AGRO 2015 MONTPELLIER
07 -10 SEPTEMBER

The International Scientific Week
on Agricultural Systems

FSD5
Proceedings

SEPTEMBER
7-10, 2015
Le Corum
MONTPELLIER
France

5th International Symposium for Farming Systems Design

"Multi-functional **farming systems** in a **changing world**"

ESA European Society for Agronomy

AGROPOLIS INTERNATIONAL

Proceedings of the 5th International Symposium for farming Systems Design

FSD5

Montpellier, September 7 - 10, 2015

Editors: Gritti Emmanuel S. – Wery Jacques
Cover design: Olivier Piau – Lisbeth Michel
Final edition: Gritti Emmanuel S.

Special thanks to the scientific committee's members for their commitment in the reviewing and editing processes

SCIENTIFIC COMMITTEE

Francois AFFHOLDER, CIRAD, France
Senthold ASSENG, University of Florida, USA
Jean Marc BARBIER, INRA Montpellier, France
Marc BENOIT, INRA Mirecourt, France
Jacques Eric BERGEZ, INRA Toulouse, France
Peter CARBERRY, ICRISAT, India
Ken CASSMAN, University of Nebraska, USA
Olaf CHRISTEN, Agronomy and Organic Farming University of Halle, Germany
Lionel DABBADIE, UMR ISEM, CIRAD
Santiago DOGLIOTTI, Universidad de la Republica, Uruguay
Patrick DUGAN, CGIAR Research Program on Aquatic Agricultural Systems, WorldFish, Malaysia
Michel DURU, INRA Toulouse, France
Frank EWERT, Bonn University, Germany
Bruno GERARD, Global Conservation Agriculture Program CIMMYT, Mexico
Ken GILLER, Wageningen UR, The Netherlands
Bernard HUBERT, Agropolis International, France
Marie Helene JEUFFROY, INRA Grignon, France
Philippe LECOMTE, CIRAD, France
Lingling LI, Gansu Agricultural University, China
Wei li LIANG, Hebei Agricultural University, China
Eric MALEZIEUX, CIRAD, France
Charles Henri MOULIN, Montpellier SupAgro, France
Bruno RAPIDEL, CIRAD, Costa Rica
Daniel RODRIGUEZ, University of Queensland, Australia
Pablo TITTONELL, Wageningen UR, The Netherlands
Martin VAN ITTERSUM, Wageningen UR, The Netherlands

Jacques WERY, Montpellier SupAgro / ESA, France Chair of the FSD5 Scientific and Organizing Committees

LOCAL ORGANIZING COMMITTEE

Coordination:
Brigitte Cabantous, Agropolis International

Hatem Belhouchette, UMR System, IAM.M
Emmanuel S. Gritti, UMR System, Montpellier SupAgro
Laure Hossard, UMR Innovation, INRA
Amandine Lurette, UMR Selmet, INRA
Isabelle Massaï, Chaire AgroSys
Raphaël Metral, UMR System, Montpellier SupAgro
Olivier Mikolasek, UMR ISEM, CIRAD
Carole Picard, UMR System, INRA
Sandrine Renoir, UMR System, CIRAD
Charles Staver, Bioversity International
Nathalie Villemejeanne, Agropolis International

FOREWORD

Eight years after the launching of the FSD (Farming Systems Design) initiative in Catania (2007), the European Society for Agronomy (http://www.european-agronomy.org) has been mandated to organize its fifth symposium with the specific objective to strengthen the interdisciplinary and methodological focus of FSD. The overall objective is to promote research and capacity building on methodologies for the analysis and design of Agricultural Systems on a worldwide level. The research focus of this FSD community is the farm system level, the interactions and feedbacks at lower and higher levels of integration and the tools and methods required for understanding and implementing multi-functional farming systems expressing good trade-offs between agricultural production and ecosystems services. In a time when challenges for farming systems are increasingly defined by other systems operating at higher scales (food security, climate change, natural resource conservation, poverty alleviation….) it is important to keep an active scientific community sustaining innovation and capacity building on farming systems and their interfaces with those embedding systems and global issues.

These proceedings are aimed to serve as a compendium of the on going research in the FSD domain when considered worldwide and across the various sectors of agriculture (including fish-based systems). They include all the presentations (orals and posters) selected by the Scientific Committee of the 5th Farming Systems Design conference held in Montpellier (France) from September 7 to 9, 2015 (http://fsd5.european-agronomy.org/). A part of these communication have also been selected to compose special issues of major journals in the domain (Agricultural Systems and European Journal of Agronomy) and others will give raise to individual submissions in other journals.

The major achievements and challenges of the FSD approach are browsed through the 6 short sessions of the symposium "Farming Systems Design in Action: Methods, Achievements and Challenges" and are further developed and illustrated in the thematic sessions covering:

- *The grounds of the FSD approach* in quantitative analysis of crops (session T1. Assessing performances and services of cropping systems) and farms (T2. Assessing performances and services of farming systems).
- *The research frontiers on methodologies* for systems experiments at field level (W3. Cropping systems design: what can we do with field experiments and expert knowledge?), support of transition pathways at farm level (W4. Farms in transition), integrated analysis (T7. Scaling up from farm to landscape and multiscale scenario analysis of agricultural systems) and design (T8. Co-design and co-innovation with farmers and stakeholders) of agricultural systems.
- *A specific focus on crop models* (T3. Crop modelling and yield gap analysis for agricultural systems analysis and design) *and farm models* (T4. What's new with bio-economic models for the analysis and design of agricultural systems?) and the way they can be developed and used to sustain system's analysis and design.
- *Three typical challenges* on which the multi-scale and multi-domain FSD approach is likely to bring significant breakthrough: T5. Designing Climate Smart Agricultural Systems; T6. Designing sustainable agricultural systems with legumes; W6. Pathways for sustainable intensification of African agriculture?
- *Applications of the FSD approach to specific types of farming systems*: W1. Animal-based systems and crop-livestock interactions at farm and territory level; W7. Aquaculture systems, W2. Annual crops based systems; W5. Silvo-arable and silvo-pastoral systems.

Prof. Jacques Wery

(FSD5 Chair and ESA Executive Secretary)

Farm type-specific adoption behaviour in sustainable soil nutrient management: the case of smallholder farms in Ioba province, Burkina Faso.

Boundia Alexandre Thiombiano [*±1, 2, 3] **& Quang Bao Le** [2, 4]

[1] West African Science Service Center on Climate Change and Adapted Land Use (WASCAL)
[2] Department of Environmental Systems Science, Swiss Federal Institute of Technology (ETH Zurich)
[3] Institut du Développement Rural (IDR), Université Polytechnique de Bobo-Dioulasso (UPB), 01 BP 1091 Bobo-Dioulasso 01, Burkina Faso
[4] CRP-Dryland Systems, c/o International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 950764 Amman 11195, Jordan

[*] Speaker
[±] Corresponding author: boundia@gmail.com

1 Introduction

Sub-Saharan Africa has failed to ensure sufficient and sustainable food production (Food and Agriculture Organization [FAO] et al., 2013), mainly as a result of soil nutrient depletion (Pimentel and Burgess, 2013). The persisting food insecurity and poverty, despite proven sustainable soil nutrient management (SNM) practices (Vlek et al., 1997; Ingram et al., 2008), denote the failure of policy intervention to leverage farm incentives to adopt SNM practices (Anley et al., 2007). The main objective of this study was to analyse the farming system type-specific behaviour in the adoption and use of SNM practices in a semiarid region of Burkina Faso.

2 Materials and Methods

The study was conducted in Ioba Province, southwestern Burkina Faso. Based on soil degradation information, vegetation index (NDVI) and demographic data, three communes were selected. Six villages (i.e., two villages per commune) were chosen according to the two major soil types in each commune. We randomly sampled and surveyed 360 household-farms to obtain a multidimensional dataset, using the Sustainable Livelihood Framework (Sconnes, 1998) as a guide. Binary logistic regressions were used to analyse the determinants of mineral fertiliser use intensity, separate the adoption of mineral and organic fertilisers and combine mineral-organic fertiliser adoption at the plot level for different farming systems. Only maize plots were considered as it was the main food crop for which the farmers used most of the available fertilisers.

3 Results - Discussion

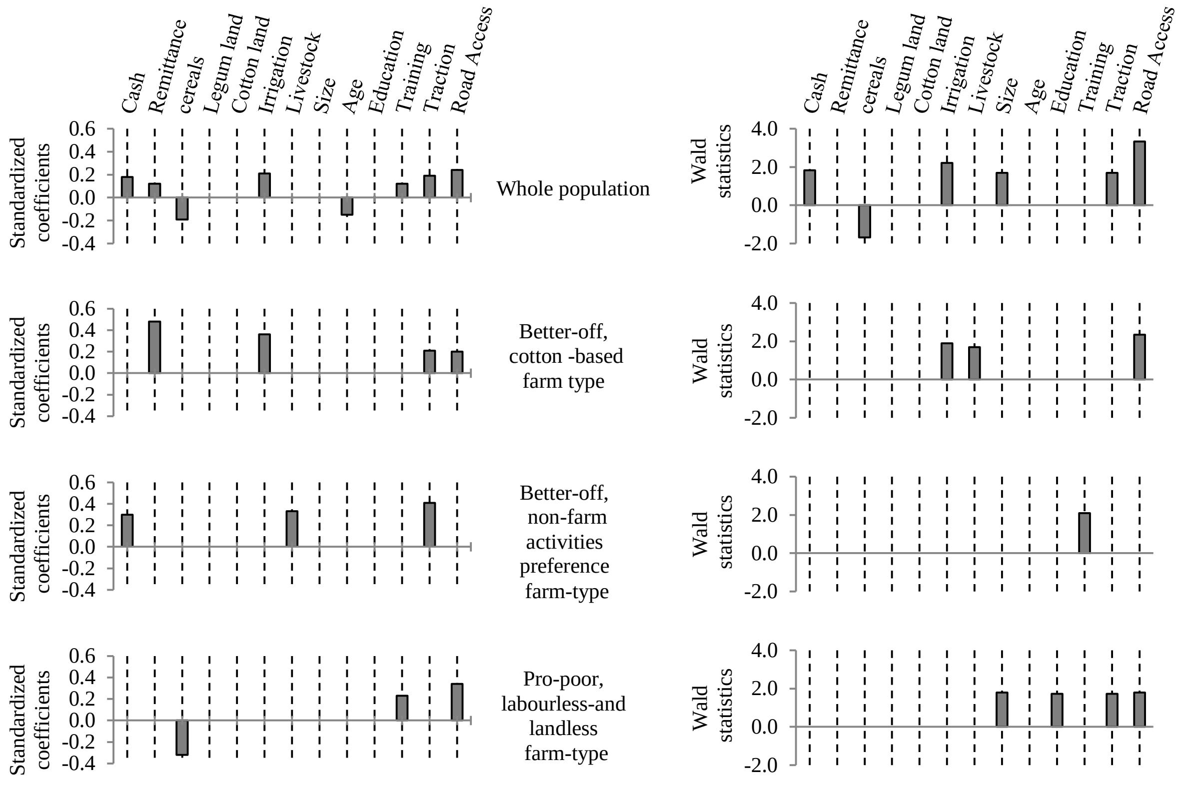
No multi-collinearity was found among explanatory variables (VIF < 0.5 and tolerance > 0.2). The Hosmer and Lemeshow test at 5% showed a good fit of the bi-logit models to the data. The calculated area under the receiver operating characteristic (ROC) curve was between 0.7 and 0.9, indicating that the models were good and excellent predictors of the outputs compared to chance.

Table 1. Adoption of mineral and organic fertilizers

Explanatory Variable		Adoption of mineral fertilizer				Adoption of organic fertilizer			
		Whole population	Farm type I	Farm type II	Farm type III	Whole population	Farm type I	Farm type II	Farm type III
Intercept		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Cash		1.5E-05***	3.5E-05**	2.8E-05**	n.s	n.s	n.s	n.s	n.s
Remittance		n.s	9.9E-04**	n.s	n.s	1.3E-04*	n.s	n.s	n.s
Cereals		n.s	6.4**	-12.0***	n.s	-2.9**	n.s	n.s	n.s
Legum land		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Cotton land		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Irrigation		34**	73**	n.s	n.s	n.s	n.s	n.s	n.s
Livestock		0.6**	n.s	2.0**	n.s	n.s	0.46*	n.s	n.s
Size		0.2**	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Age		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Education		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Training		n.s	n.s	1.3*	n.s	n.s	n.s	n.s	n.s
Traction		2.5*	n.s	16.5*	n.s	n.s	n.s	8.99*	n.s
Road Access		0.1***	n.s	n.s	n.s	n.s	0.09*	n.s	n.s
Hosmer and Lemeshow test	χ^2	13.2	18.2	4.7	4.4	6.2	4.42	4.49	4.5
	df	8	8	8	8	8	8	8	8
	p	0.12	0.02	0.786	0.8	0.6	0.82	0.8	0.8
% correct prediction		73.2	82.2	76.70	79.4	68.4	72.6	72.6	66.7
Area under ROC		0.8	0.9	0.9	0.9	0.7	0.8	0.7	0.8

Note: Symbols *, **, and *** indicate statistical significance at 10%, 5, and 1% respectively. n.s means not signifcant

The results (Table 1 and Fig. 1) showed that the variables identified as affecting factors in the whole population's adoption and use of fertilisers had different affecting patterns across farm types. Most of the variables were type-specific affecting factors, influencing only a particular farm type (e.g., livestock in Fig. 1a). A type-specific factor might also affect more than one farm type (but not all farm types) and have an aggregate effect on the whole population (e.g., training in Fig. 1a). A common affecting factor would influence the whole population, as well as all farm types. However, it might be an aggregated affecting factor and might have no significant effect on individual farm types (e.g., cash income and cereals in Fig. 1b). Furthermore, the amplitudes and signs (direction of the effect) of the variables' coefficients varied. These results revealed the existence of responsive heterogeneity of farms for the adoption and use of fertilisers. This difference in the farmers' adoption and use behaviour in sustainable SNM practices was driven by their livelihood characteristics.



(a)- Mineral fertilisation use intensity (b) Adoption of combined mineral-organic fertilizers

Fig 1. Determinants of mineral fertilizer use and adoption

4 Conclusions

The results generally match those of past studies on the determinants of fertiliser adoption and use (Anley et al., 2007; Martey et al., 2014). Our study additionally showed the existence of heterogeneity in the adoption behaviour and use of sustainable SNM practices. This implies that effective policy interventions promoting the adoption of SNM practices should be designed according to the farming system type for leveraging farm incentives to adopt SNM practices. Farm design studies also need to account for the farmers' behavioural heterogeneity. This study's results can be used for scaling-out research and serve as a framework for policy intervention and further studies in the region.

Acknowledgements. Authors are grateful to German Federal Ministry of Education and Research (BMBF) which fully funded this research through West African Science Service Center on Climate Change and Adapted Land use (WASCAL)

References

Anley, Y., Bogale, A. & Haile-Gabriel, A. (2007). Adoption decision and use intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo District, Western Ethiopia. Land Degradation & Development 18(3): 289-302.

FAO, IFAD & WFP (2013). The State of Food Insecurity in the World 2013. The multiple dimensions of food security. Rome, Italy, Food and Agriculture Organization of the United Nations.

Ingram, J. S. I., Gregory, P. J. & Izac, A. M. (2008). The role of agronomic research in climate change and food security policy. Agriculture, Ecosystems & Environment 126(1–2): 4-12.

Martey, E., Wiredu, A. N., Etwire, P. M., Fosu, M., Buah, S. S. J., Bidzakin, J., Ahiabor, B. D. K. & Kusi, F. (2014). Fertilizer Adoption and Use Intensity Among Smallholder Farmers in Northern Ghana: A Case Study of the AGRA Soil Health Project. Sustainable Agriculture Research 3(1): 36.

Pimentel, D. & Burgess, M. (2013). Soil Erosion Threatens Food Production. Agriculture 3(3): 443-463.

Sconnes, I. (1998). Sustainable rural livelihoods. A framework for analysis. IDS Working Paper 72.

Vlek, P. L. G., Kühne, R. F. & Denich, M. (1997). Nutrient resources for crop production in the tropics. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences 352(1356): 975-985.