AGRO 2015 MONTPELLIER
07 -10 SEPTEMBER

The International Scientific Week
on Agricultural Systems

FSD5
Proceedings

FSD
Agricultural systems by design

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

SCALING UP AGRO-ECOLOGICAL INNOVATION ADOPTION AMONG FARMING SYSTEMS. APPLICATION TO IMPROVED FALLOWS IN MARTINIQUE

Laurent Parrot [*±1] **1, Laurent Hennig**[2]**, Eric Roux** [3]**, Lucile Vantard** [3]**, Alexandra Jestin**[4]**, François Ratye** [2] **& Paula Fernandès**[4]

[1] UPR HORTSYS, Cirad, 34398 cedex 5, Montpellier, France
[2] Istom, 95000, Cergy, France
[3] SISEP, Ministère de l'agriculture de l'agroalimentaire et de la forêt, BP 642 – 97262 Fort-De-France cedex, Martinique
[4] UPR HORTSYS, Cirad, BP 214, 97285 Le Lamentin Cedex 2, Martinique

* Speaker

± Corresponding author: laurent.parrot@cirad.fr

1 Introduction

Agro-ecological innovations face low adoption rates among farmers. Agro-ecological innovations are basically new farming practices whereas agrochemical inputs can be considered as objects. Farming practices are dependent on spatial variables (agro-ecological zoning), the farmer's profile (agronomic expertise), the farming system (mechanized or not, access to labor). Agro-ecological innovations are also dependent on a time frame spanning over several years. Therefore agro-ecological innovations case studies have a poor generic range outside their timeframe, their agro-ecological zoning or even commodity chain in which they have been studied.
The objective of this paper is to suggest a methodology for improving the generic range, and therefore a scaling up, of case studies focusing on agro-ecological innovations. We articulate this methodology around participatory approaches with the key stakeholders, the adaptability of the agro-ecological innovations to the farmer's and farming systems constraints, and the access to census databases.
We tested this methodology with a case study focused on improved fallows in Martinique and the vegetable sector. Martinique is a tropical island of the French West Indies representative of the constraints faced by resource limited and import dependent economies. Martinique faces the challenges of a declining agricultural sector, a large dependence on imports, and environmental degradation (Agreste, 2011, 2013). One alternative to agro-chemical inputs is the promotion of improved fallows. The current practice for fallows in Martinique is to let spontaneous grass and weeds expand on the plots. Improved fallows consist in introducing annual leguminous species to restore the biological and chemical properties of the cultivated soil, respond to local soil borne diseases (nematodes), and compete against weeds (Fernandes *et al.*, 2009). The underlying agronomic principle is to take advantage of the existing and prevalent 2 to 3 months current fallows between the cropping periods to add green manure for a chemical and biological soil improvement.

2 Materials and Methods

A participatory approach hypothesized the adoption potential of improved fallows among farmers and validated the statistical classification of farmers.
A statistical classification from the 2010 agricultural census database was conducted among all farms involved in vegetable production (N= 1382). The participatory approach suggested two variables as potential determinants for the adoption of improved fallows: stable land tenure and total cultivated land area. We conducted a first computation of a Principal Component Analysis (PCA) and an Ascending Hierarchical Classification (AHC) based on those two variables. This first computation excluded farms with unstable land tenure. We conducted a second PCA and AHC computation among farms with stable land tenure for the five following variables related to different crops (in percentage of total farm cultivated area): vegetable, permanent grassland, banana and sugarcane, fallow, orchard. The correlations between these five variables defined the typology of farms.
We surveyed 80 farmers with a quota sampling from the results of the classification of farms. 47 variables were recorded on the profile of the farmers (socio demographic variables, network participation), agronomic practices, farm characteristics (area, mechanization potential of the land, labor supply, etc.).
We used the R 3.1.1. software and the ―glmnet‖ package to establish an econometric model with a set of 47 explanatory variables at farm and farming system level (Tibshirani, 1996). The dependent variable was the (yes/no) willingness to test improved fallows. This package uses a penalized regression method to choose coefficients of the model. A first nmodel using the 47 variables eliminated variables which have no linear link to the dependent variable; this is the Model 1. Then the economic model (Model 2) is obtained by using the variables which are meaningful for the Model 1.The Model 2 confirms each selected variable from the Model 1.

3 Results - Discussion

The two-step statistical classification among the 1382 farms involved in vegetable production resulted in 6 sub-groups of farms: unstable land tenure farms (306 farms), livestock farms (337), banana and sugarcane farms (96), pure vegetable farms (392), fallows farms (162), and orchards farms (89).We interviewed 80 farmers dispatched among 4 subgroups involved in vegetable production: the banana or sugarcane subgroup, livestock, orchards and pure vegetable farms. Farms with unstable land tenure and farms with fallows were not interviewed as they were assumed as non-adopters from the participatory approach. 80% of the farmers interviewed are willing to test improved fallows. Two models display the econometric results. A total of 12 explanatory variables were selected from the 47 initial variables (Model 1).

Table 1. Random-coefficient Logit Parameter Estimates with an elastic net penalization.

	Model 1 including 47 variables	Econometric model : Model 2 including 12 variables
Mean of error rates of prediction	9.45 %	8.65 %
Std. of error rates of prediction	1.65 %	1.56 %
(Intercept)	-3.1149	-3.3150
PRACTICING CURRENTFALLOWS	3.2476	3.3450
MULCHING_INTEREST	1.7563	1.8243
FIELD SUITED FOR MECHANIZ.	1.0992	1.1964
ADITIONAL_WORK	-0.8063	-0.8437
IMPLEMENTATION_COST	-0.7227	-0.8243
N.E._DISTRICTS	-0.7507	-0.7985
TILLAGE_REQUIREMENT	-0.6602	-0.7061
TRAINING_LEVEL	0.5911	0.6545
NEMATICIDE_INTEREST	-0.4166	-0.5219
DEPLETED_FERTILITY	0.3403	0.4353
LABOUR_AVAILABILITY	0.1676	0.1924
FERTILITY_INTEREST	0.0530	0.0839

Notes. Std. is the standard deviation. For the Model 1, the selected parameters are $\alpha = 0.99$ and $\lambda = 0.0345$. For the Model 2, the selected parameters are $\alpha = 0.99$ and $\lambda = 0.0315$.

The explanatory variables for the willingness to test improved fallows show the importance of already practicing current fallows on the farm (FALLOWS) as well as other additional agronomic benefits (MULCHING, TILLAGE, FERTILITY, etc.) and farm characteristics (FIELD SUITED FOR MECHANIZATION for example). Spatial considerations (N.E. DISTRICT) confirm the geographical constraints of agro-ecological innovations. Economic considerations are also confirmed. Fieldwork revealed that the pure vegetable farm group was also interested in improved fallows, in contradiction with an assumption of the participatory approach.

4 Conclusions

Scaling up agro-ecological innovations is possible with the access of an agricultural census and a quota sampling procedure as it reduces the investigation costs and the error margins. Farmer’s knowledge of the underlying agronomic principles of agro-ecological innovations is crucial in the willingness to test them. The participatory approaches are necessary but they need to be tested on the field as their assumptions can be contradicted (in our case, the total cultivated land area threshold). The fact that agro-ecological innovations may spread among various farming systems also highlighted the risk of exclusion of farms unsuited to their implementation.

*Acknowledgements.*This work was financially supported by the Comité Interministériel pour l’Outre Mer (CIOM) and the Fonds européen agricole pour le développement rural (FEADER). The authors would like to thank the farmers and the other participants of the following institutions: the Chambred’Agriculture; the Institut Technique Tropical (IT2); and the farmer groups.

References

Agreste. (2011). Données Martinique premières tendances. Direction de l’alimentation de l’agriculture et de la forêt de la Martinique. Service de l’information statistique économique et prospective.

Agreste. (2013). Mémento de la statistique agricole 2013. Agreste Martinique. Direction de l’alimentation de l’agriculture et de la forêt de la Martinique. Service de l’information statistique économique et prospective.

Fernandes, P.,Temple, L., Crance J., Minatchi, S. (2009). Innovations agroécologiques en Martinique : freins et leviers organisationnels, institutionnels, techniques et économiques. Innovations agronomiques, 4 : 457-466.

Tibshirani, R. (1996). Regression shrinkage and selection via the LASSO.Journal of the Royal Statistical Society Series B-Methodological 58(1), 267-288.