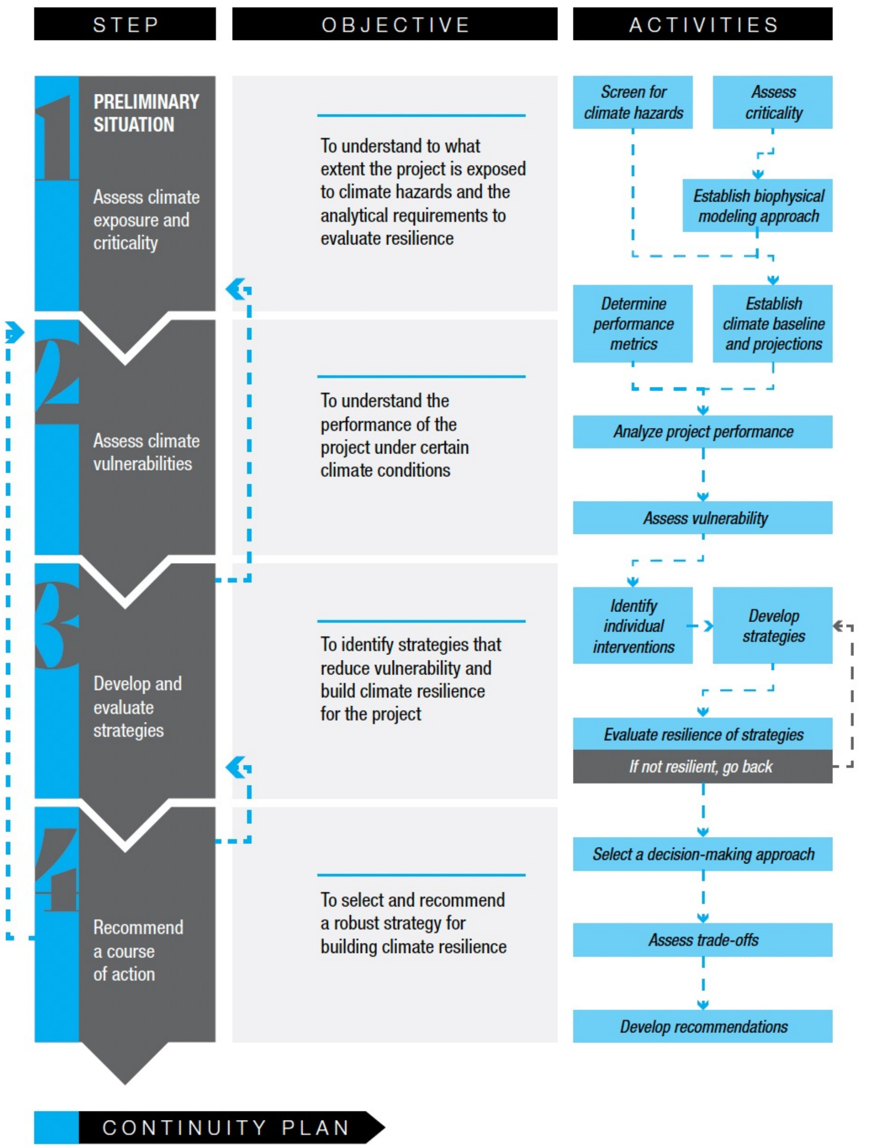
FEWS NET is a leading provider of early warning and analysis on acute food insecurity around the world. FEWS NET relies on a global network of partners to report and provide insightful information on the severity of food insecurity in dozens of countries.

Providing evidence-based early warning information and analysis of food insecurity and its drivers worldwide

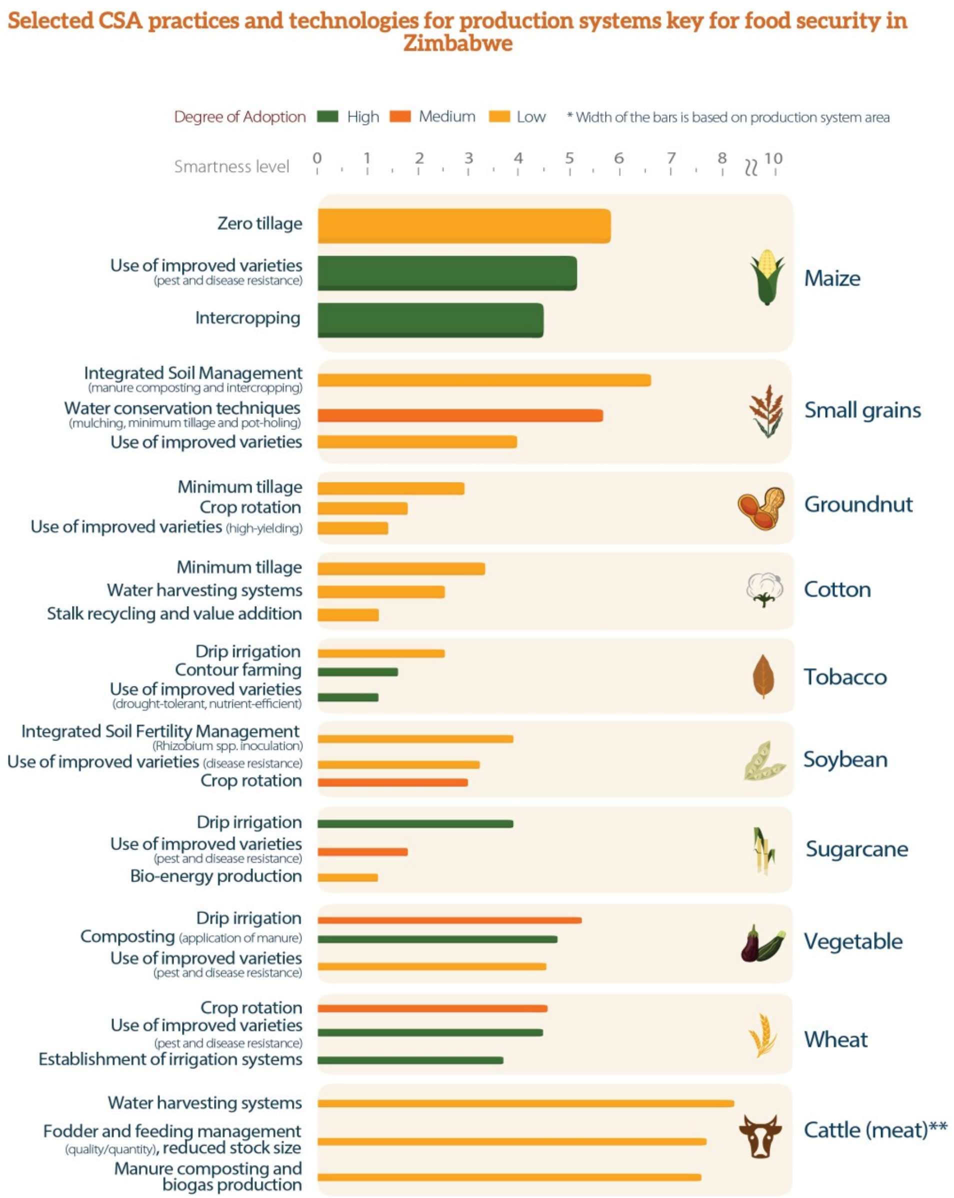
The United States Agency for International Development (USAID) established the Famine Early Warning Systems Network (FEWS NET) in 1985 in response to devastating famines in East and West Africa and a critical need for better and earlier warning of potential food security crises.

DEVELOPING A PLAN

Figure 3.3. Framework for Enhancing the Climate Resilience of Investment Projects



INFRASTRUCTURE



DEVELOPING INNOVATIVE INSTITUTIONS

Food and Climate Systems Transformation (FACT) Alliance

Catalyzing stakeholder-driven research to solve the world's most vexing food and climate challenges

FACT ALLIANCE

The Food and Climate Systems Transformation (FACT) Alliance is a first-of-its-kind initiative, connecting researchers, the private sector, non-governmental organizations (NGOs), farming communities, and governments to drive innovation and inform better decision making for resilient and sustainable food systems. The effort is led by Greg Sixt, J-WAFS research manager for food and climate systems, and consists of over 20 global member institutions at the vanguard of research and policy on climate change and food systems.

RESOURCES NEEDED/PRIORITIES CHANGES

- The potential investments required and the possible yields in the dryland zones of Sub-Saharan Africa.

- These investments are comparable to Africa's food import bill, which costs the continent about $35 billion to $42 billion each year.
- These estimates make a strong case for investing in enhanced rainfed agriculture by managing green water.

- The question then arises as to how this can be done at scale to help regenerate rural economies across Africa, increase food security and contribute to the continent's growth and development.

Table 6: Investments and yields by water management type.[12]

Agricultural water management type	Investment required	Possible annual yields
Large-scale commercial irrigation	$19 billion	18 million tons
Small-scale irrigation	$40.5 billion	22.7 million tons
Improved rainfed agriculture	$31.5 billion	126 million tons

WE ARE CALLED TO ACTION

- **Smallholder farmers in developing countries, are often not empowered to do adaptations, since they often do not have the economic, institutional, educational or other support to take action (Bustamante et al., 2014; Smith et al., 2007).**
- **Smallholder farmers are often in the regions of the world most at risk from climate change, both gradual and through extreme events, such as droughts, floods and heatwaves (IPCC, 2022).**
- **it is important to support small holder farmers to implement adaptation options is their farming practices, that also co-deliver the climate change mitigation (Smith & Olesen, 2010).**

- **Deuteronomy 15:11, “You shall open wide your hand to your brother, to the needy and to the poor, in your land.”**
- **Psalm 9:18 For the needy shall not always be forgotten, and the hope of the poor shall not perish forever.**

- **Let us not forget the Small Holders/Subsistence and their families and the Invisible 60% of Africa**
- **We have a call to action NOW and even more so in light of a Changing Climate**

Thank you!

Climate-Smart Agriculture in Zimbabwe

Climate-smart agriculture (CSA) considerations

A P — Agriculture is the mainstay of Zimbabwe's economy, yet recurrent droughts and the impact of climate change through temperature increases and reduced rainfall are already negatively affecting Zimbabwe's agricultural sector particularly due the high reliance on rainfed crop production

M — The livestock sector is largest source of agricultural GHG emissions at 71% followed by cropland at 29%. In livestock, emissions are mostly from enteric fermentation (38.6%) and manure left on pastures (28.4%). In crops, high emissions emanate from savanna burning (20.5%), compounded by deforestation from tobacco production and curing by smallholder farmers, while burning of sugarcane fields before harvest is also common.

A M P — Against a backdrop of securing national food security and projections that all production systems are expected to be somewhat negatively affected by climate change, the adoption of Climate-Smart Agriculture (CSA) as an agricultural adaptation and mitigation strategy is increasingly becoming important.

A M I — Conservation agriculture is the most widely promoted CSA practice (over 100,000 farmers practicing on over 125,000 hectares). Other CSA activities that have potential for scaling up and out include seed multiplication of drought tolerant crops, small scale irrigation, and agroforestry. Efforts are needed to reduce the frequency of veldt fires through improved savanna and grassland management. Soil based CSA practices such as precise fertilizer application, manure application, agroforestry, crop rotations and intercropping, along with soil conservation structures are also important.

A M I — For livestock production, the main climate-smart practices include fodder management and conservation, water harvesting and manure management including biogas production. Rearing of small livestock (such as goats) is also increasingly common as an adaptation strategy. However, animal health management, improved breeds and improved feed have the most potential to enhance resilience in the sector.

I $ — The agriculture sector requires USD $2.3 billion for implementation of the proposed adaptation and mitigation action plans in the country's Climate Change Response Strategy. However, financing for CSA projects is constrained by the limited government funding toward agriculture and limited enabling conditions for leveraging capital investments. Public and private sector partnership are needed to ensure adequate financing for CSA practices.

A M P I — Services to support CSA have included weather index based crop and livestock insurance and provision of improved climate information targeted at smallholder farmers, through use of information technology (particularly cell phones). More could be done to promote private sector involvement in building the capacity of a variety of stakeholders to understand, use and demand appropriate climate information to support agricultural adaptation efforts.

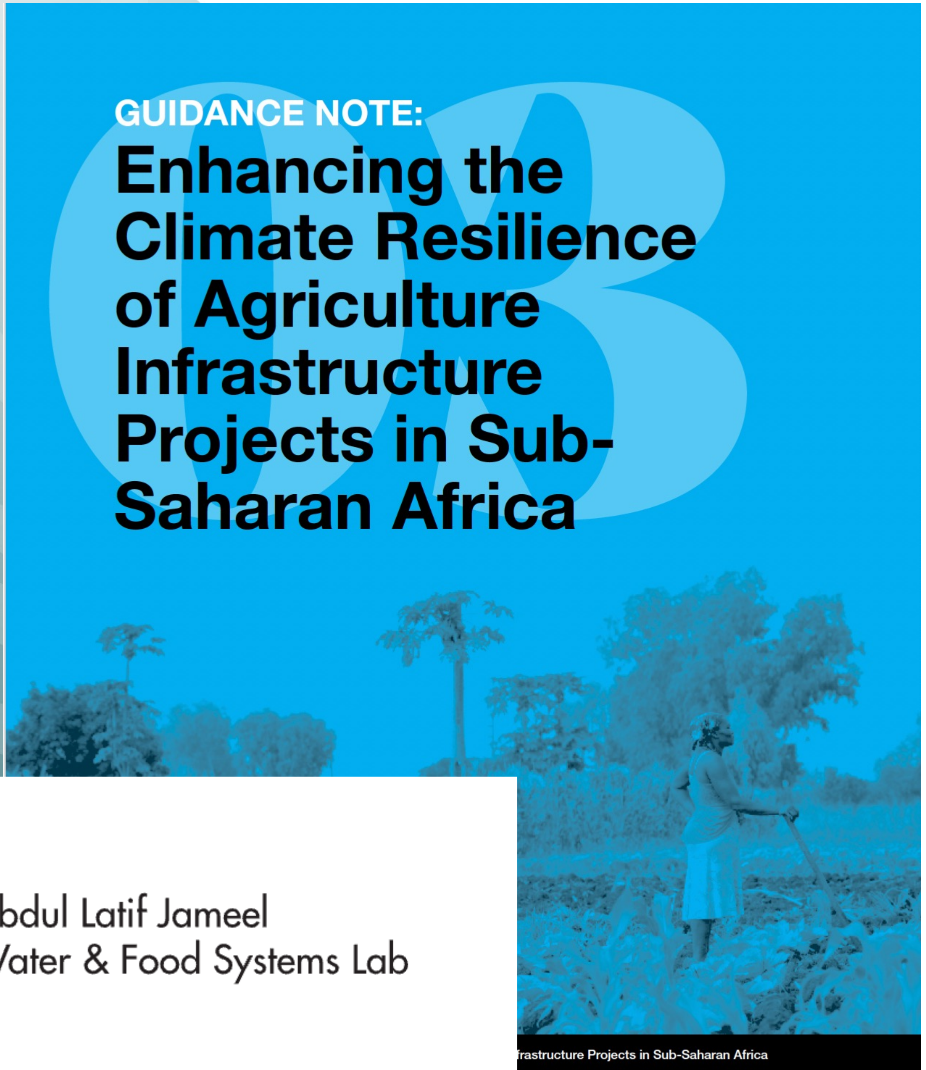
I $ — There is potential to access international financing for CSA, particularly through the Green Climate Fund (GCF) and the Adaptation Fund (AF) both of which the country has not yet accessed. In addition, there is opportunity to access the Extreme Climate Facility set by the African Union to support adaptation practices on the continent.

I $ — Capacity building of government and non-governmental organizations involved in CSA activities is required for Zimbabwe to write bankable proposals and access the various funding streams for climate change adaptation and mitigation projects.

A Adaptation | M Mitigation | P Productivity | I Institutions | $ Finance

The climate-smart agriculture (CSA) concept reflects an ambition to improve the integration of agriculture development and climate responsiveness. It aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and reduce/remove greenhouse gases (GHGs), and require planning to address trade-offs and synergies between these three pillars: productivity, adaptation, and mitigation [1]. The priorities of different countries and stakeholders are reflected to achieve more efficient, effective, and equitable food systems that address challenges in environmental, social, and economic dimensions across productive landscapes. While the concept is new, and still evolving, many of the practices that make up CSA already exist worldwide and are used by farmers to cope with various production risks [2]. Mainstreaming CSA requires critical stocktaking of ongoing and promising practices for the future, and of institutional and financial enablers for CSA adoption. This country profile provides a snapshot of a developing baseline created to initiate discussion, both within countries and globally, about entry points for investing in CSA at scale.

UKaid — WORLD BANK GROUP — CGIAR — Research Program on Climate Change, Agriculture and Food Security — CCAFS — CIAT 1967-2017



MIT J-WAFS Abdul Latif Jameel Water & Food Systems Lab