MASSEY ENGINEERING
www.me.ac.nz

Massey University
COLLEGE OF SCIENCES

MEASUREMENT OF BED GRAIN AND AIR CONDITIONS DURING SUN DRYING OF RICE

Pyseth Meas, Tony Paterson, Don Cleland, John Bronlund, John Mawson, Allan Hardacre, Joe Rickman

Introduction

- Sun drying has been used since the beginning of human life to dry grains, plants and other agricultural products
- Still common practise throughout Asia
- No good experimental data available in the literature looking at the effects of different parameters and tempering treatments

Objectives of this paper

- To collect comprehensive sets of data covering both the driving forces for drying and the resulting drying in beds of rice put out in the sun for sun drying for validating a mathematical model of the drying process

Input parameters

- The drying rate in open sun depends on several factors such as;
- solar intensity, ambient air temperature and relative humidity (RH), wind velocity, the initial grain moisture content (MC), rice variety, bed depth, the type of drying pad, whether the bed is covered or shaded, and the intensity of stirring

Output parameters

- Bed moisture content
- Drying time
- Water activity or relative humidity through out the bed
- Temperature through out the bed

Rice

- Two local rice varieties (Phka Knhey and CAR11) were dried from about 22% to 14% moisture content in a set of sun drying experiments that was conducted from 8 am to 4 pm from December 10 to 25, 2004 in Cambodia.

Experimental plan

- Two rice varieties were dried (5 kg for each sample)
- On four drying pads (tarpaulin, nylon net, nylon net on a 7 cm husk layer and a mat made of sugar palm leaves)
- Two bed depths (2 and 3 cm)
- Two manual stirring methods (none and every hour)
- Two covering methods (none and covering combined with shading from 11 am to 2 pm).
- The experiment was designed as a full factorial with the drying pads as blocks.

Measurements made

- Solar intensity, wind speed, ambient air temperature and RH,
- Temperature and RH of the air in the bed layers about 0, 5, 10 and 15 mm from the top surface of the 2 cm bed and about 0, 8, 15 and 23 mm from the top surface of the 3 cm bed at 5 min intervals
- Only 2 of 16 beds were intensively monitored each day

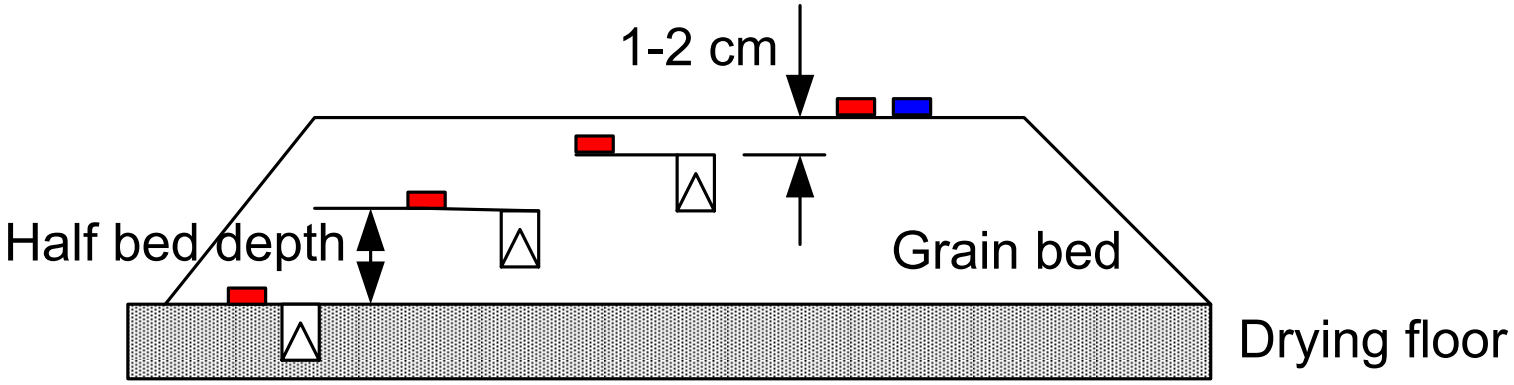
Measurements

- Solar intensity: A calibrated Li-200SB solarimeter or pyranometer was exposed horizontally to the sun.
- Wind speed: measured and recorded every hour using a wind speed indicator
- Ambient air temperature and RH were measured by I-buttons and Tinytag or Tinytalk loggers respectively

Measurements

- Bed temperature: U type thermistors
- RH (water activity) in the bed: Hycal square semi conductor sensors
- Frames or supports were made to hold all the sensors firmly at the pre-designated layers: namely the surface, top, middle and bottom of the beds.
- The outputs were recorded by a Squirrel 1200 series datalogger.

Placement of temp and RH sensors

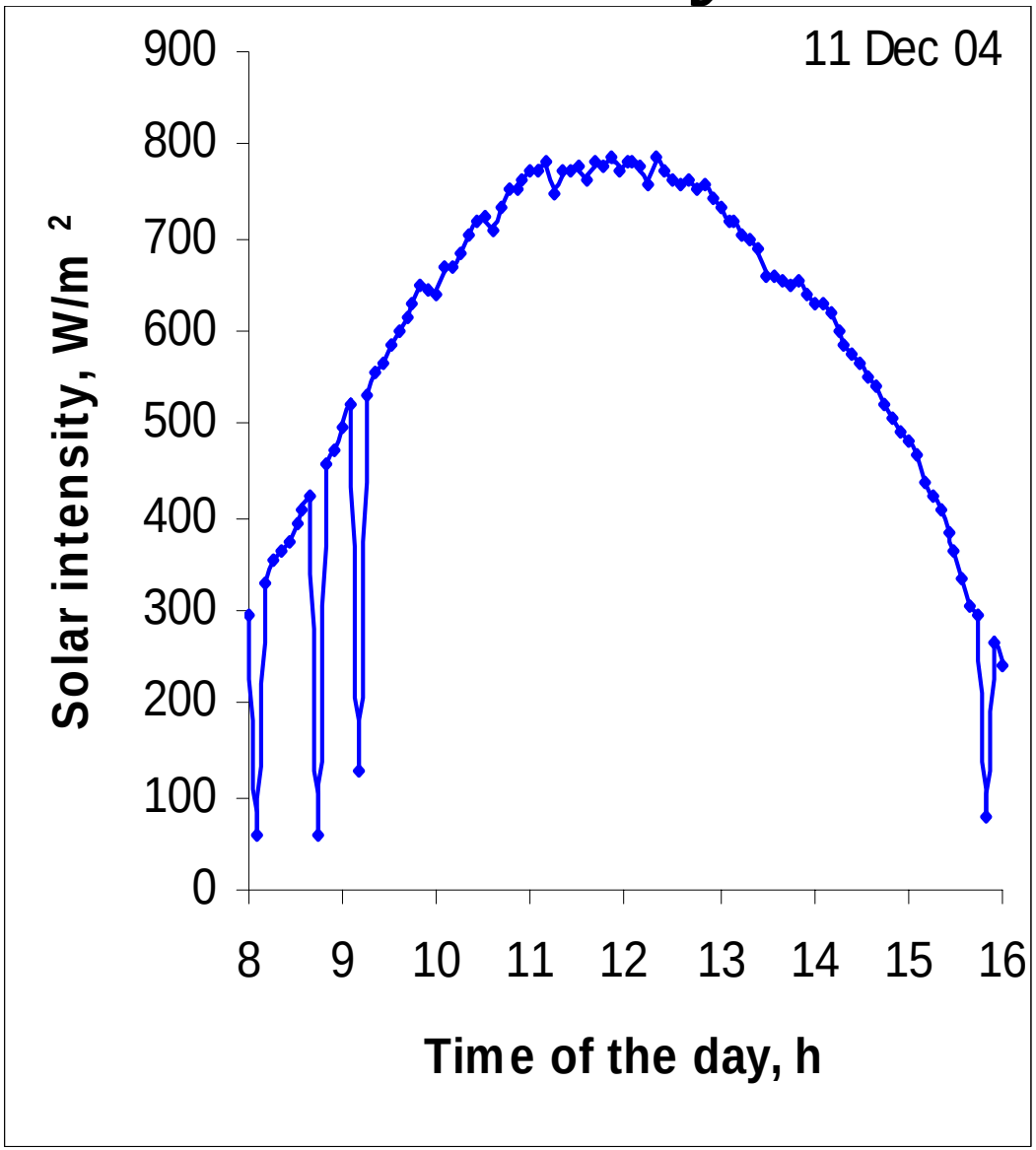


- Hobo RH data logger
- I Button temp data logger
- Tiny tag RH data logger

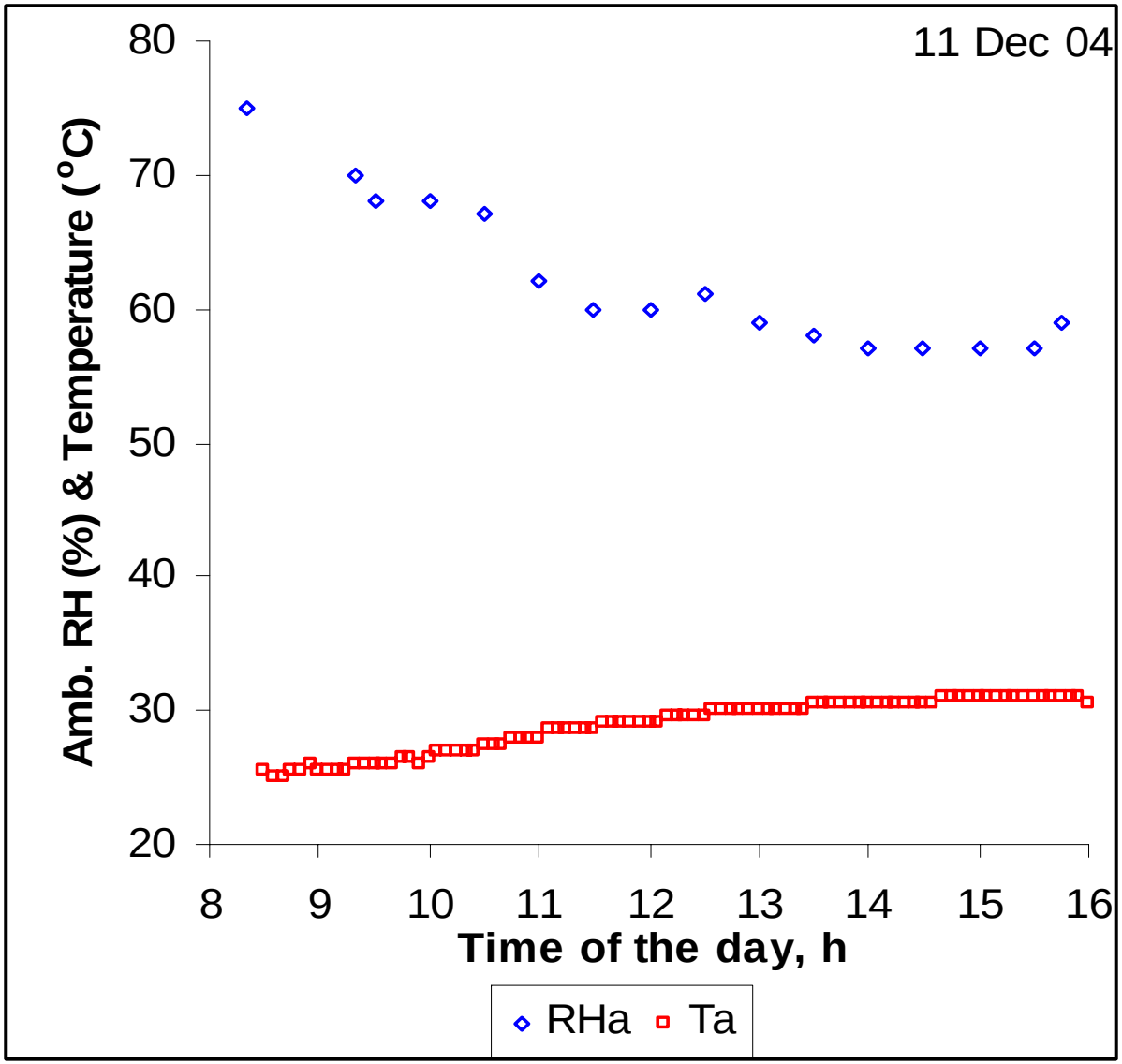
RH sensors

Hycal RH and temperature sensors

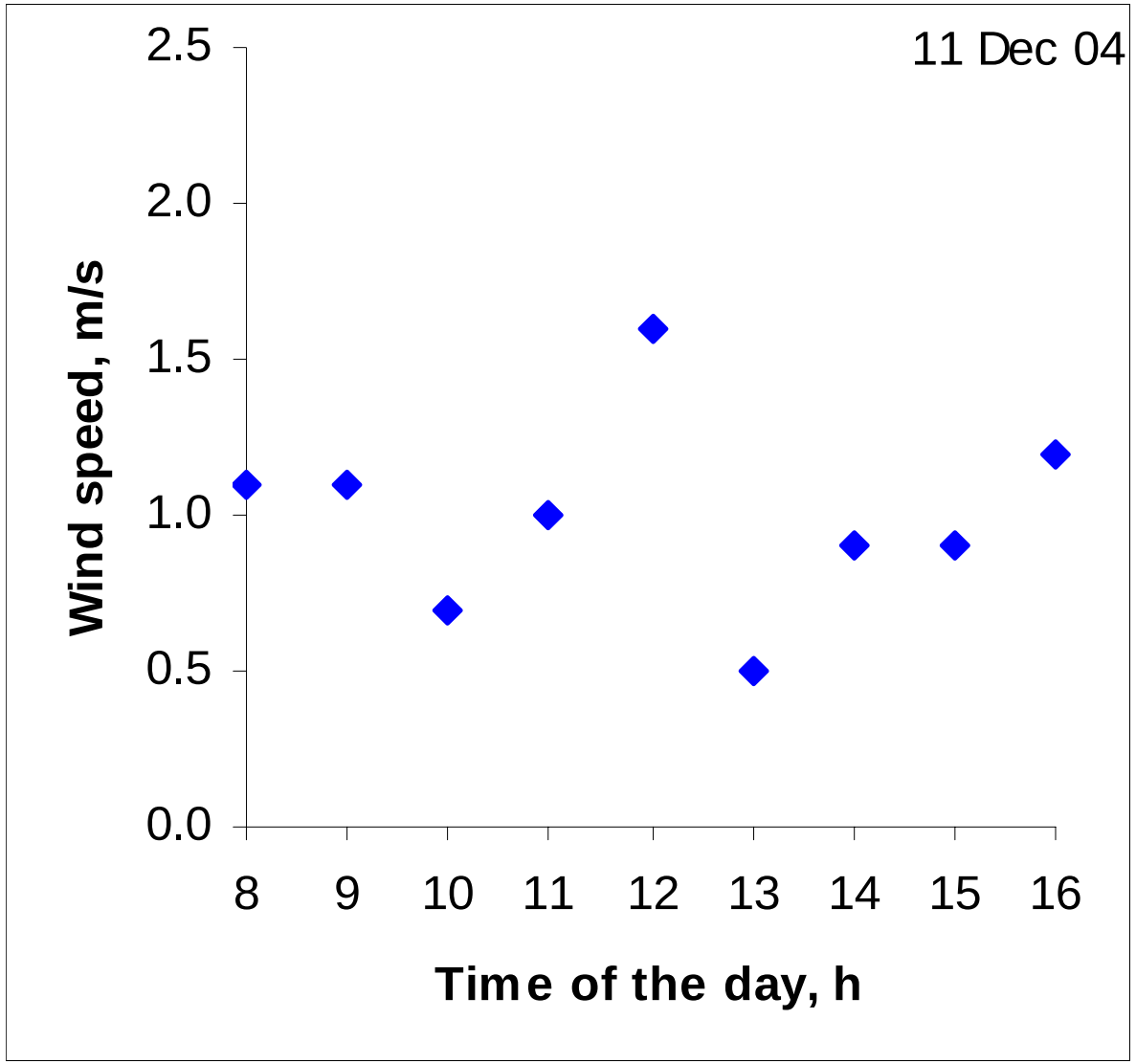
Solar Intensity



Ambient Air Conditions

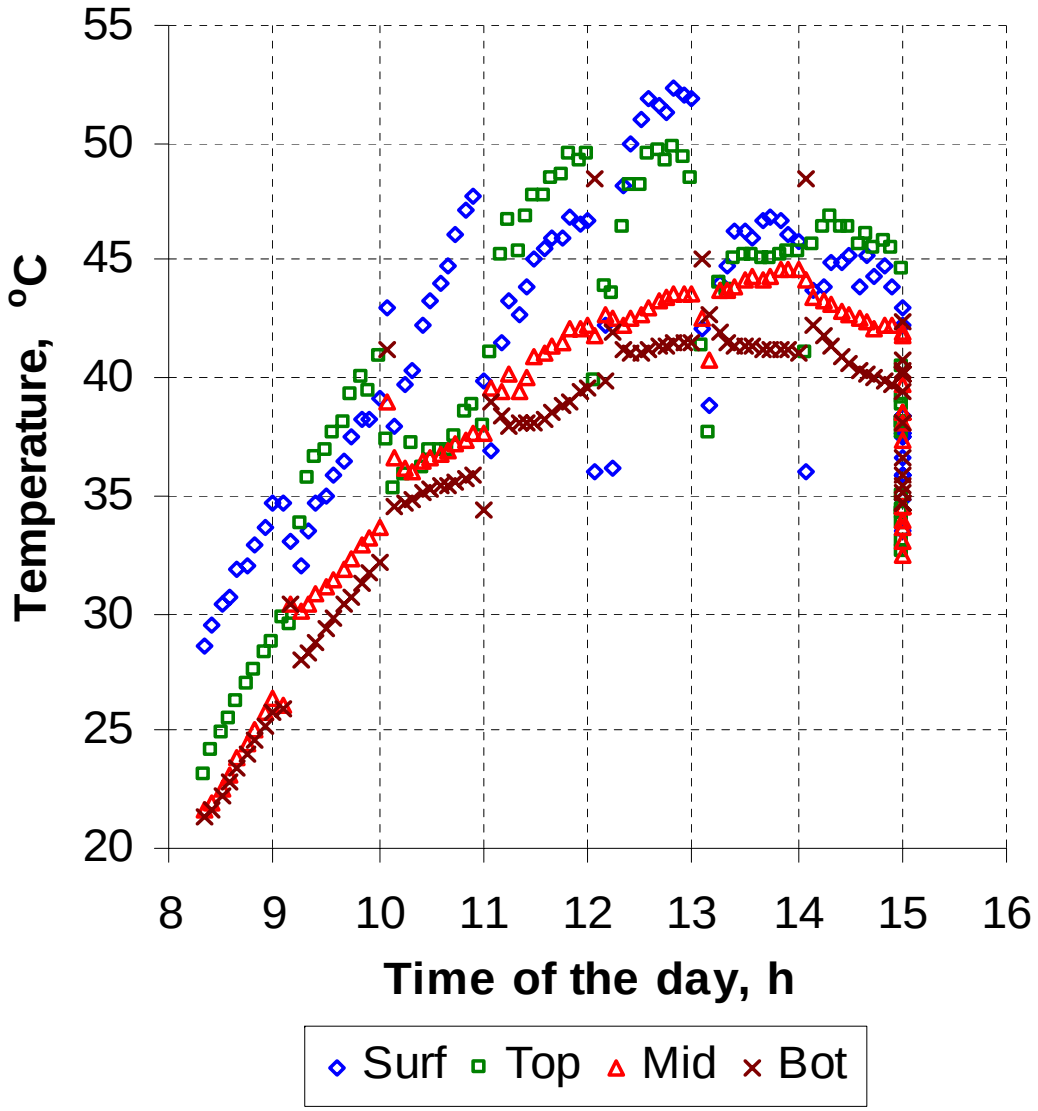


Wind speed



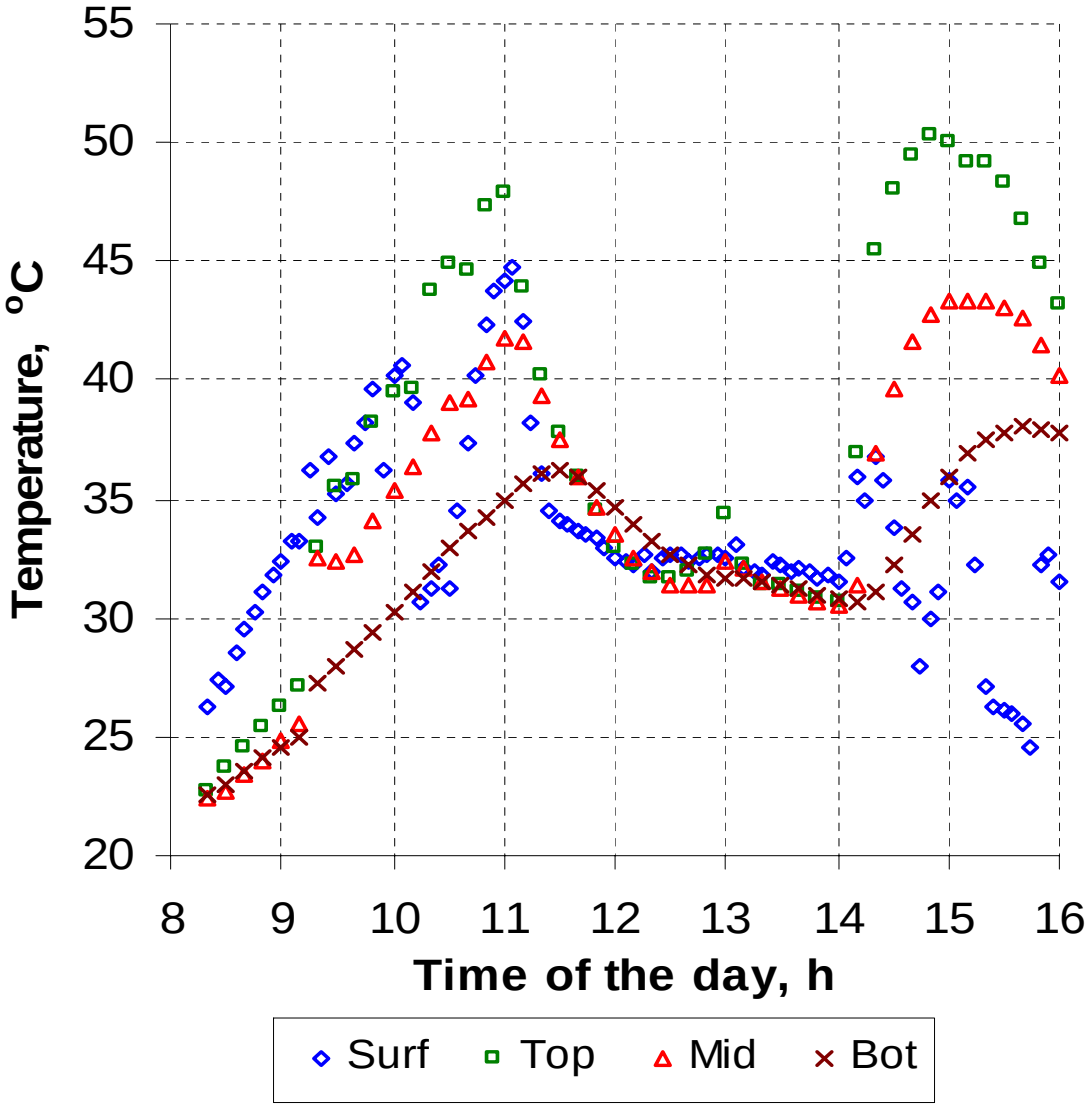
Bed temperature

CAR11, 2 cm, tarpaulin spread on polystyrene, stirring, no covering, Day One (Dec 11, 2004



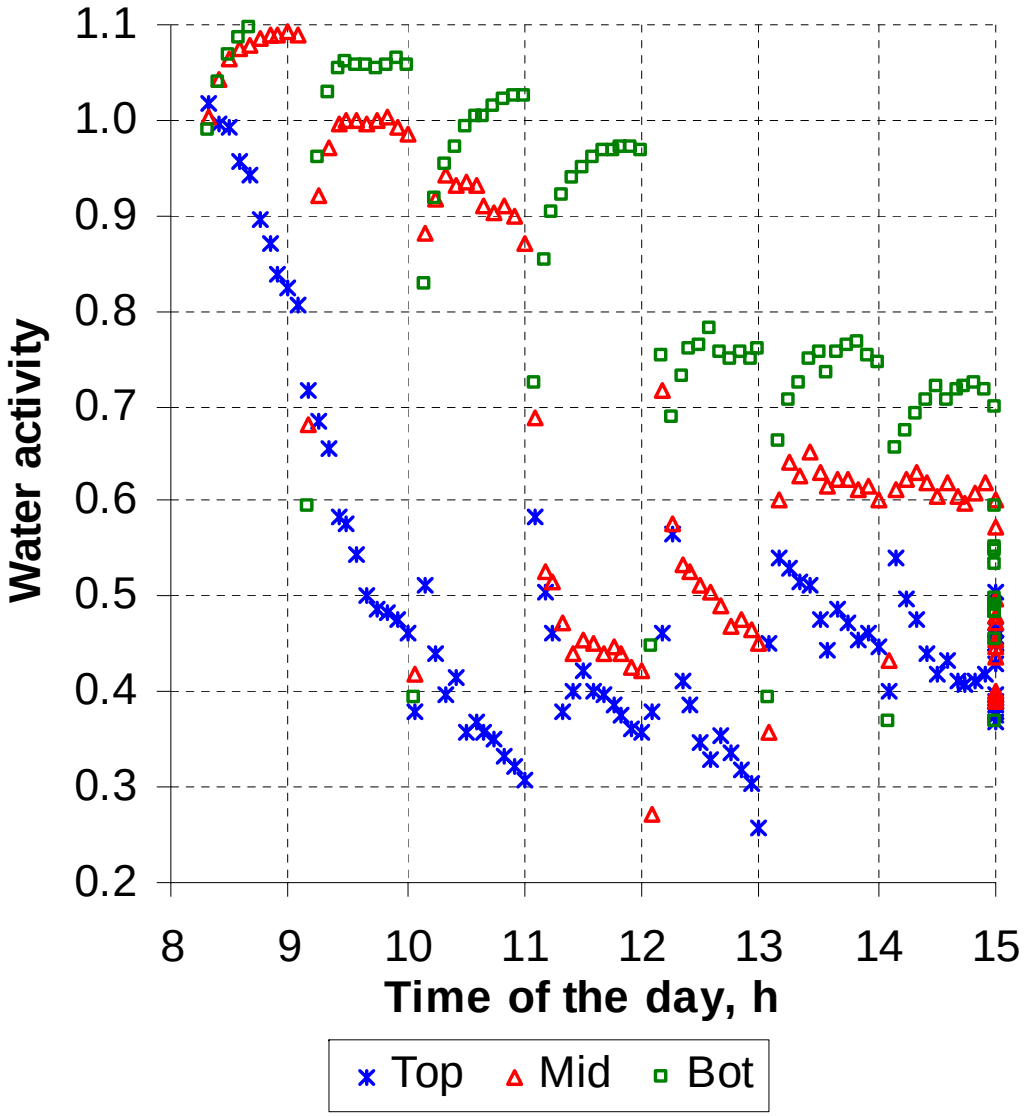
Bed temperature

CAR11, 3 cm, tarpaulin spread on polystyrene, no stirring, covering plus shading, Day One (Dec 11, 2004)



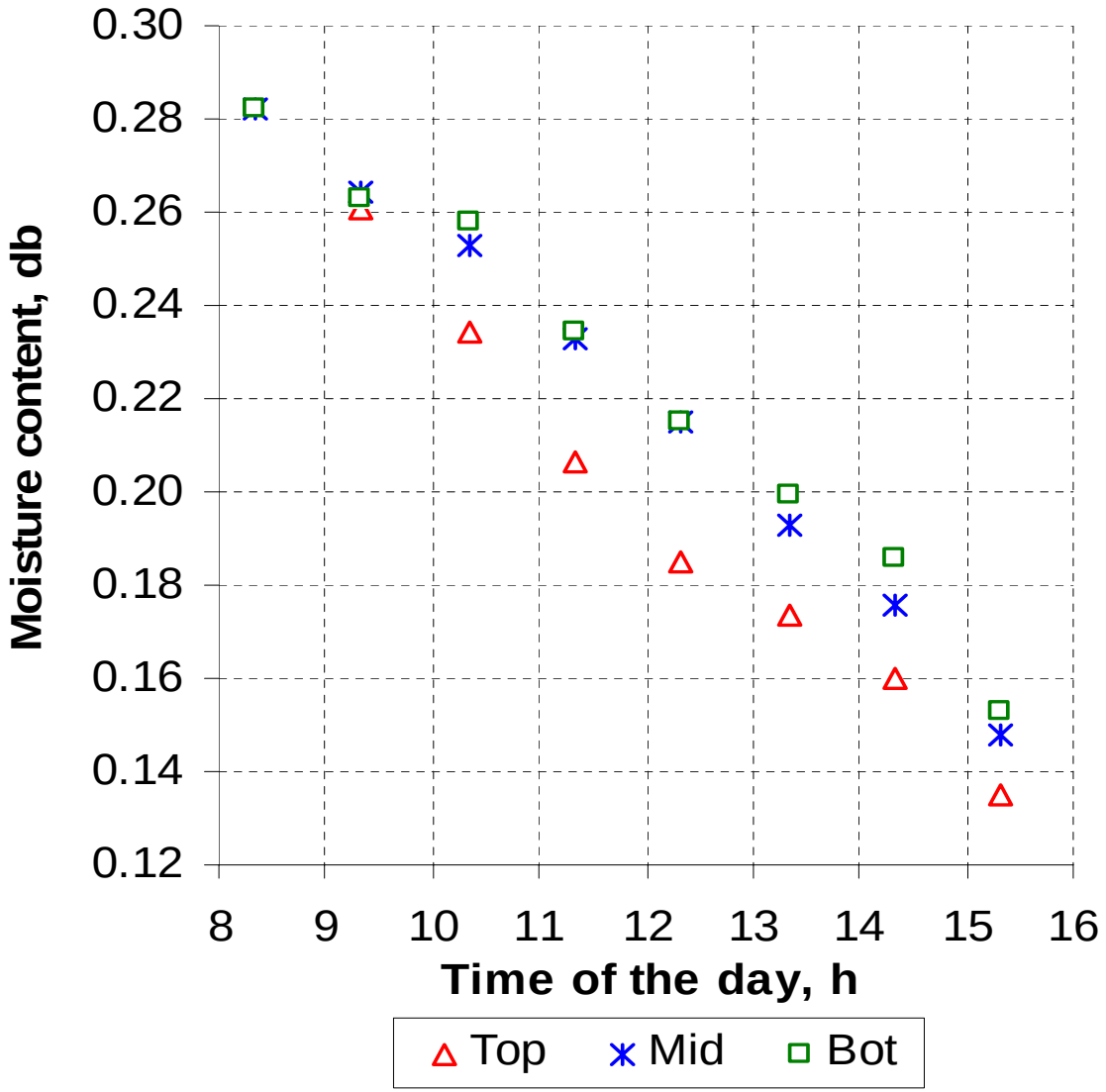
Water activity in bed

CAR11, 2 cm, tarpaulin spread on polystyrene, stirring, no covering, Day One (Dec 11, 2004)



Moisture content

CAR11, 2 cm, tarpaulin spread on polystyrene, stirring, no covering, Day One (Dec 11, 2004)



Conclusions

- Solar intensity was found to change according to the cloud movement in addition to the normal daily cycle
- Ambient air RH and temperature, and wind speed changed significantly from day to day and during the day
- The temperature of the grain within the bed was more affected by the solar intensity than the temperature of the ambient air

Conclusions

- The grain on the top layer of the drying bed got hotter and dried faster than the other grain of the layers below
- At noon, stirring could reduce the temperature of the grain at the bed surface by about 5°C while covering and shading reduced the temperature from about 55°C to about 35°C

Conclusions

- Water activity within the bed was affected slightly by the solar intensity, changed during the drying time and was different for different drying days
- Grain moisture content reduced steadily during the drying but stayed almost constant when the bed was covered and shaded
- Stirring and covering and shading reduced the temperature difference between the grain from different layers possibly avoiding grain damage due to temperature greater than 43°C.

Acknowledgements

- International Rice Research Institute
- NZ foreign aid scholarships
- Asia 2000
- Ministry of Agriculture, Forestry and Fisheries of Cambodia
- British American Tobacco
- Agriculture Improvement Project
- Pyseth’s many friends and relatives who were called on to help