THE CHALLENGES OF CLIMATE CHANGE AND VARIABILITY TO CROPS' YIELD IN SEMI-ARID – KENYA

By

MARY M GITHINJI
Kenya Meteorological Dept, Nairobi.



‘Extract’ *from Msc Thesis(1998-1999)*

- **INFLUENCE OF WEATHER ON BEANS’ YIELD**: A case study at Katumani, Machakos-Kenya.



PRESENTATION OUTLINE

- Introduction
  - Aim/Objective
  - Location of study area
- Climate and Rainfall Distribution
- Data source & types
- Data Analysis
- Water balance analysis
- Summary & Conclusion*
- Further work

Introduction

BEANS

- One of the major food-crops in Kenya.
- A source of protein in the diet of many Kenyans.
- The study area has been known as a 'Problem District' in terms of:-
  - harsh climatic conditions
  -overstocking
  -soil erosion
  -overpopulation (considering the limited resources)

and eventually became '*a food insecurity area*'



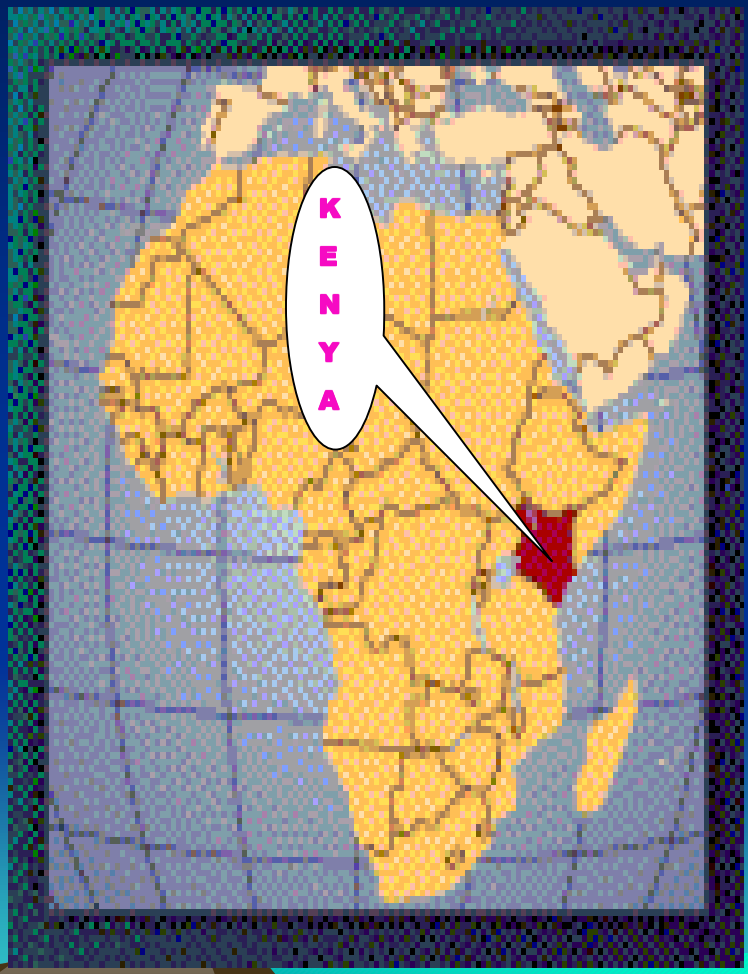
AIM/OBJECTIVE

- To get a relationship between bean yields & meteorological parameters ….. and to come up with a Yield Forecasting Model based on the relations for this region.

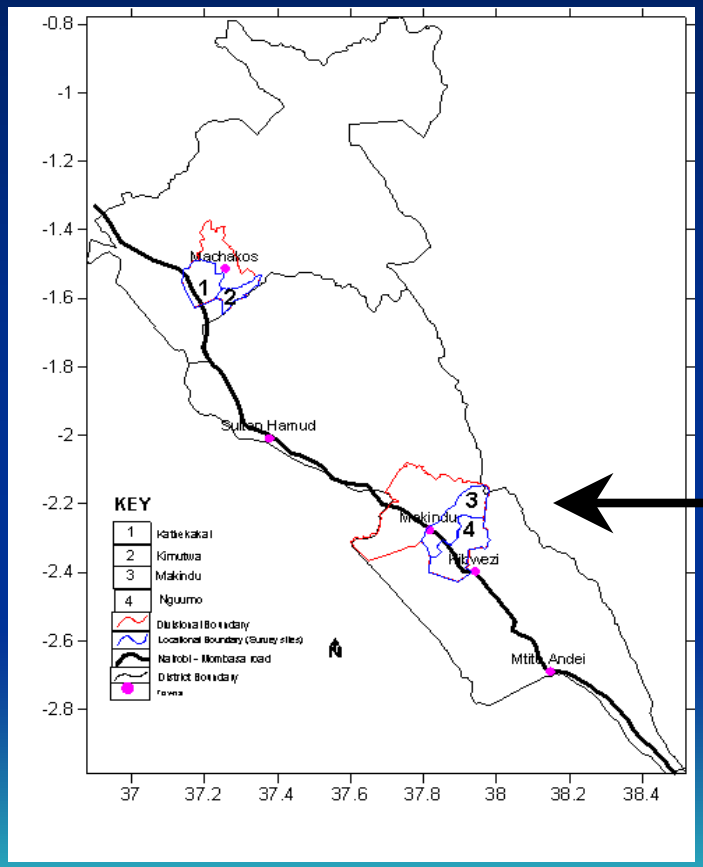


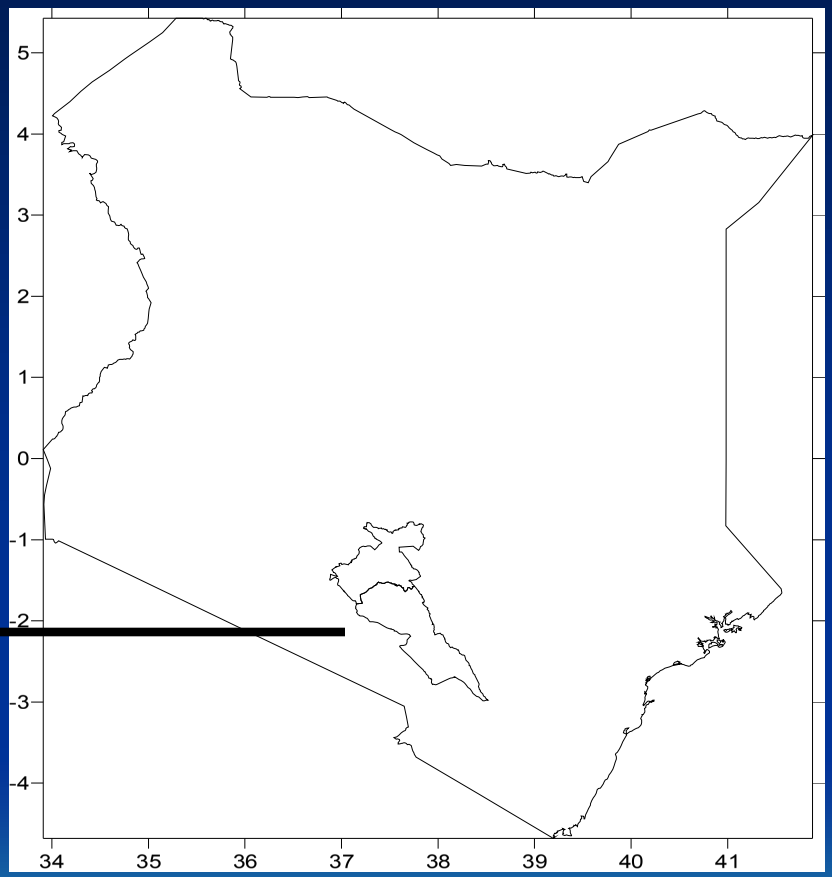
Location of study area

- Latitude 10 35’S
- Longitude 37014’E
- Altitude 1575m above sea level



STUDY AREA


Machakos
1
2
Sultan Hamud
3
4
Makindu
Nguumo
Mtito Andei
KEY
1 Katiekakai
2 Kimutwa
3 Makindu
4 Nguumo
Divisional Boundary
Locational Boundary (Survey sites)
Nairobi - Mombasa road
District Boundary
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
37
37.2
37.4
37.6
37.8
38
38.2
38.4

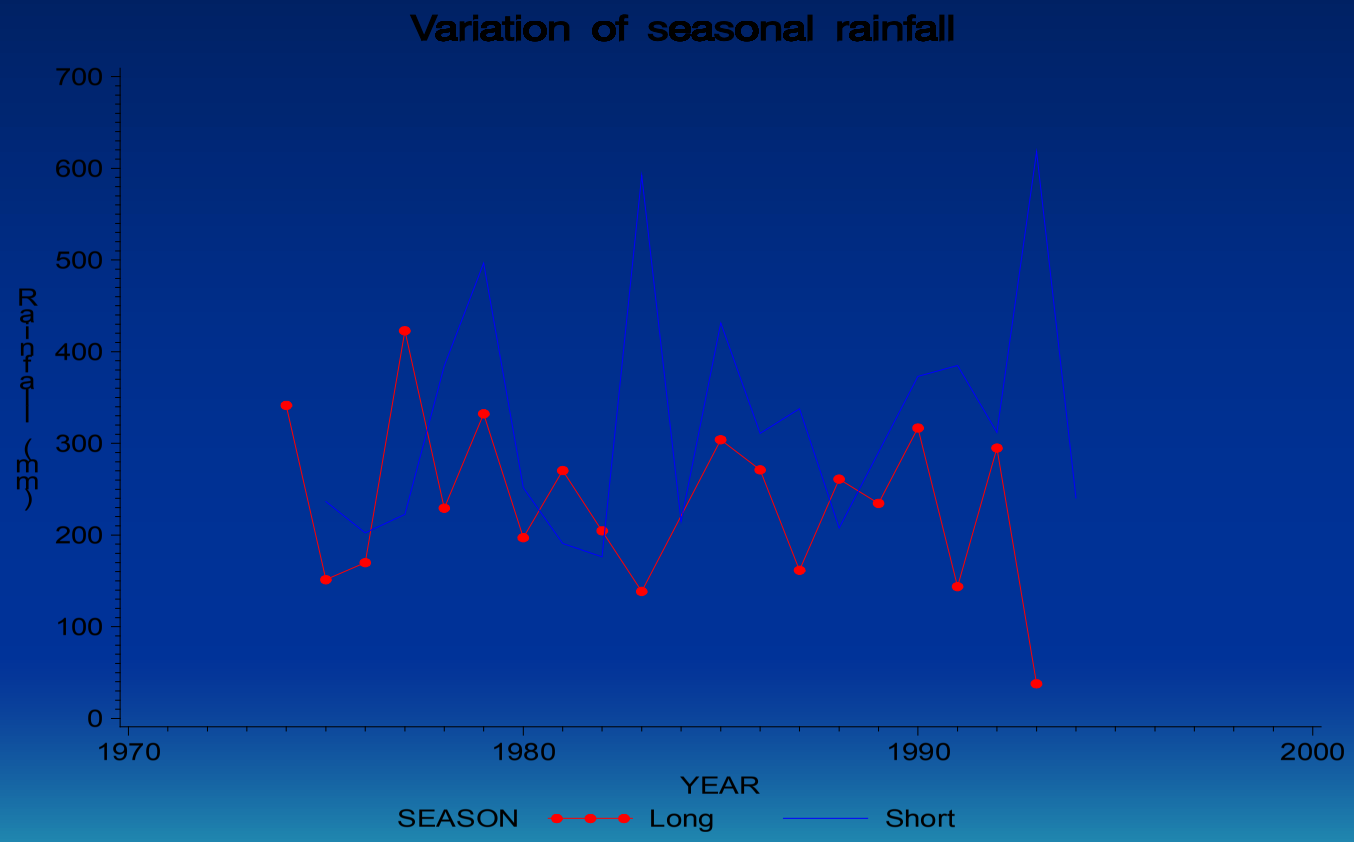

5
4
3
2
1
0
-1
-2
-3
-4
34
35
36
37
38
39
40
41

Climate and Rainfall Distribution

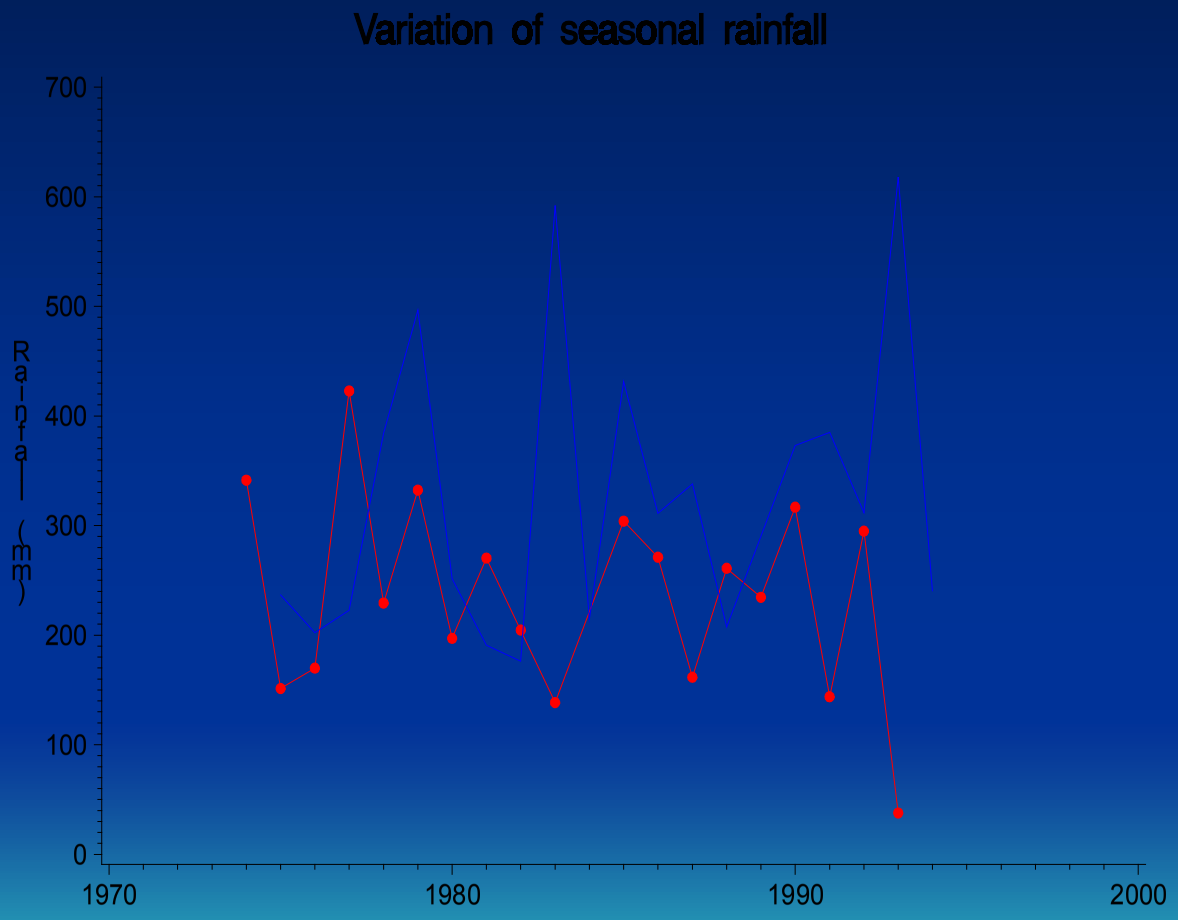
- A semi-arid area with bimodal rainfall pattern.
- Colloquially these are termed as the “long rains” and the “short rains”,
  - ‘Long rains’ - March, April, May, June*,
  - ‘Short rains’ - October, November, December,
- Annual total rainfall is approximately 800-1000mm.
- Poor distribution of rainfall: Both spatial & temporal
- Temperatures are normally between 20-25^{0}C. Mean temp approx. 19.3^{0}C July and August- coldest months while October and March are the warmest prior to the rains.



Seasonal variation of rainfall for Katumani within the period 1984-2003.



Seasonal variation of yield for Katumani within the period 1984-2003.



GROWING SEASONS

- Two growing seasons related to rainfall distribution:

- ‘long’ March-May (MAM) and
- ‘short’ October-December (OND) seasons

*Rainfall most determinant factor; then temperature in the tropics where rainfed agriculture is practised.



Sources & Types of data

- Climate/Weather Data: Kenya Meteorological Department (KMD), Nairobi.

- Weather parameters considered:
  - Total rainfall (mm)
  - Total radiation (gm Ca/cm^2/day or Langleys)
  - Total evaporation (mm/day)
  - Average Relative Humidity (%)
  - Maximum, minimum & mean temperatures(^{0}C)



Yield Data

Source: Katumani Dry Research Centre (KDRC),
Kenya & Kenya Bureau of Statistics
Average Yield in Kg/ha

Period of study: 20 years (1984-2003)

Two seasons:

- Long rains' season – April, May,
- Short rains' season- October, November, December

Analysis

- Multiple Regression and Correlation Analysis- to determine the degree of the relationship between the weather variables and the yields for the respective periods of time.
- F- & t-tests



Statistical Regression model used

- $Y = a + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots + b_nX_n$.

where,

- Y= Yield
- b_i= i^{th} multiple regression coefficient of Y on X_i when other (n-1) variables are kept constant.
- X_i= externally independent variables
- i= 1,2,3,……,n
- a= constant.
- Yield as the independent variable while wx parameters as the independent variables.

*coefficient indices very small

Water balance analysis

- Water balance is more realistic than rainfall in that it gives an estimate of the water estimate in the soil at any particular time of the year.
- The water balance calculates the volume of soil water (SW) in a specified depth of soil, normally the root zone.
- $Swi = Swi\text{-}1 + R - E - D - RO$ Eqn 1

Water balance cont'd

where,

SW -volume of soil water

inputs of rain (R), and

outputs of evapotranspiration (E),

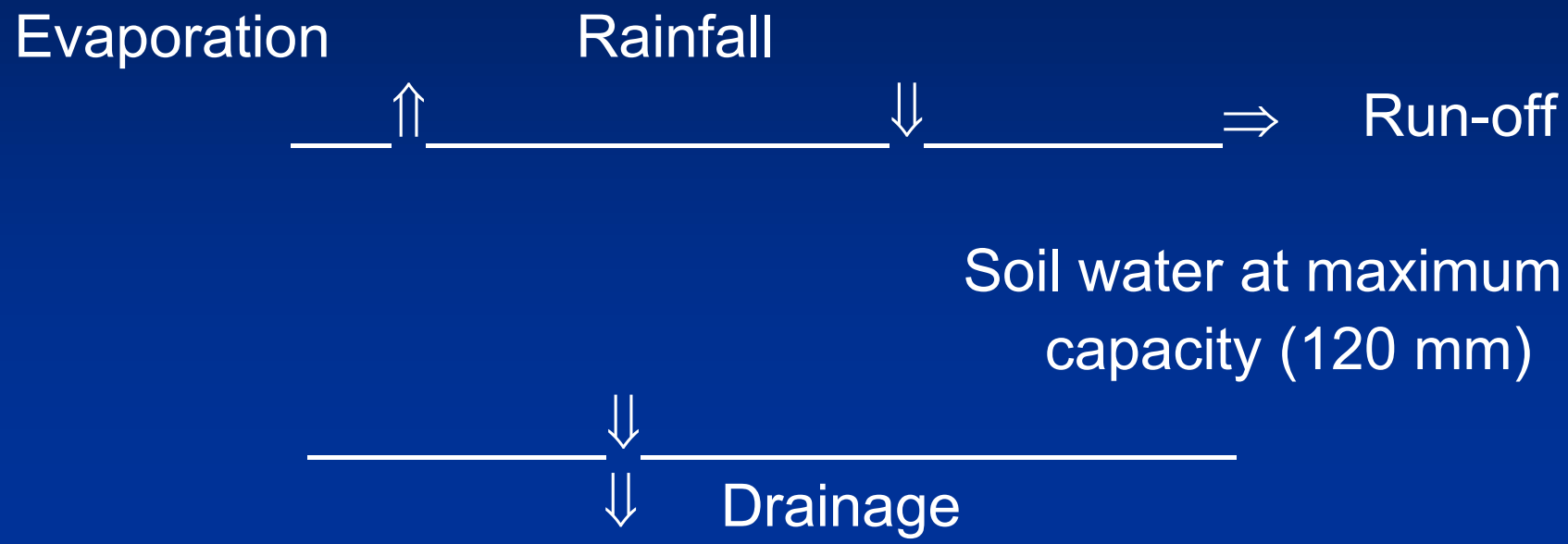
drainage (D) and run-off (RO):



Water balance cont'd

- The water holding capacity depends on the type of soil.
- It usually ranges from 60 mm/m for sandy soils to 260mm/m for clay soils.
- At Katumani, soils are sand-loam type, the water holding capacity is estimated as 100mm/m. Assuming rooting depth of 1.2m, the AWC at field capacity becomes 120mm i.e. 1.2m x 100mm/m = 120mm.

Simple water balance illustration.



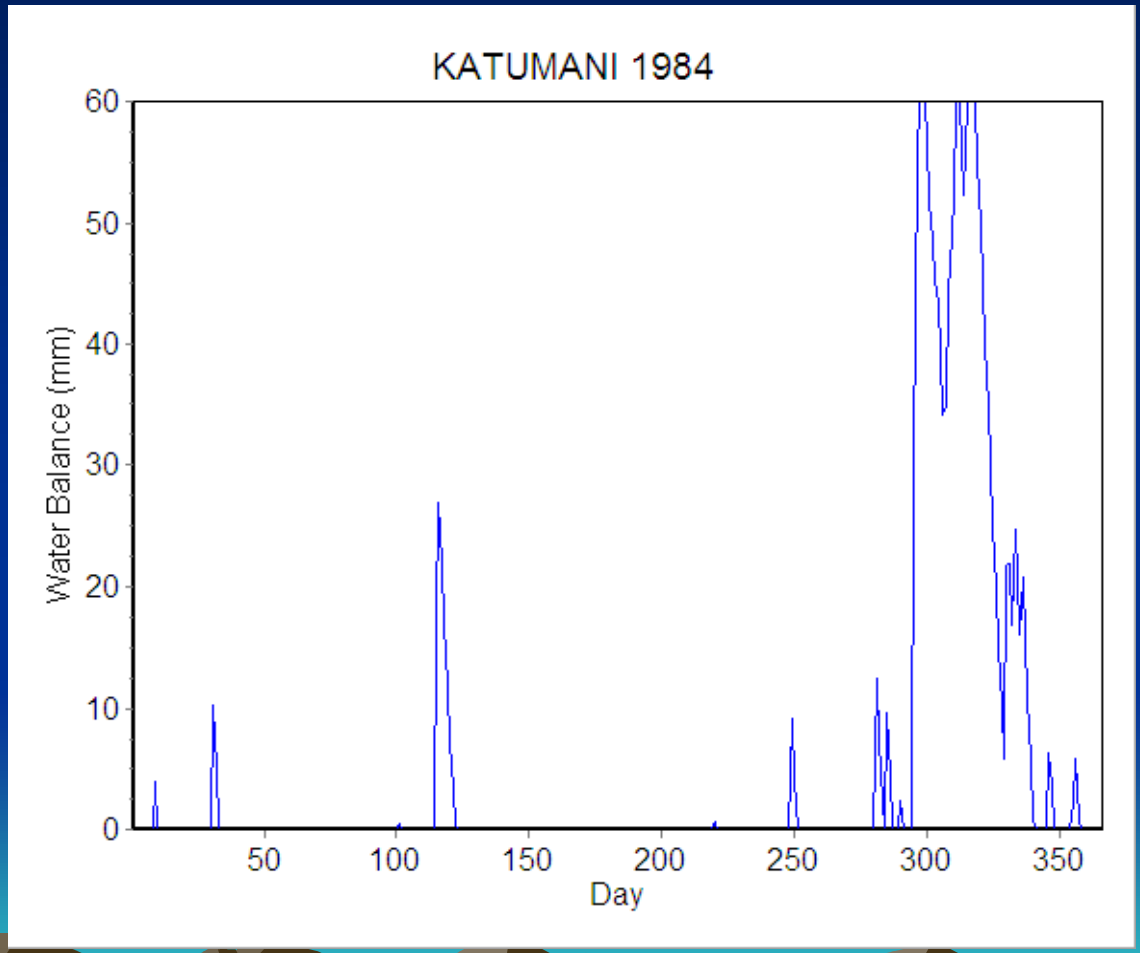
Water balance cont'd

Assumptions:

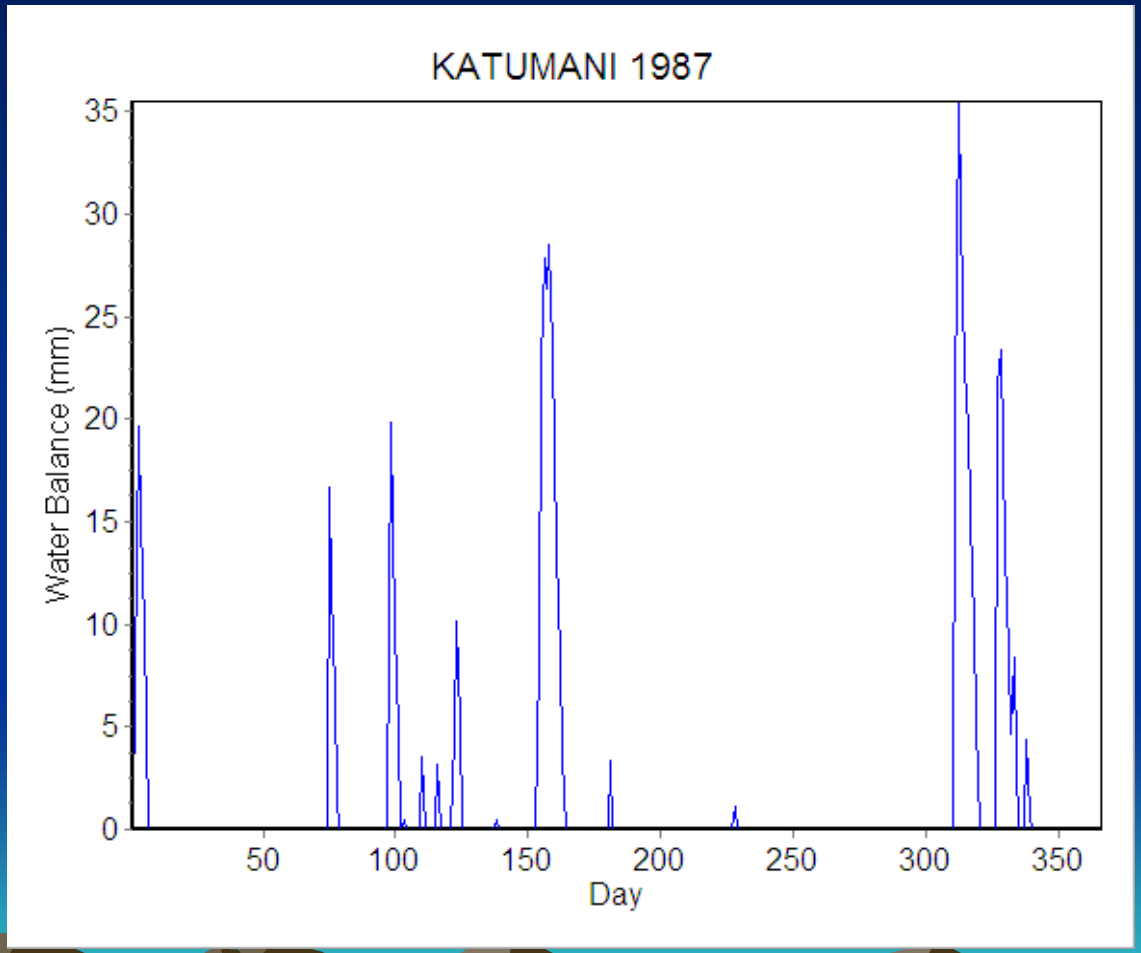
- Soil water content is zero at the start of the season.
- Run-off is zero.
- Rainfall is the input and evapotranspiration is the output.
- Excess water is assumed to be drainage if the soil water content reaches maximum.



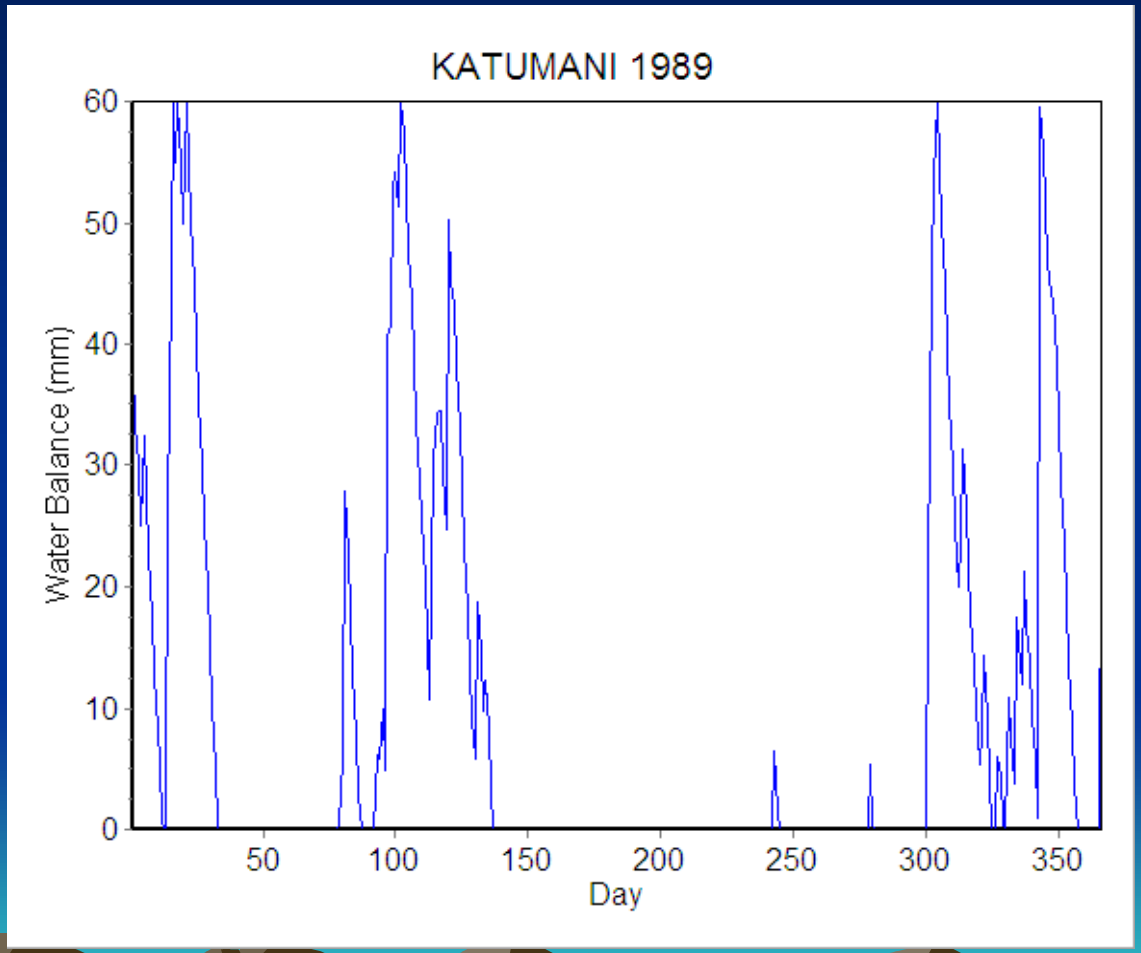
Water balance results



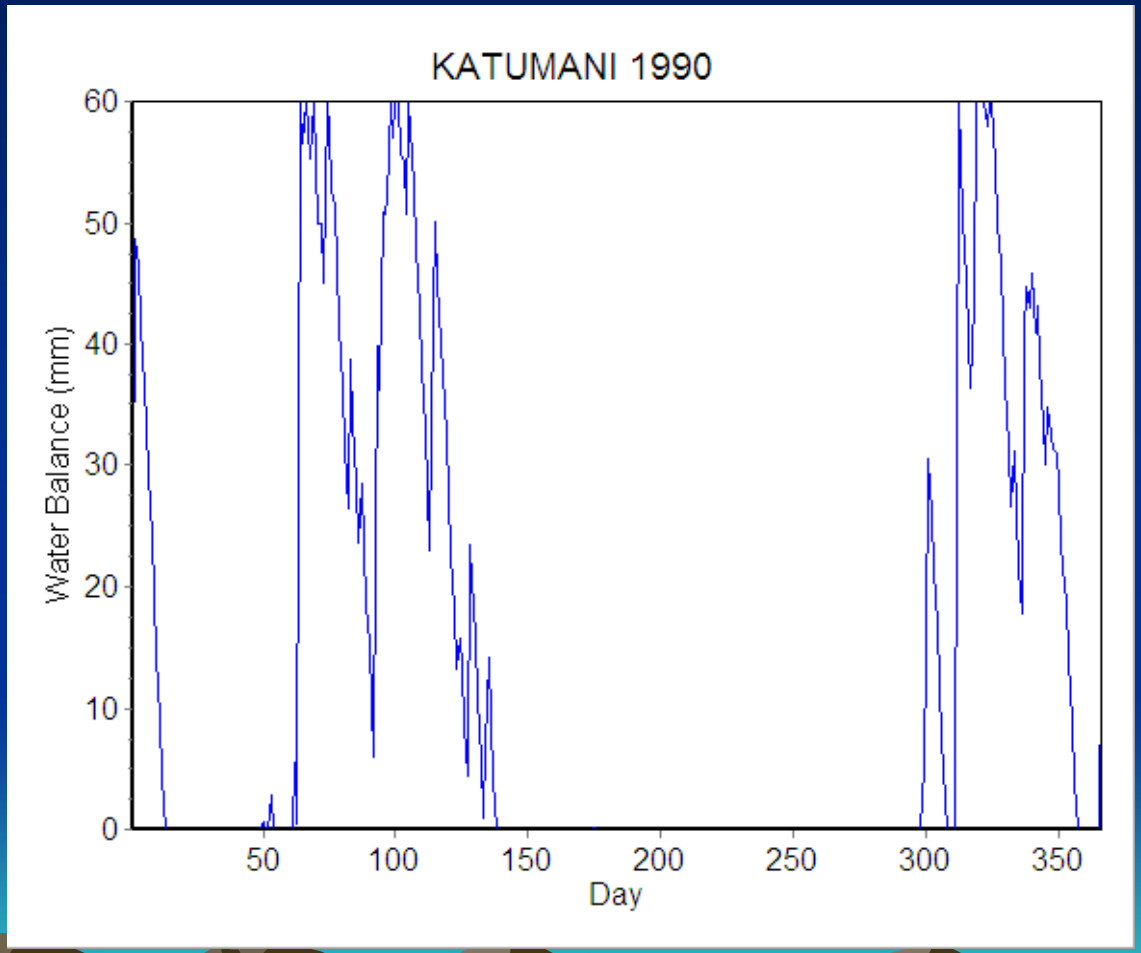
Results cont'd



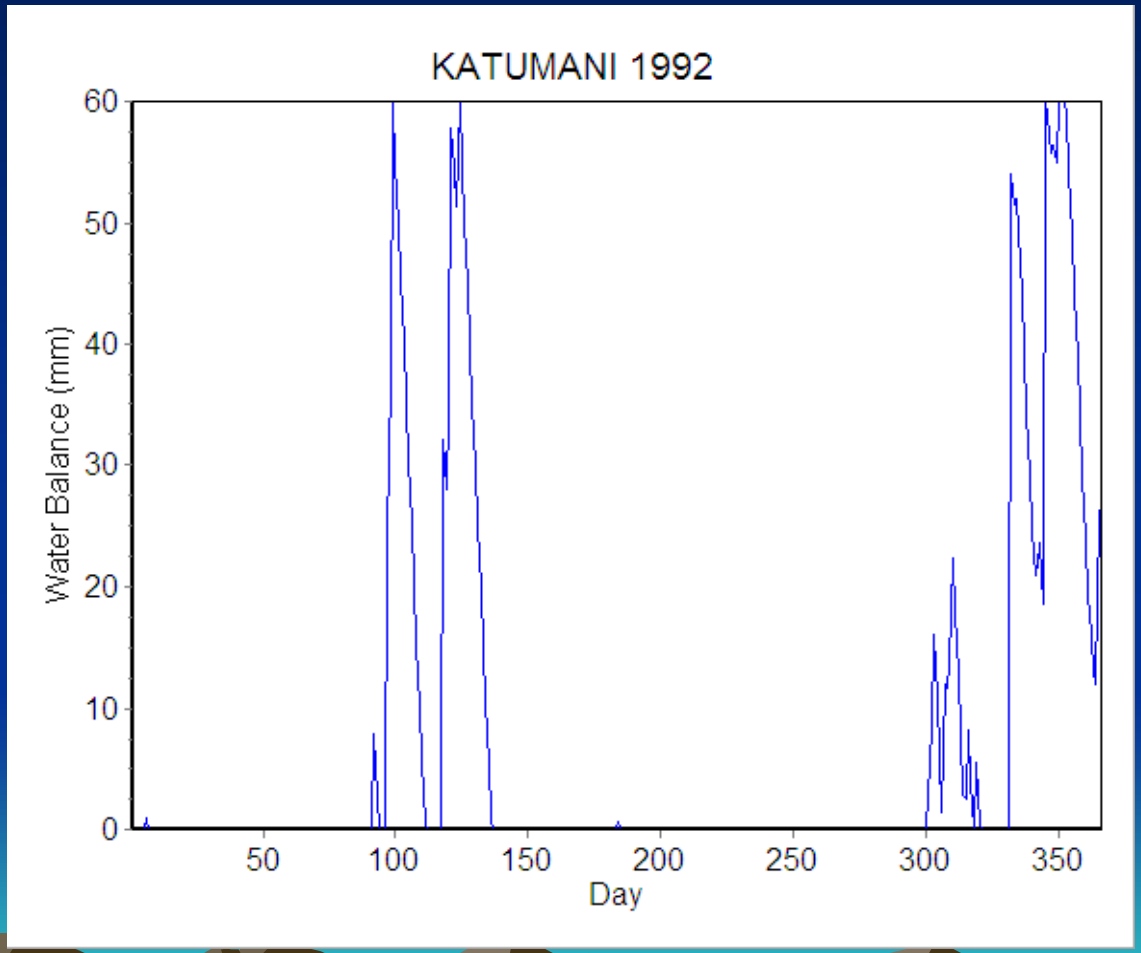
Results cont'd



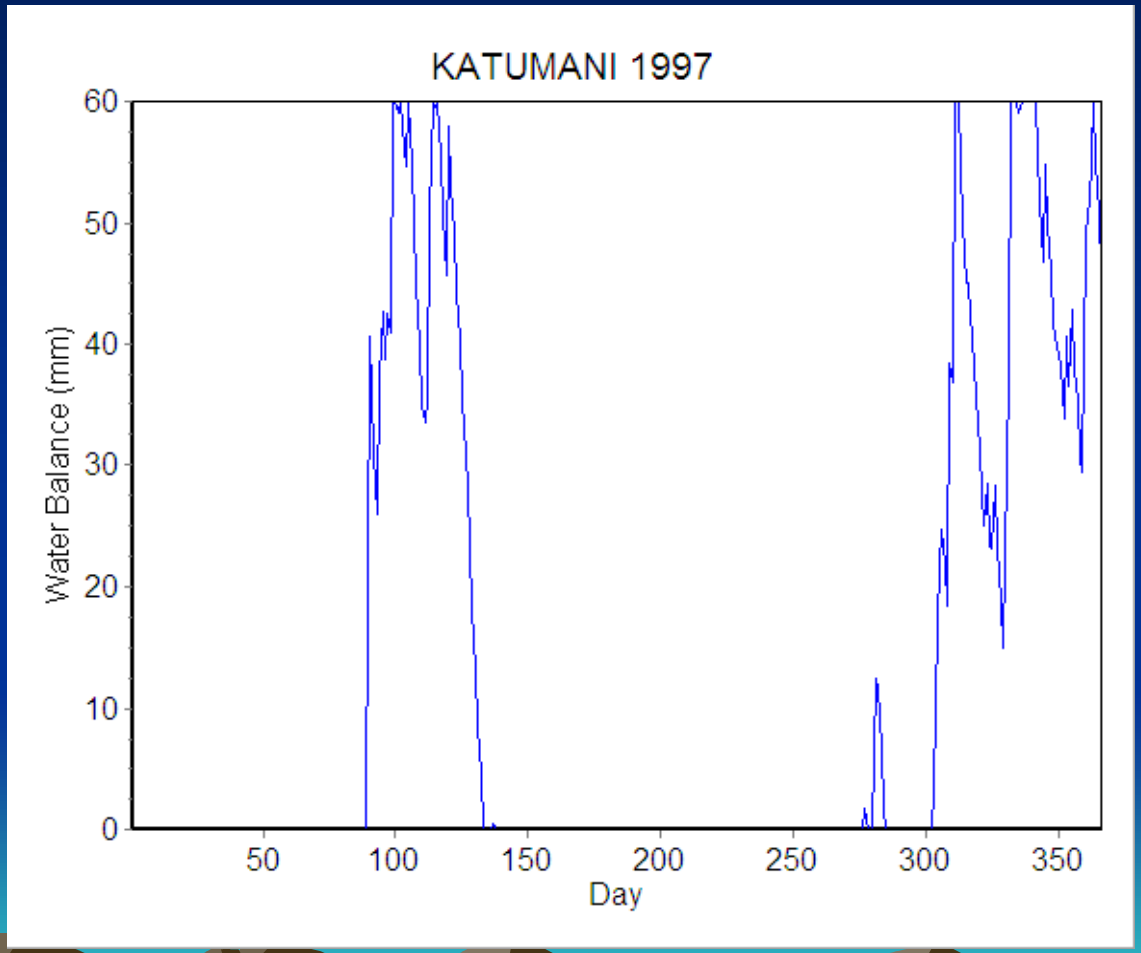
Results cont'd



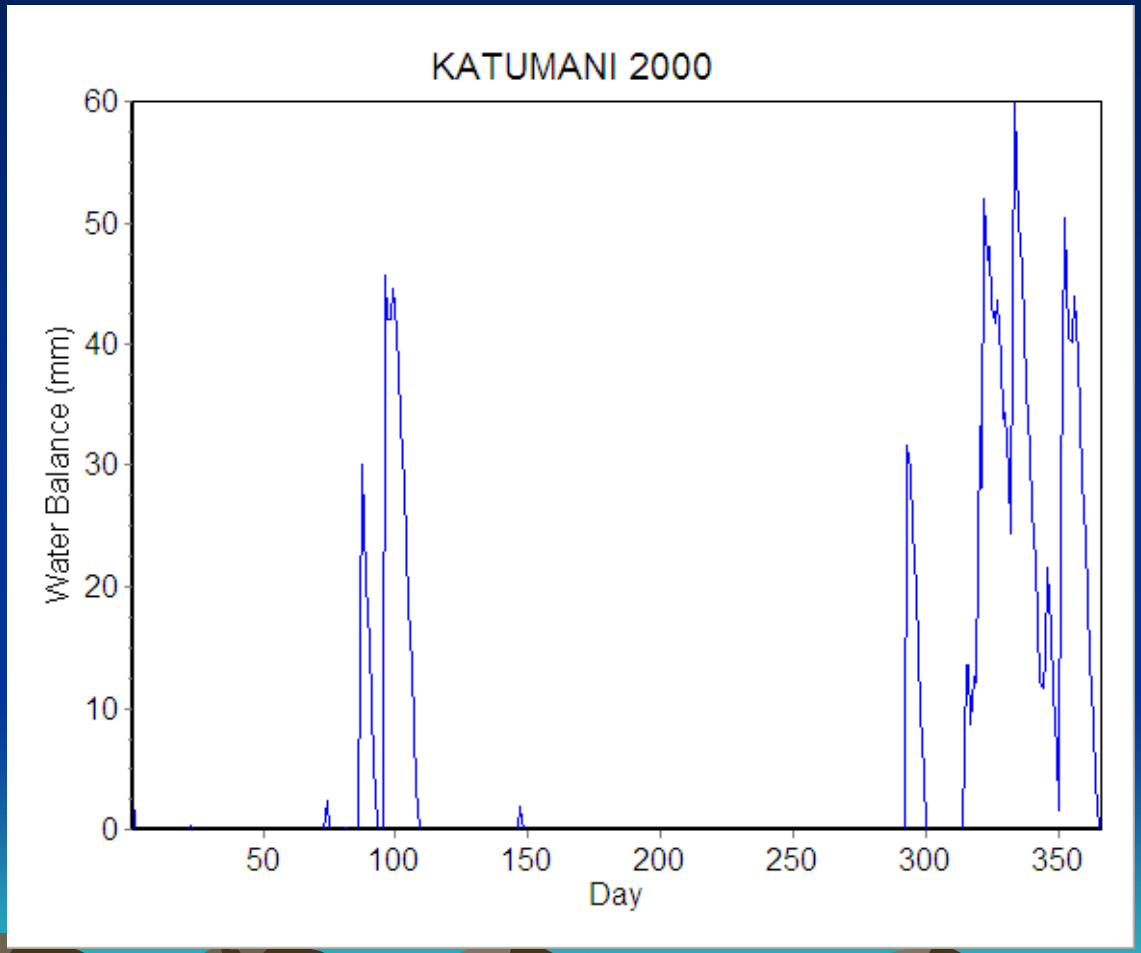
Results cont'd



Results cont'd



Results cont'd



Summary & Conclusion*

- Lack of relationships between weather variables and yields means that the objective of being able to forecast beans yields could not be achieved.
- Water balance during the various seasons was the most variable feature, and the one most likely to account for the high variation in yields.

Further work

- If this work is pursued further, more tangible results would be achieved and bean growing at Katumani-Kenya would be planned and projections in yield realised other than leaving it to nature to take its course.



E N D

THANK YOU FOR YOUR ATTENTION!

