Impacts of Climate Change on Agriculture and Adaptation Strategies: Malaysia Experiences

Mohamad Zabawi bin Abdul Ghani

Outline

- Introduction
- Climate Change and Agricultural
- Types of impacts on agricultural production
- Climate and rice
- Adaptation measures
- Conclusion

2

Introduction

- Agriculture is the major land use across the globe,contributed to a major economic, sosial,cultural activity and ecosystems
- Highly sensitive to climate variation which causes variability in production
- Climate change will exact a major consequence on food availability and security

3

Climate and agriculture

- Governing factors
  - Temperature, radiation, CO_2
- Limiting Factors
  - Water, Nutrients
- Reducing Factors
  - Pest & diseases

4

1. Temperature

- can have both positive and negative effects on crop yields
- Generally temperature increases have found to reduced yields and quality of many crops, most importantly cereal and feed grains.
- Temperature increases lead to higher respiration rates, shorter periods of seed formation, lower biomass production, smaller and lighter grains and therefore lower crop yields and perhaps lower grain quality such as protein levels.

2. Rainfall

- CC will modify rainfall, evaporation, runoff and soil moisture storage
- Increases in precipitation (total, timing and variability) may benefit semi-arid and other water-short areas by increasing soil moisture, but could aggravate problems in regions with excess water, while a reduction in rainfall could have the opposite effects

- The occurrence of moisture stress during flowering, pollination and grain-filling is harmful to most crops such as maize, soybeans, wheat and rice
- Moisture stress mainly cause by increased evaporation from the soil and accelerated transpiration

3. Climatic variability and extreme events

- CC also change the variability of climate, particularly in the frequency of extremes weather events such as drought, flood, storm and heat waves
- The changes will exact a major consequence on food availability and security
- Certain varieties of crops are grown near their limits of maximum temperature tolerance, such as rice in Southern Asia

- The occurrence of heat spells can be particularly detrimental
- Frequent droughts not only reduce water supplies but also increase the amount of water needed for crop growth in particular to fulfill the evaporative demand
- With the potential change in extreme events, the impact of waterlodging (flood), high temperatures and water deficit (drought) on the productivity of crops seem to also be increased in the future.

Types of impacts on agricultural production

Crops and forages

Item subject To impact:	Temp	Rainfall	CO_2	Extreme Events	Sea Level
Plant Size – yield	X	X	X	X	
Water requirement	X		X		

10

Types of impacts on agricultural production

Soils

Item subject To impact:	Temp	Rainfall	CO_2	Extreme Events	Sea Level
Soil Moisture	X	X		X	
Soil fertility	X	X			

11

Types of impacts on agricultural production

Irrigation and water supply

Item subject To impact:	Temp	Rainfall	CO_2	Extreme Events	Sea Level
Quantity	X	X		X	
Seasonality of supply	X				
Non agricultural competition	X	X		X	

12

Types of impacts on agricultural production

Others

Item subject To impact:	Temp	Rainfall	CO_2	Extreme Events	Sea Level
Low lying land inundation				X	X
Weed competition	X	X	X		
Insects, fungus, and diseases	X	X			

13

Climate change and rice

14

Rice – Current situation

- Consumption= 2.4 mill. ton/yr. Currently imports 30% (800,000 tonnes)
- Current SSL ~75%, aiming at 90% by 2010
- Target Yield →10 ton/ha
- Guranteed Minimum Price (GMP) RM550→RM650/ha
- Additional Fertilizer → RM140/ha
- Certified Seeds – 2009

15

Rice

- An increase 1°C daily ave. may result in a 10% yield reduction
- High night T°may cause reduction in CHO reserves and lead to an increase in empty grain

16

Climatic requirements for rice cultivation

Climatic Characteristics	No Stress	Slight Stress	Moderate Stress	Severe Stress	Very Severe Stress
Mean daily air Temperature (o C)	28-25	24-22 29-30	21-20 31-32	19-18 33-34	<18 >34
Mean daily maximum air temp. (o C)	34-29	28-27 >34	26-24	23-22	<22
Mean daily minimum air temp. (o C)	>20	20-19	18-17	16-17	<16
Mean annual Rainfall (mm)	>2000	2000-1750	1749-1500	1499-1250	<1250

17

Growing conditions in Malaysia

- Average temperature is about 26oC
- Growth temperature in Malaysia already in the optimum
- Temperature above 25oC may cause decline in individual grain
- Grain yield may decline between 9 – 10% for each 1oC increase in temperature
- Detailed studies on growth and production responses to climate change are not available

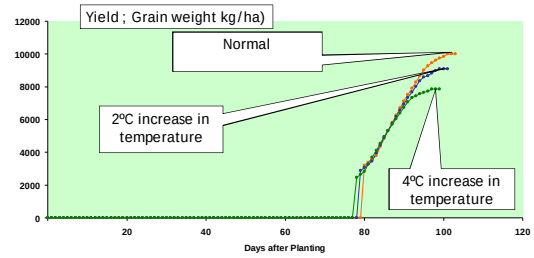
Rice: Vulnerabilities to Climate Change & Extreme weather

Simulation study

- Assessments – using local climatic data (MADA)
- DSSAT Ver. 4.5
- Developing genotype coefficient
- IRRI variety – closely related MR 219
- Current temperature, 2oC and 4oC increase in temperature
  > flood and drought during planting

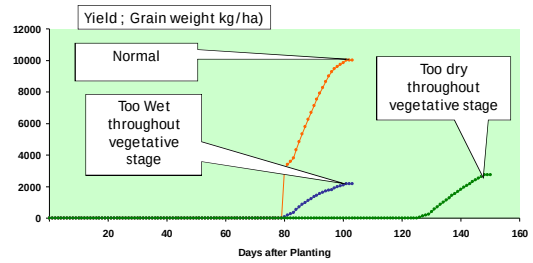
19

Vulnerability; Temperature increase



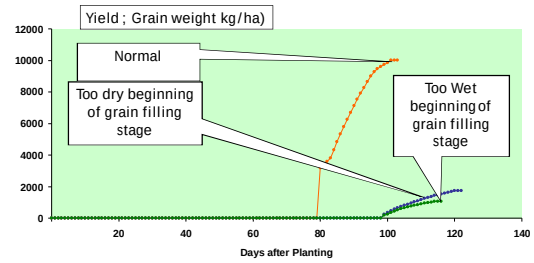
20

Vulnerability; Vegetative stage



21

Vulnerability; Reproductive stage (Grain filling period)

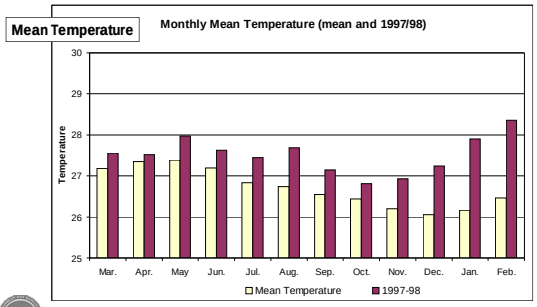


22

Observed Changes in Productivity Of Rice Due to Climatic Variability In the Past

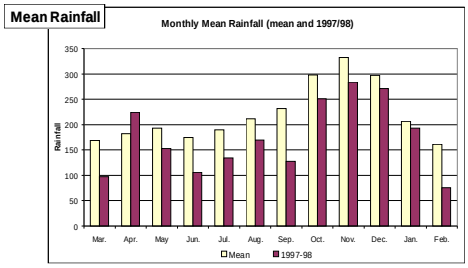
23

The Malaysian climate: mean and El Nino of 1997/98



24

The Malaysian climate: mean and El Nino of 1997/98



25

Estimated loss of rice yield due to climatic variability: Malaysia 1980 - 1999

Item	Mean yield loss (%)
Mean yield loss for Non El Nino Years (NEY)	5.65
Mean yield loss for El Nino Years (NEY)	6.8
Net El Nino Effects	-1.15

26

Estimated Net loss of rice due to El Nino

Year	Estimated % net loss	Production ('000 tonnes)	Estimated production without El Nino ('000 tonnes)	Difference ('000 tonnes)	Price (RM/ton)	Loss (RM mill)
1981	4.0	1,748.77	1,818.72	69.95	511.85	35.80
1980	1.8	1,884.98	1,918.91	33.92	660.00	22.38
1998	5.66	1,994.24	2,107.11	112.87	1,413.85	159.58
					Total net loss	217.76

27

Adaptation measures

28

Research and Development

- Short maturating variety
  - Latest variety : 100 days (MR 211)
  - Less risky to water stress
- Development of drought resistant varieties
  - gene bank (>12000 accessions) → drought tolerant varieties
  - Aerobic rice production
  - develop high yielding varieties to suit different rice environments, inc. drought prone areas
- Water saving technologies
  - optimize water use efficiency
  - dry rotation and dry seeding
  - improved irrigation techniques
  - reduce water loss and wastage
- Precision farming; efficient utilization of production inputs including water
- Controlled production system

29

Water Resource Management

What's been done:

- Continued improvement of irrigation infrastructures
  - water recycling, effricient / timely distribution of water, conservation strategy
- Enhanced management support services
  - storage system, delivery, distribution etc.
- Management & control system
  - irrigation schedule
  - Telemetry System
- indegeneous water storage system (sugarcane plantation)
  - man-make lakes as storage + mobile sprinkler system
  - cheap and easy to maintain

30

31

32

Conclusion: Agriculture in general

- Yield potential is likely to decline due to even small rises in global temperature,
- Greater frequency of droughts and floods will affect local production
- S&T must spearhead agricultural production in the next 30 years at a pace faster than the Green Revolution's during the past three decades." – FAO Director General 2007

33

Conclusion: Agriculture in general

- CC adaptation is needed in all agro-ecosystems (crops livestock and grasslands).
- Adaptation may involve selection of alternative crops, revised planting dates, improved irrigation and modified chemical inputs
- Developing adaptation options for agriculture that do not exacerbate climate and other environmental changes is crucial.

34

Conclusion: Rice

- Drought-resistant varieties as well as crop varieties that can survive severe flooding.
- the need to generate crop varieties with improved water-use efficiency suited to production with reduced water inputs

35

Terima Kasih (Thank you)

36