TROZ Centre for Agriculture in the Tropics and Subtropics

The Uplands Program
Research for Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia

Parameterisation and Modelling of Growth and Yield Development of Mango (*Mangifera indica* L.) in North Thailand with Application of the WaNuLCAS Model

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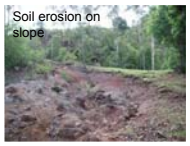
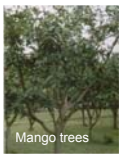
Introduction

In mountainous areas of North Thailand soil erosion is a severe problem, resulting from population growth and expansion of agricultural land into fragile uplands. Mango, one of the major fruit crops in Thailand, can be an alternative to annual crops and is, thus, an option to prevent soil degradation. To test mango growth under different environmental conditions and in diverse agricultural systems modelling can be a useful tool.


Expansion of agricultural land


Soil erosion on slope


Mango trees

Location of the research area in North Thailand (orange star)

Objectives

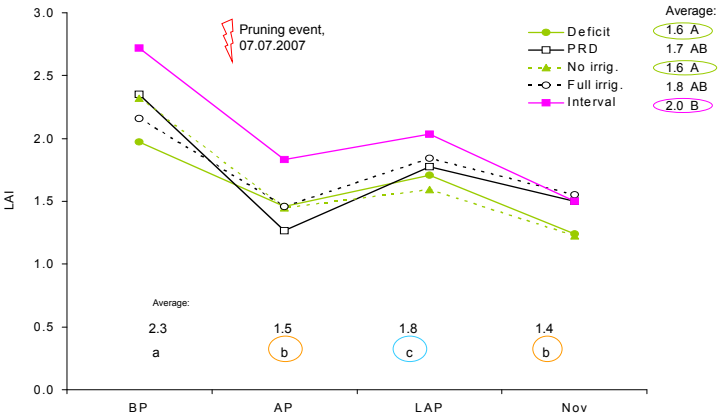
- Parameterise mango growth of the Thai varieties “Chok Anan“ and “Nam Dok Mai” for two sites in North Thailand
- Calibrate mango tree data sets for WaNuLCAS 3.2 (Water, Nutrient, and Light Capture in Agroforestry Systems)
- Run five mango growth scenarios for evaluation/testing sensitivity of model

Materials & Methods

- Location: Multiple Cropping Centre (MCC) of Chiang Mai University (CMU) and research station of Mae Jo University north of Chiang Mai, Thailand (18.53° N, 100.03° E, 350 m a.s.l.),
- Climate: Tropical monsoon climate, warm and wet May-October, cooler and drier November-January, warm and dry February-April; average temperature 2003-2006: 27.3°C, annual average precipitation during the same period: 1323 mm,
- Experimentation period: June-August 2007,
- Site characterisation: MCC -12 years old mango orchard on former paddy field; Mae Jo -11 years old mango orchard organised in five irrigation options,
- Data collection: Farmer Survey (n=10), expert interview (n=3); leaf area index (LAI) determined with Licor plant canopy analyzer LAI-2000 on four dates, leaf weight ratio (LWR), specific leaf area (SLA), functional branch analysis (FBA) and root length density (RLD),
- Parameterisation: Generate tree data sets, set up the model (MCC + Mae Jo),
- Calibration: Adjust model output until it reaches field data,
- Scenarios: irrigation, off-season production and intercropping,
- Pruning dates:
  - 3rd of July, before pruning (BP)
  - 19th of July, immediately after pruning (AP)
  - 30th of August, late after pruning (LAP)
  - 15th of November, very late after pruning (VLAP)

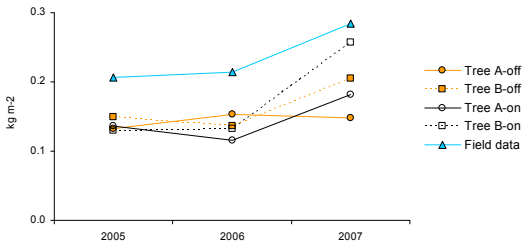
Results

Results of leaf area index (LAI) measurements



LAI development as affected by pruning and irrigation. Data were recorded on four dates in July, August and November 2007 at the Mae Jo research station, Chiang Mai, Thailand.
Deficit-deficit irrigation, PRD-partial root zone drying, no/full irrig.-no/full irrigation, interval-interval irrigation.
Values followed by the same letter within a column do not significantly differ from each other at P<0.05.

Scenarios



Fruit yield results for three years of **on-season** (-on) and **off-season** (-off) simulation **scenario** for tree A and B compared to field data observed at Mae Jo orchard, North Thailand.

Results of **intercropping scenario** in a 11 year model run.

Tree	Total biomass	LAI	Fruit biomass cumulative	Crop biomass cumulative
	(kg m²)		(kg m²)	(kg m⁻²)
A	2.49	4.1	1.64	3.93
B	1.31	5.3	1.57	4.33
C	2.04	2.1	1.67	4.71

Conclusions

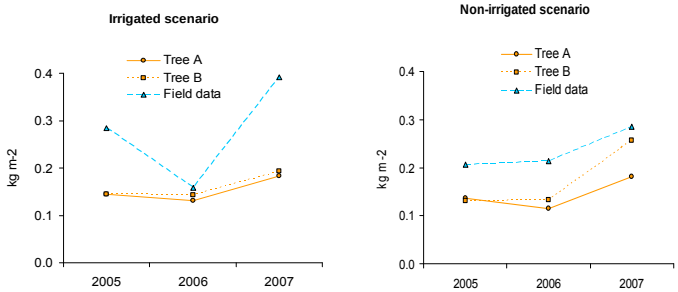
- **LAI** of CA mango at Mae Jo orchard differs between measuring times with respect to pruning but not between irrigation treatments except the interval irrigation treatment.
- **LAI** and **fruit biomass** are well simulated by the WaNuLCAS model, **tree biomass**, **height** and **diameter** show poorer results.
- Model scenario outputs for **irrigation** and **off-season** production gave rather poor results, **intercropping** scenario returns reasonable values.
- Mango growth was satisfactorily modelled by WaNuLCAS. The model may, thus, contribute to identify and evaluate options for alternative cropping systems, but tree data sets still have to be **validated.**

Modelling results of growth parameters

Results of calibration of three mango trees in an 11 year model run and field data from Mae Jo orchard and Multiple Cropping Centre, Chiang Mai University, North Thailand in comparison.

Tree	Total biomass	Height	Diameter	LAI	Fruit biomass cumulative	Fruit biomass 1 harvest
	(kg m²)	(m)	(cm)		(kg m²)	(kg m²)
A	1.40	5.6	13.5	4.1	1.11	0.18
B	1.37	6.2	11.6	5.3	1.31	0.26
Field data Mae Jo	1.45	3.9	16.0	2.2	n.a.	0.29
C	1.85	8.5	12.7	2.9	1.38	0.20
Field data MCC*	2.12	4.5	18.0	2.5**	n.a.	0.39***

* Field data from 12 year old trees; **estimation from LAI data near by and from Pitchit; ***adaptive calculation of data from Pitchit; MCC = Multiple Cropping Centre at CMU; n.a.= not available as field data.



Fruit yield of mangos in kg m^{-2} dry weight for simulated tree A and B and observed field data from Mae Jo orchard, North Thailand for the years 2005-2007.

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This thesis was financially supported by Stiftung für Tropische Agrarforschung and carried out within the framework of the DFG funded SFB 564 - Uplands Program.