The Potential Impact of Climate Change on Nigerian Agriculture

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Presentation Outline

- Introduction
  - CC indicator, IPCC view, CC in Nigeria, Extreme weather and crop yield and major concerns
  - Objectives
  - Hypotheses
- Literature Review
- Methodology
  - Modelling, crops, data, variables, welfare issues
- Expected Contribution to knowledge

Impacts of CC (IPCC 2001)

- Temperature. 10 warmest years in history in past 15 years, 20th century the warmest in past 600 years, warming in Africa at .05oC/decade
- Climate variability and extreme climate events. More frequent
- **Agriculture**: Crops' yield: gains in some temperate areas but losses in most tropical and subtropical zones, **Water**: Reduced streamflow & groundwater recharge, intensity and frequency of floods and droughts
- **Small island and low-lying coasts**: Coastal flooding & erosion, loss of infrastructure, displacement of population, fisheries, corals, beaches

CC in Nigeria

year	Average climate	Change
1901 - 1935	26°C	
1936 - 1970	26.5°C	0.5
1970 - 2005	27.8°C	1.3

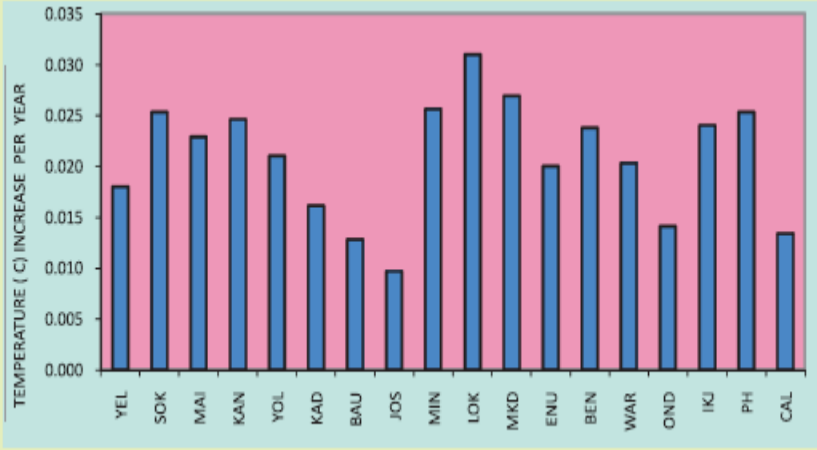


Fig. 6: Hot season temperature increase: 1941-2000

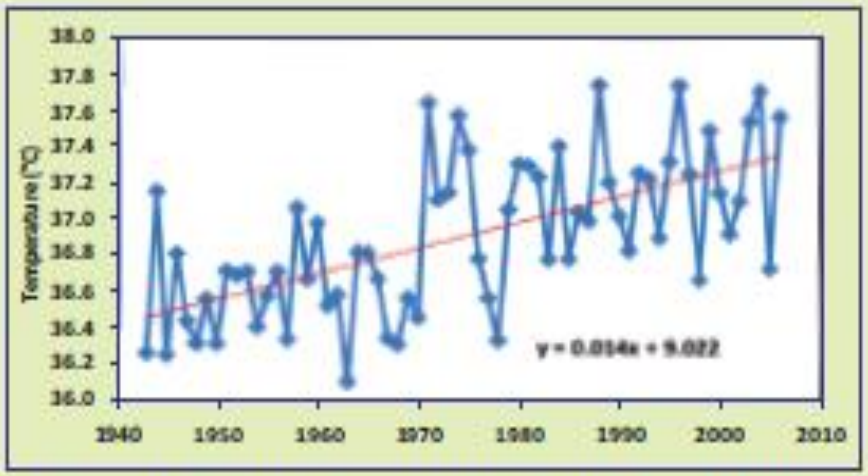


Fig.7a: Hot season temperature in the North: 1941-2010

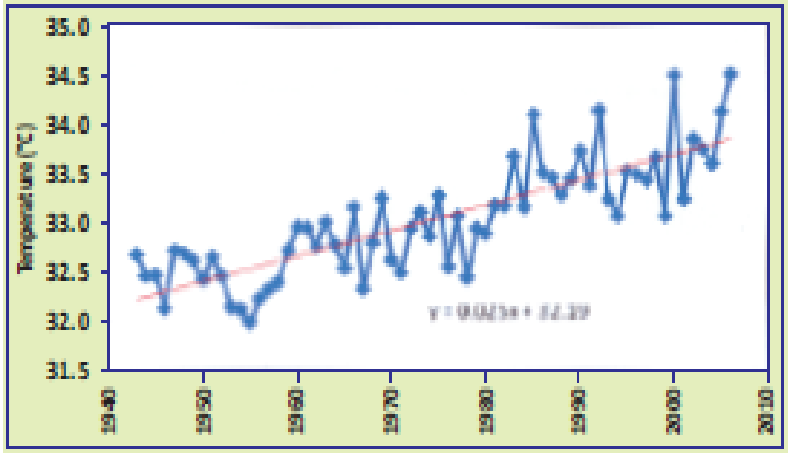


Fig.7b: Hot season temperature in the South: 1941-2010

Extreme weather in Nigeria 2011

S/N	STATION	RAINFALL(mm)	MONTH
1	Lafia	125.6	May
2	Calabar	146.4	June
3	Ado Ekiti	207.5	July
4	Ikeja	233.0	July
5	Oshodi	177.7	July
6	Benin	169.6	July
7	Warri	138.7	July
8	Uyo	180.5	July
9	Owerri	150.7	August
19	Ibadan	153.5	August
11	Obudu	133.3	August
12	Bauchi	132.5	September
13	Bida	109.0	September
14	Lokoja	102.2	September
15	Asaba	201.0	September
16	Ogoja	129.6	September

S/N	STATION	HIGHEST VALUE(°C)	PERIOD	DURATION (DAYS)
1	Bauchi	40.5	April - May	6
2	Bida	40.5	March - April	4
3	Gombe	41.5	March - May	15
4	Gusau	41.7	April - May	14
5	Kano	42.2	April- May	33
6	Katsina	42.3	April - May	44
7	Lafia	41.4	March - May	11
8	Ibi	40.7	March - April	13
9	Maiduguri	44.4	March - May	57
10	Minna	41.6	March	9
11	Nguru	43.5	April - May	52
12	Potiskum	42.5	March - May	45
13	Sokoto	44.0	March - May	65
14	Yelwa	43.4	March - May	38
15	Yola	43.0	March - May	52

Weather extremes and Crop Yield

- **Common knowledge**
- Source of low yield despite improved management practices
- Source of unpredictable yield variability
- Induce conditions that favour pests and diseases

- **Nigeria situation**
- Heat stress, severe floods, windstorms, heat waves and several other extreme weather and climate events are common events
- NIMET often provides early warning advisories and collate the trend and magnitudes on daily, monthly, quarterly and yearly basis

Major concerns

- Socio-economic impacts of extreme weather events in Nigeria have not been empirically investigated
- Previous works on climate change impacts have used average climatic factors which masked the effects of extreme weather
- Little empirical evidence exists on crop yield variation in response to the alterations in climatic conditions in sub-Sahara Africa.
- Increased government expenses on subsidized agric insurance premium
- Increase in ad-hoc disaster intervention fund
- Little attention to climate change induced production risk

Research question and objectives

- **Research Questions**
  - Are extreme weather conditions important to crop production in Nigeria?
  - Are extreme weather conditions a source of crop production risks Nigeria?
- **1.3 Objectives of the Study**
  - estimate the effect of extreme daily temperatures and rainfall on yields of Nigerian crops
  - estimate the effect of extreme daily temperatures and rainfall on yield variability of Nigerian crops.
  - Simulate the welfare impacts of yield changes under alternative climate scenarios

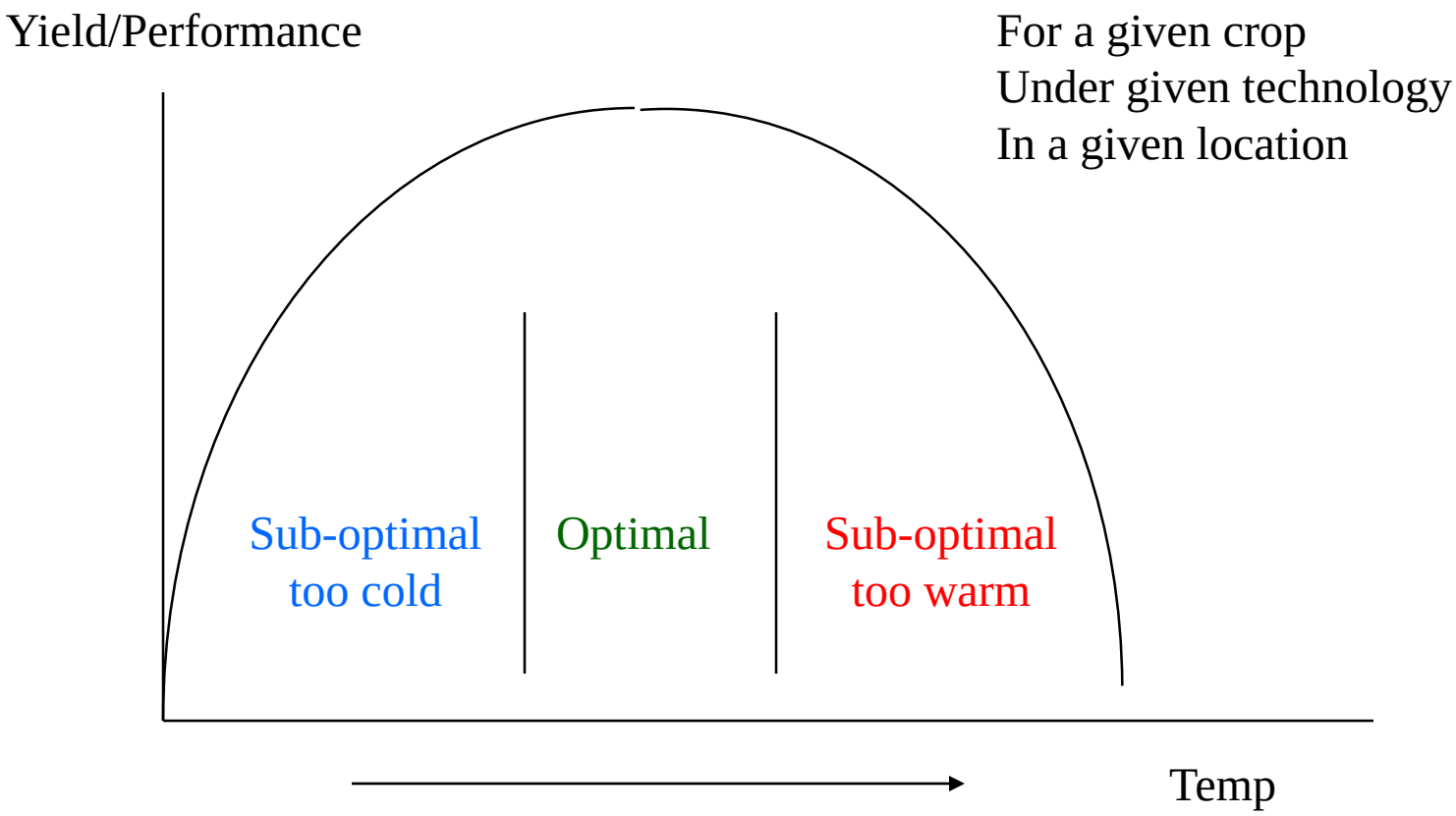
Key literature review

Author	Short Title	Model Employed	Results
Rosenzweig and Parry (1994)	Impact of climate change on world food supply	Calibrated crop model	Developing countries will bear the brunt of climate change
Chi-Chung Chen 1998	Yield variability as influenced by CC	Panel data Just and Pope – 1973 – 1997 for 48 states	CC effects vary depending on the crop being considered
Deschenes and Greenstone (2004)	Random weather fluctuation and agricultural output	Fixed effect regression	Climate change will increase profit by 4%
Holst et.al 2010	Impact of climate normal and variance on production	Just and Pope Production Risk model using panel of 26 provinces from 1985 - 2007	Positive net benefit of CC in the short run

Literature Review

Author	Short Title	Model Employed	Results
Robertson, S. M 2012	A Spatial Model of Agricultural Land Use with Climate Change for the Canadian Prairies	Production function	Shows that the use of GDD, predict yield better than average temperature
Chalise and Ghimire 2013	Effects of climate change on peanut yield	production function	Excessive temperature negatively affects yield
Just and Pope 1979	Production function estimation and risk consideration	Just and Pope model	Correct heteroscedasticity and estimate variance equation
Levin and Lin 1993	Panel unit root test	Levin and Lin unit root for panel data	Test for stationarity of panel data

Impact of Climatic Variables on Crop Performance



Major Crop grown in Nigeria

Group	Crop
Grains	Maize, Millet, Rice, Sorghum, wheat
Root and tubers	Cassava, cocoyam, potatoes, sweet potatoes, yam
Pulse	Cowpea, Soyabeans
Industrial	Cashew, Cocoa, Coconut, coffee, cotton, ginger, groundnut, rubber, sugarcane, Melon, Oil palm

Model Specification

$$Y = f(X, \beta) + h(X, \alpha)\varepsilon$$

- *Y* is crop yield
- *f(≅)* is an average production function
- X is a set of independent explanatory variables (climate, location, and time period).
- The functional form h(≅) for the error term μi, is an explicit form for heteroskedastic errors, allowing estimation of variance effects.

ML Estimator

$$\ln L = -\frac{1}{2}\left[n\ln(2\pi) + \sum_{i=1}^{n} \ln h^2(X, \alpha) + \sum_{i=1}^{n} \frac{Y_i - f(X, \beta))^2}{h^2(X, \alpha)} \right]$$

The shadow price of climate variables can be computed as follows:

$$wc = \frac{\partial E(y)}{\partial c} p_y \quad = \quad \alpha_c \frac{p_y * E(y)}{c}$$

wc is the shadow price of climate variable c

$E(y)$ Is the expected output and

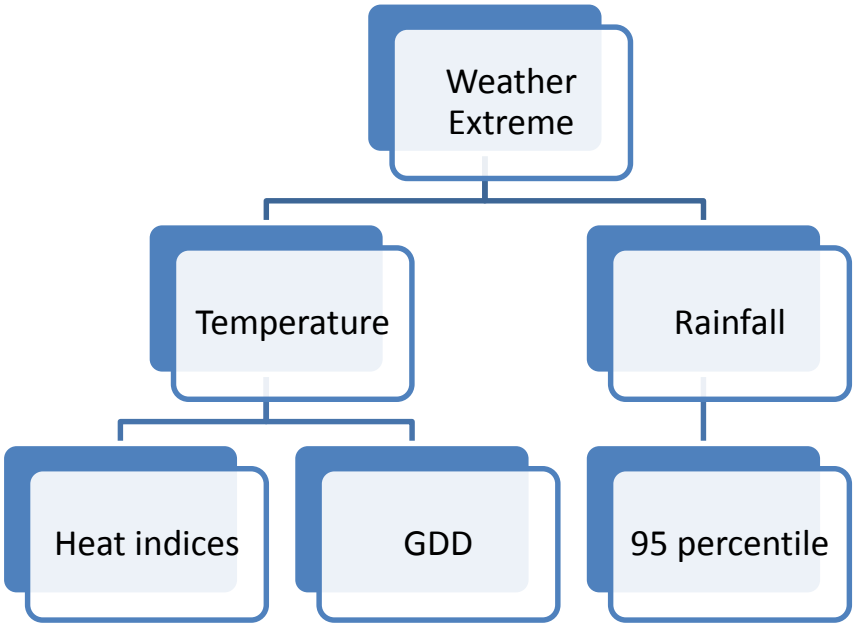
p_y is the output price.

α_c represents the estimated output elasticity with respect to the climate factor to be obtained from the mean production function of the Just-Pope procedure.

Data and Sources

Variables	Source	Span
Output/area/yield/price	FAOSTAT	1971 - 2012
Output/area/yield/price of each crop	National and state ADP offices	1991 - 2012
daily rainfall and temperature (min & max)	National Meteorological Station	1971 – 2012
Growing season for each crop in Nigeria	USDA Bulletin	**http://fas.usda.gov/pecad/pecad.html**
Temperature threshold for each crop	Luo (2011) and interaction with colleagues in Agronomy dept	

Variable measurements



- Yields are measured in tonnes per hectare
- Location are handled with dummies
- Trend is included to cater for technological change
- Prices are quoted in Naira

Predictions

- To Predict likely impacts of future CC yield response models' parameters will be employed to project impacts under predictions of two AOGCM models of future climate for years 2020 and 2100:
  1. Canadian Climate Centre (CCC). More pessimistic predictions of severe impacts
  2. Parallel Climate Model (PCM). Relatively mild predictions of CC
- While both agree on temperature warming trend the PCM predictions are much lower than the CCC
- The two however give contrasting precipitation scenarios: CCC predicts decrease whereas PCM projects increase

Model		Current averages	2020	2100
CCC	**Temperature (0C)**	23.29	24.9 (+1.6%)	29.96 (+6.7%)
PCM		23.29	23.9 (+0.6%)	25.79 (+2.5%)
CCC	**Precipitation (mm/month)**	79.75	78.8 (-3.7%)	65.08 (-18.4%)
PCM		79.75	89.8 (+12.5%)	83.18 (+4.3%)

welfare impacts of Yield Change

- Employ appropriate Agricultural Sector partial equilibrium Model
- IMPACT – IFPRRI

Core System	Model
Producer	Area, production, yield and supply equations
Consumers	Food, feed, others and total demand
Trade	Export, import,
Price	Price linkage
Closure	Model closure

Expected significance of the Study

- The effectiveness of NAIC anchors on her ability to predict agricultural production risks.
- volatility of world food prices because a bad harvest year may drive a country to import staple food, which in turn pushes up the world market price.