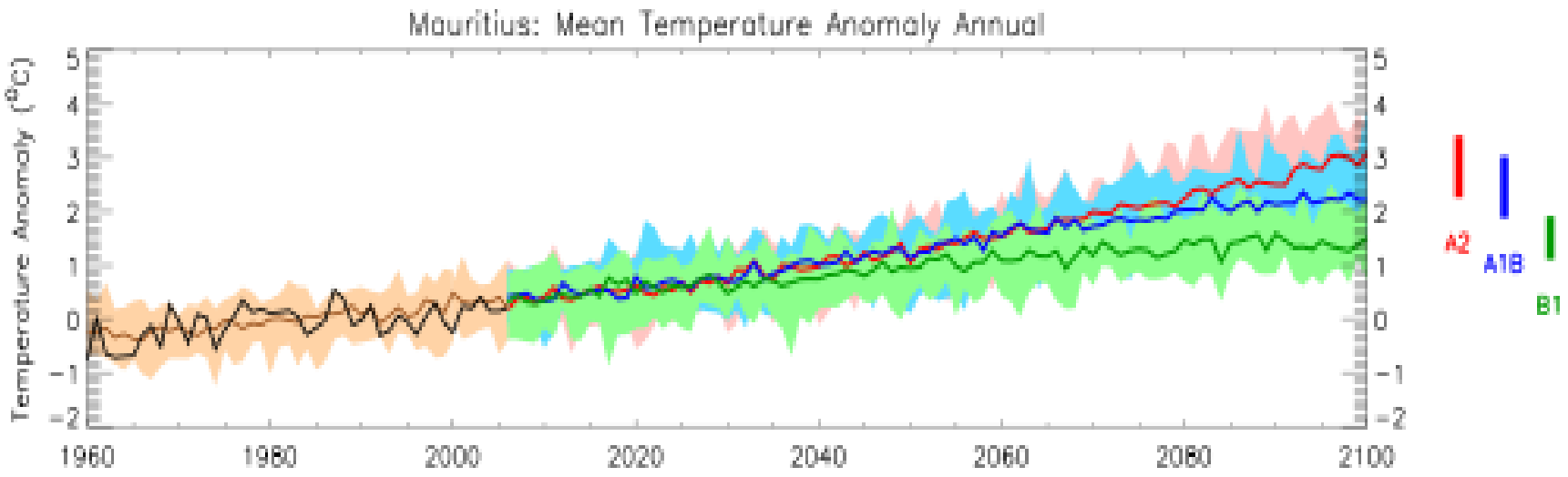
Climate Change and agriculture in Mauritius - impacts and vulnerability assessment

R. Sultan

Climate change in Mauritius

- Some common observations
  - Mean annual temperature has increased by 0.6° C since 1960,
  - an average rate of 0.13°C per decade.
  - This increase in temperature is most rapid in January, February and March,
  - (0.16°C per decade)
  - And least rapid in October, November and December (0.10°C per decade).

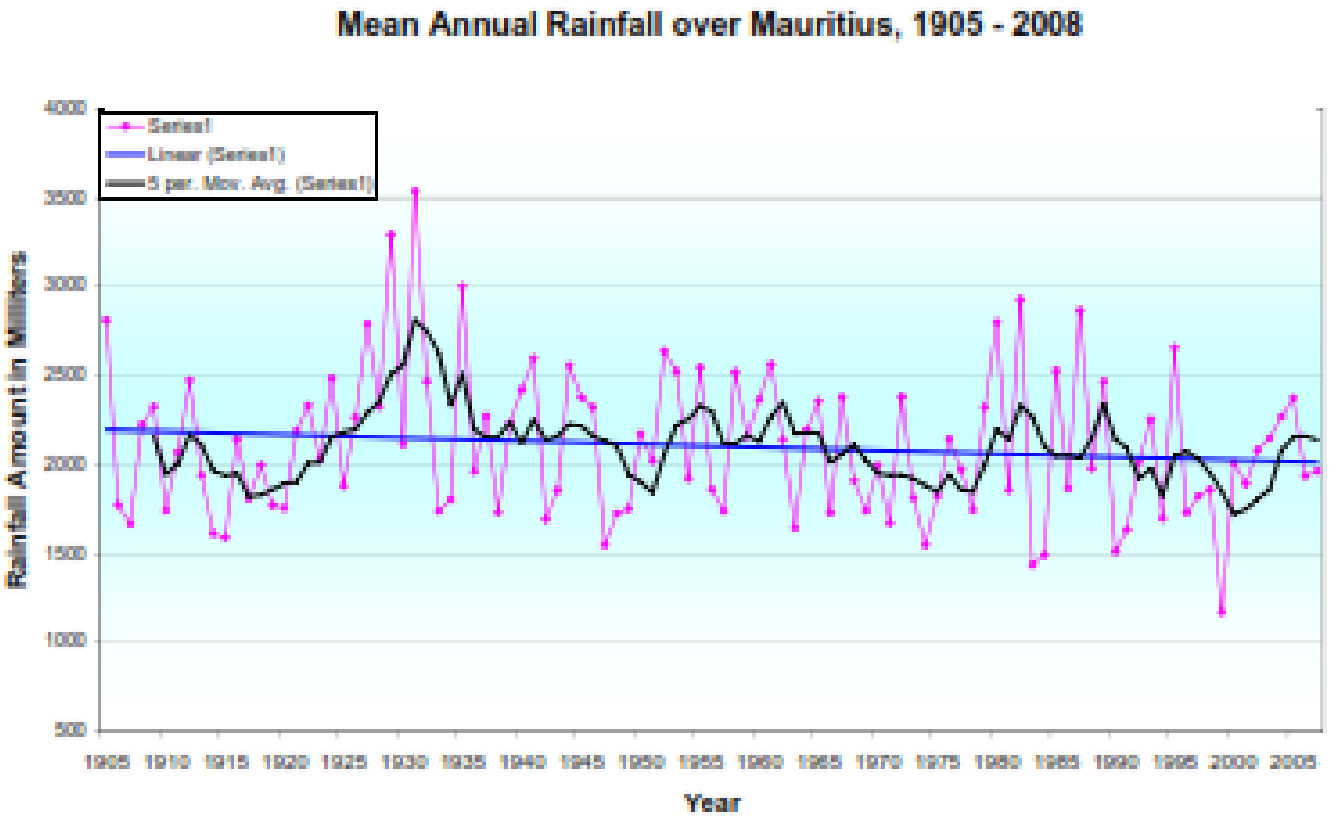
Mean temperature Anormaly Annual



Climate change in Mauritius Precipitation

- Long term time series of rainfall amount over the past century (1905-2008) show a decreasing trend in annual rainfall over Mauritius
- Rainfall has fallen over the period 1960 to 2006 in October, November and December
- This averaged of 7.7mm per month (8.7%)

Mean Annual Rainfall over Mauritius 1905-2008



Projections - Temperature

- The mean annual temperature is projected to increase by 1.0 to 2.0°C by the 2060s, and 1.1 to 3.4°C by the 2090s.
- The range of projections by the 2090s under a ny one emissions scenario is 1.0-1.5°C.

Climate change in Mauritius

- All projections indicate substantial increases in the frequency of days and nights that are considered ‘hot’ in current climate.
- Annually, projections indicate that ‘hot’ days will occur on 29-48% of days by the 2060s, and 33-71% of days by the 2090s.
- Days considered ‘hot’ by current climate standards for their season are projected to occur on up 100% of days in January, February, and March and January, August, September by the 2090s

Projections Precipitation

- The range of projections in mean annual rainfill from different models is large and straddles both negative and positive changes (-20% to +24%), with ensemble median changes close to zero

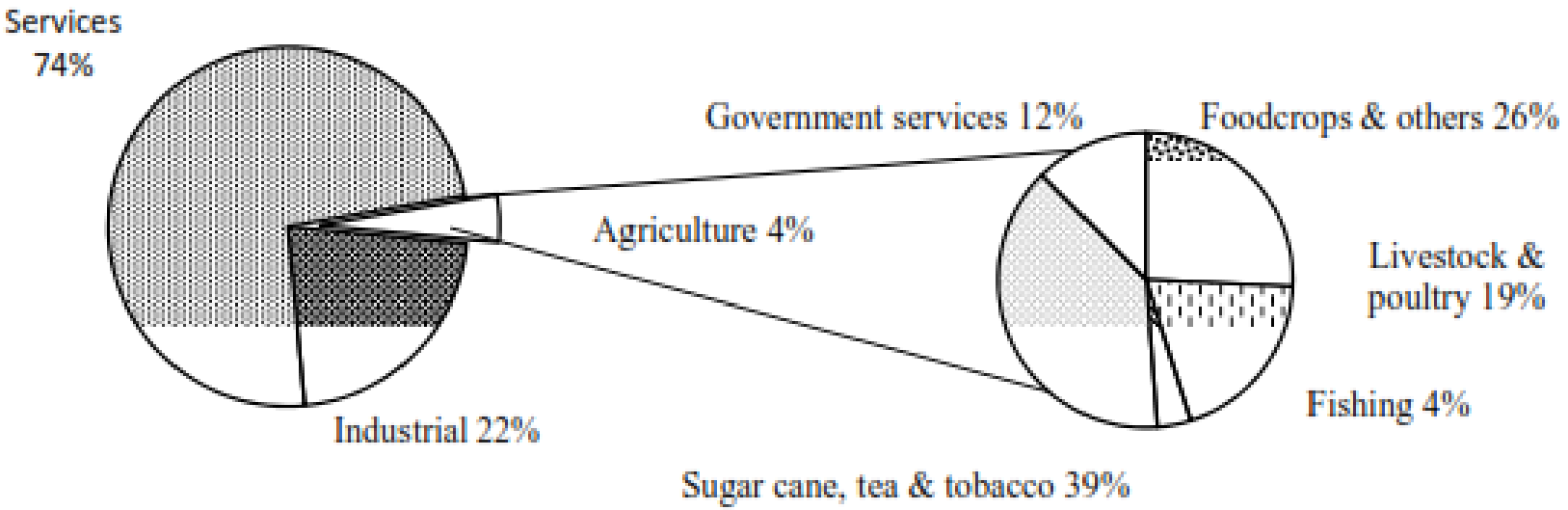
Agro-ecological and climatic features in Mauritius

- Agricultural activities on Mauritius stand at around 4-5 % of the GDP
- Area harvested under food crops in 2009 = 7083 hectares = 16781 arpents
- Foodcrops = 113943 tonnes
- Employment in agriculture (2009)=47300
- Share of agriculture in total employment = 9%

Agro-ecological and climatic features

- Employment in agricultural activities - Foodcrops , flowers and other agriculture
- Large establishments: 6350
- Small establishement: 17150
- Male: 14530
- Female: 8970
- Total: 23500

Share of agriculture in the economy – Republic of Mauritius 2009



Focus

- Focus: an economic analysis of the impacts of climate change on agriculture
- What is the economics of climate change?
- What is that economic analysis all about?

The agroecosystem

- The agroecosystem is a complex system of interactions between atmosphere and climate, nutrients and soils and biological factors
- Crops respond directly to changes in temperature, moisture and carbon dioxide
- Livesock production may be affected by heat-induced appetite and productivity of pasture and grassland

Temperature

- Temperature affects the rate of photosynthesis, that is, the rate which plants absorb and respire carbon dioxide from and to the atmosphere
- The rise in temperature leads to higher respiration rates and this reduces the crop yields
- The rise in temperature can also lower the quality of grain since higher temperatures result in a shorter grain filling period

Changes in temperature

- Optimum temperature ranges vary for different crops and crop varieties
- Climatic changes can alter the suitable geographic range of crops
- Temperatures in many low latitude countries are often close to the thermal tolerances of many crops grown in these countries
- Temperature changes can interact very closely with changes in the availability of water and nutrients

Changes in temperature

- Elevated temperatures lead to increased evaporation and transpiration rates and this diminished soil moisture
- Soil nutrient levels could be affected by increased rates of decomposition induced by higher temperature

Rainfall

- Without increases in rainfall, soil moisture will decrease as a result of higher temperatures
- Some areas may experience decreases while others may receive increases
- Some evidence suggests that more rain will fall in heavy rainfall events

The production function approach

- Many studies have used the production function approach
- This is a traditional approach

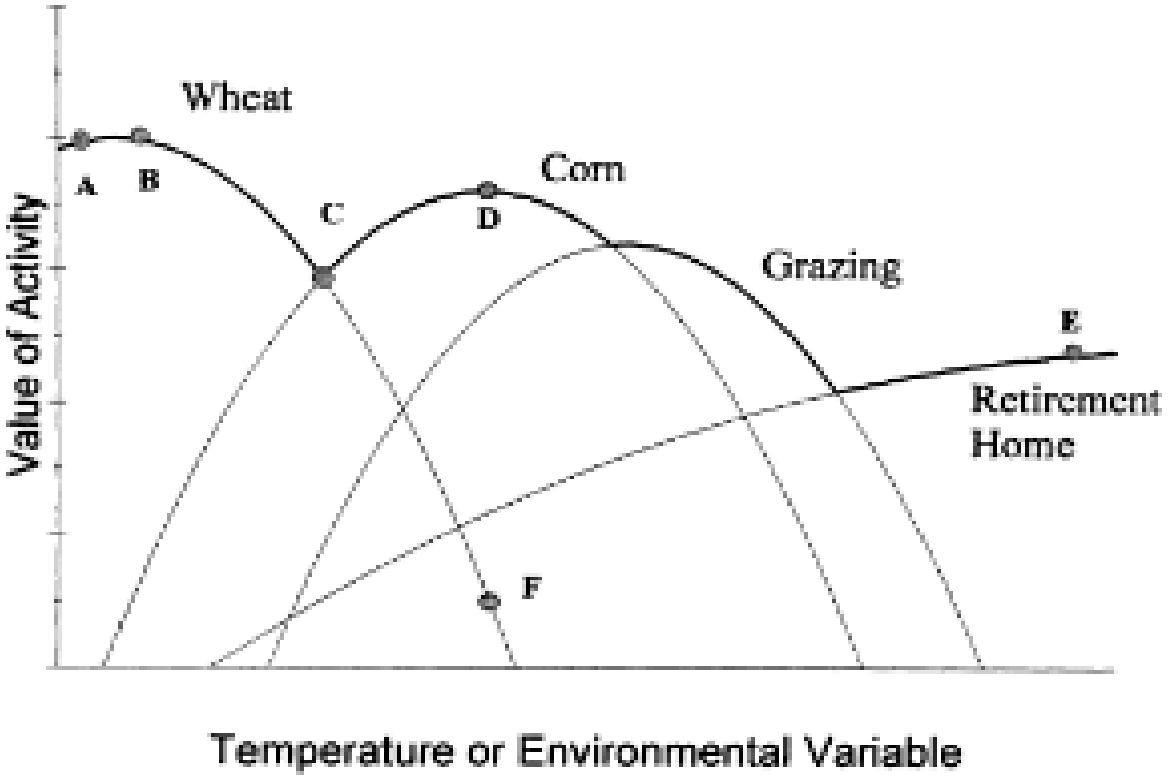
- Experimentation, laboratory exercise, controlling for factors affecting yield

- It takes an underlying production function and estimates impacts by varying one or a few inputs such as temperature, precipitation and carbon dioxide level

The Production function approach

- It omits the variety of the adaptations that farmers customarily make in response to changing economic and environmental conditions
- Adaptation matters…
- Example: introduction of new crops, changes in land use, farming to livestock

Change in value of activity due to changes in temparature



Analytical framework

- Ricardian approach
- Incorporate private adaptation that gives the farmer the opportunity to modify the production and planting environment in order to increase profit
- It allows changing crops, planting dates etc
- Also: substitution of inputs are allows

Climate change and yield

Countries analyzed	Crop yield (2050)
South Africa, Namibia, Mozambique, Botswana, Zambia, Zimbabwe, Tanzania, Uganda, Kenya, Nigeria, Cameroon, Ghana, Sierra Leone, The Gambia	Decline (10–20%) in Mozambique, Tanzania, Uganda, Botswana and Namibia; up to 10% decrease in other African countries.

T

Region	Crops	Crop response tool	Yield impact %	Comments	Reference
Africa	cereals	FAO method with monthly data	See comments	For 29 countries: 35M tons of potential cereal production; for 17 countries, +30M tons	Fisher et al. (2001)
Zimbabwe	maize	CERES crop model	-14; -12	Two doubled CO2 climate scenarios	Smith et al. (1996)
Zimbabwe	maize	CERES crop model	-17	HadCM2 2040 - 2069 downscaled to 10 min of arc by interpolation	Jones and Thornton (2003)
Africa	maize, millet	Various methods	-98 to +16 -79 to -14	Range is across sites and climatic scenarios	Reilly and Schimmelpfennig (1999)
Africa	cereals	Yield transfer functions	-10 to +3	Range is across sites and climate scenarios. Includes adaption	Parry et al. (1999)
Africa	maize	Yield transfer functions	Falls by as much as 30%	Similar methodology to Parry et al. (1999)	Parry et al. (2004)

Source: IPCC (2001b, Table 5-4); reproduced in Challinor et al. (2007)

Table 1.1.2: Change in annual crop revenue by region (USD billions/yr)

AEZ	PCM	CCC
North Africa	-4%	-7%
West Africa	-17.5	-32%
Central Africa	-28%	-79%
East Africa	-11%	-12%
Southern Africa	-12%	-17%
Total	-14%	-30%

Source: Kurukulasuriya and Mendelsohn (2008)

For Mauritius - A rise in temperature in the period January, February and March

- Current mean: 25.5

	Projection	1 C rise	Rs23400/acre
			=10% fall in annual revenue

A rise in temperature in the period July, August, and September

- Current mean: 20.1

	Projection	1 c rise	Rs10800/acre
			4.6% fall in revenue

A fall in precipitation in Winter (August-October)

- Current mean=115mm
- Projection =-1mm monthly
- Impact:- Rs280/acre

A rise in precipitation in summer

- Current mean: 316mm
- Projected: 1mm
- Impact: Rs112/acre

Careful with estimates

- Treatment of price – constant
- No adjustment costs are accounted
- Preliminary analysis with limited survey data

- Research avenue:
- more detail assessment of the impacts of climate change on agriculture