Modelling Crop Diversification Strategies for Sustainable Intensification in Dryland Cropping System of Semi-arid Southern India

ID 814

Ranganath Lakshmaiah, Ernst-August Nuppenau, Stephanie Domptail
Justus-Liebig University Giessen, Inst. of Agric. Policy and Market Res., Germany

1) Introduction

Agriculture growth driven by intensification (fertilizer, high yielding seeds and plant protection chemicals), led to simplification of agro ecosystem wrt species and genetic diversity.

Declining land size, investment in irrigated agriculture for livelihood has lead to wider scale adoption of monocropping or narrow rotations in drylands with limited external inputs. So dryland soils are degraded with low soil organic carbon (SOC) and **'natural fertility'.**

Legume-based cropping systems (rotation and intercropping) combined with appropriate **soil nutrient management** strategies enhance SOC and **'natural fertility'.**

In short-run, farmer adopting a legume-based rotation must forgo returns from relatively high remunerative cereal crop for less remunerative legume crop.

Any recommended **crop diversification strategy** must inform farmer on this **trade-off in short-run** and appropriate input management strategies in cropping system for sustainable long-run benefit.

Sustainable intensification (SI) of dryland cropping systems is defined as efficient allocation of external inputs (non-renewable resources) and temporal choice (long-run) of crops over finite period for given output, factor prices and crop yield level

2) Theory: Sustainable intensification

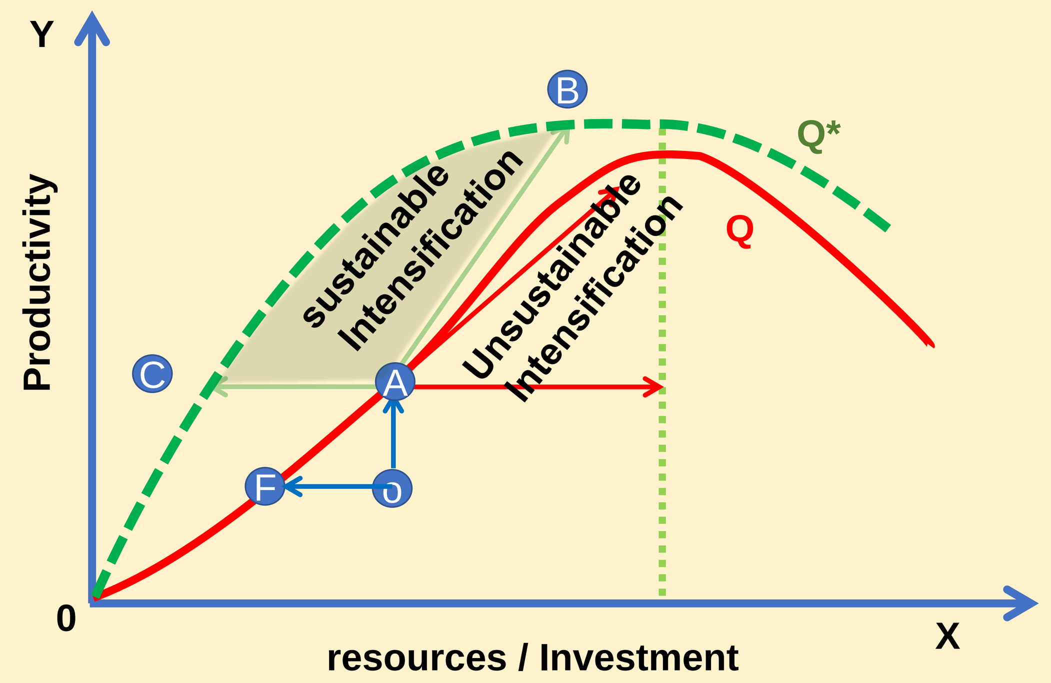

Figure 1: Representation of sustainable intensification concept using production functions. (Tittonell (2017).

Legend :

Line "Q" is attainable productivity (environmental limit)

Line "Q* " is new attainable productivity by sustainable intensification (new environmental limit)

Point "O" is initial state of agriculture system

Resource is soil fertility

Investments are seed, fertilizer, manure

Table 1 : Agricultural system trajectories and associated practices for sustainable in this study

Trajectory	Implications	Agriculture practice
O → A	Reducing resources at current productivity level	Appropriate input combination level (capital, organic manure & fertilizer)
O → F	Increasing productivity for same resource level	
O → A & F	Intermediate strategy	
A → C &B	shift toward a new production function,	Crop diversification in for Long run

3) Study Area and Sampling

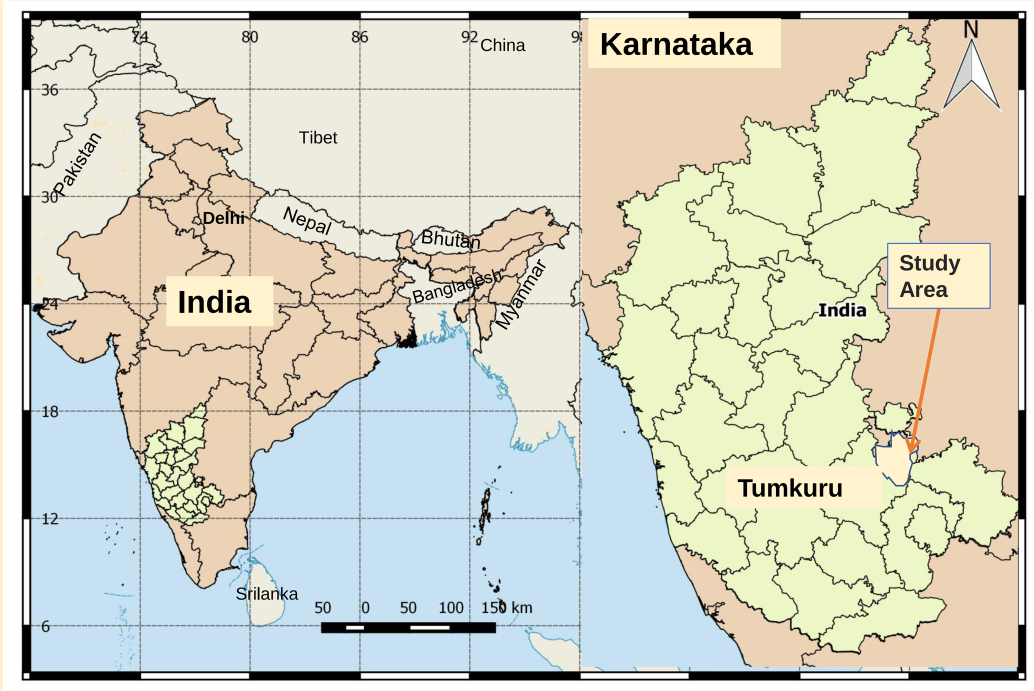

Figure 2: Map showing study area in Karnataka state of India
Source: Constructed using QGIS

$12^0\ 45'$ & $14^0\ 20'$ north latitude and $76^0\ 20'$ & $77^0\ 31'$ east longitude

Location & Sampling: Field level crop production data of 838 dryland plots from 198 households sampled in five village clusters in of Tumkur district, Karnataka state, India.

Primary Data: Field level data includes yields of main crop and intercrops, cropping system and inputs used for crop production in physical and monetary units.

Secondary data: rainfall for year 2013-14 near each of five village clusters is collected from rain gauge stations and agronomic experimental data on long term yield response to soil nutrient management and cropping pattern from research station in the region.

4)Analytical frame work

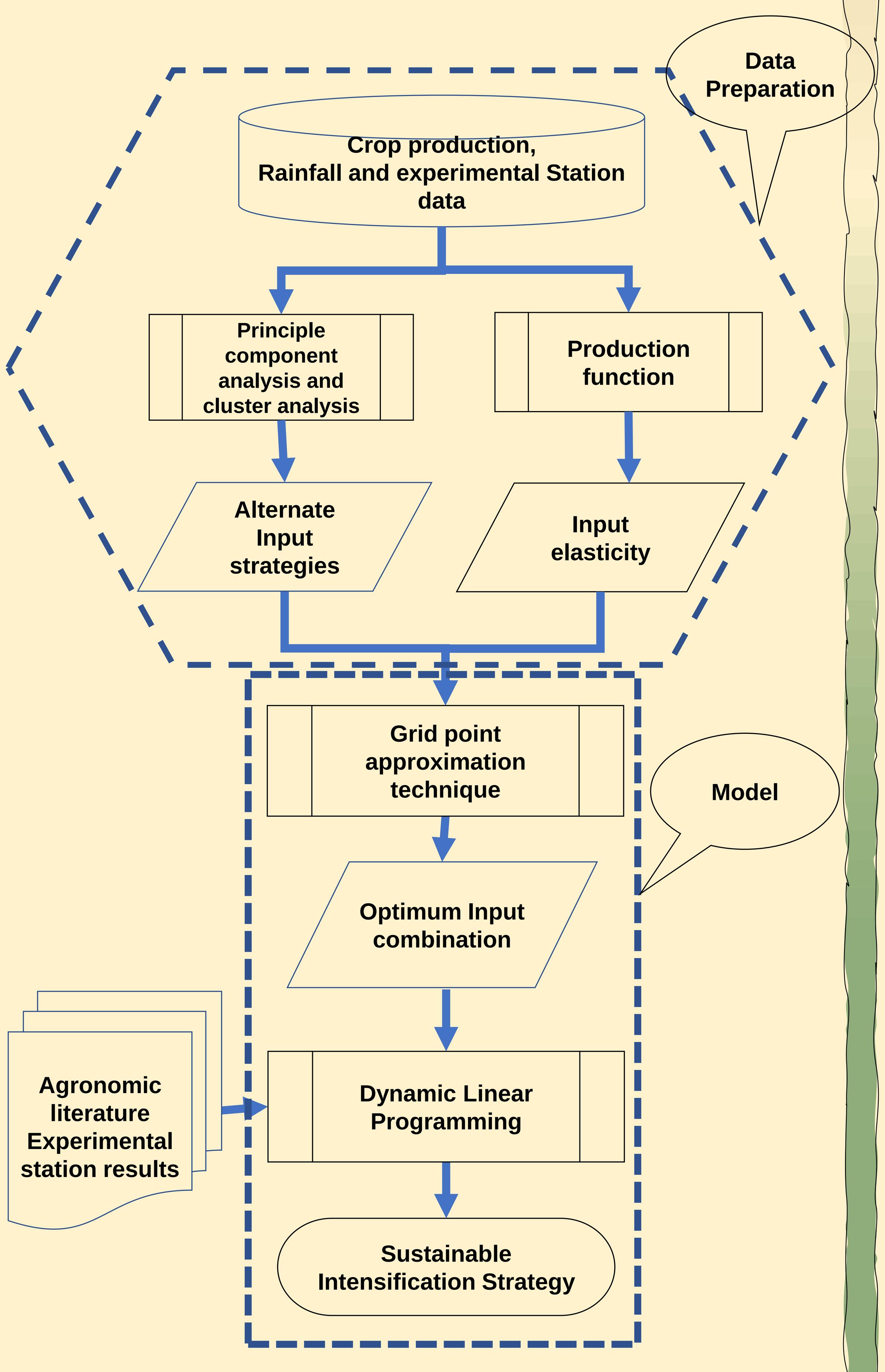

Figure 3: Schematic diagram of methodology used modeling sustainable intensification at field level.

5) Key Results and Analysis

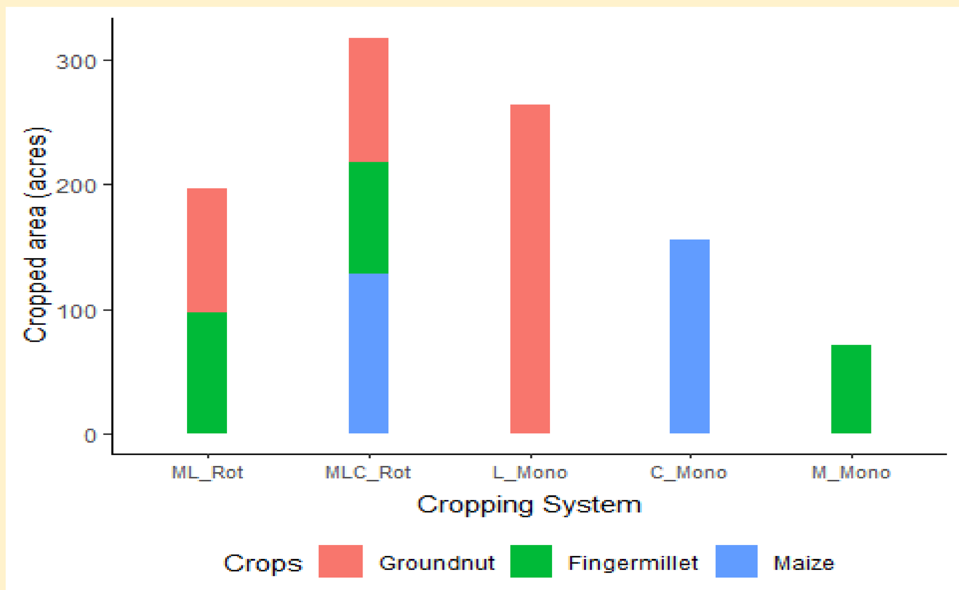

Figure 4: Area of crops under cropping pattern in the study area during 2013 -2014.

Maize, finger millet and groundnut are major crop in the region that are grown individually as monocrop or two crop rotation (finger millet and groundnut) or three crop rotation (finger millet, maize and groundnut).

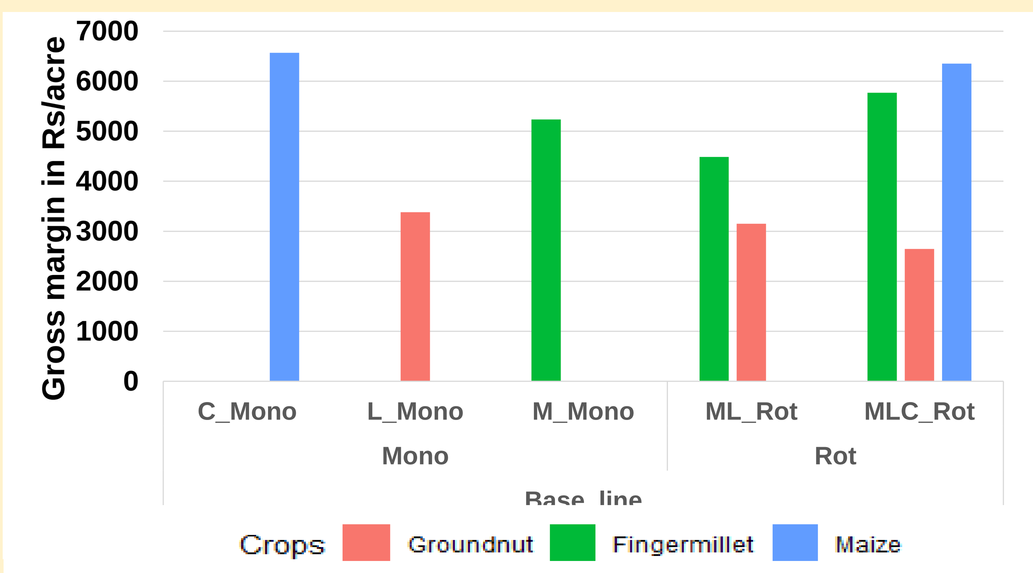

Figure 5: Gross margin of different cropping system based on current (baseline) yield levels and optimal input combination.

Maize monocrop is most remunerative while groundnut monocrop is the least remunerative cropping system.

Gross margin for both groundnut and finger millet under monocrop is higher than they are grown in rotation.

5) Key Results and Analysis

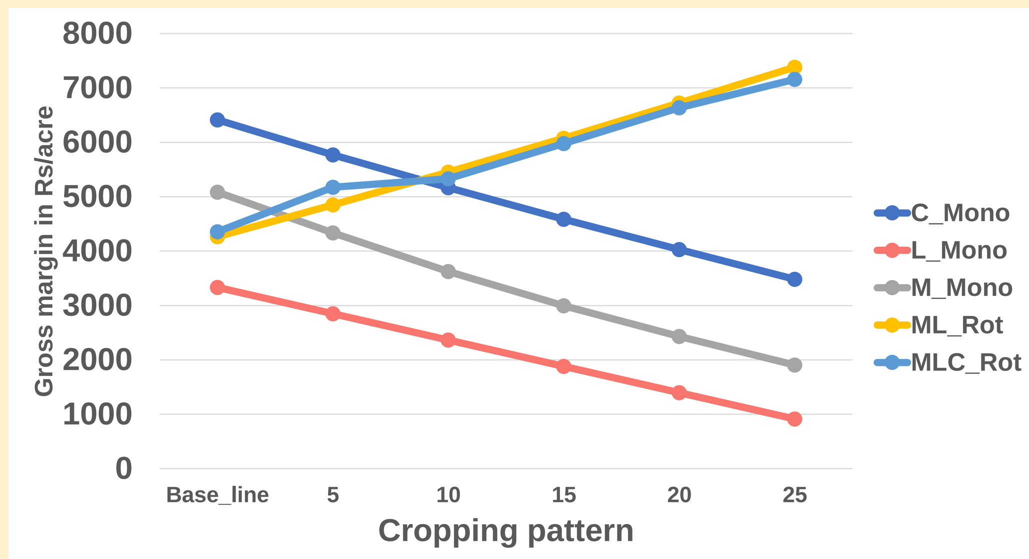

Figure 6: Simulated gross margin of cropping patterns with yield monocrop penalty and reward for rotation.

Maize, groundnut and finger millet rotation can be economical at monocrop yield penalty of 20 % in maize monocrop, or more than 9.5 % monocrop yield penalty and rotation reward can make this rotation remunerative.

Groundnut and finger millet rotation can be rewarding at monocrop yield penalty of more than 5 % due millet monocrop or more than 2.5 % monocrop yield penalty and rotation reward can make millet groundnut rotation remunerative as against millet monocropping.

6) Conclusion

The information on required monocrop yield penalty or rotation reward for economic adoption of rotation under static model can utilized to screen results agronomical experiments to identify suitable cropping system for SI.

The long term yield response to cropping system can be incorporated to allocate crops over time to improve productive capacity of soil.

Support tactical decision choice of crop, input intensity and management practices.

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