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A method combining simulation models and on farm surveys for ex ante assessment of agro-ecological innovations.

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Agro-ecological innovations are needed to reduce the impacts of current intensive agricultural practices on biodiversity and ecosystems. Whereas many published studies focus on the biophysical impacts of such innovations at field level, few attention has been given to the analysis of the potential of adoption of these innovations at farm and regional levels. In order to reduce the gap between on station and in silico innovation and farmer's adoption process, we developped an interdisciplinary method based on the combination of simulations models and on farm surveys to assess ex ante the potential of adoption of agro-ecological innovations by farmers.

Methodology

The method, presented in **Figure 1,** is based on two assumptions: 1) adoption of innovation by an individual farmer depends on the perceived utility of the characteristics of innovations ; 2) farmers are diverse in a given region and accounting for farmer spatial heterogeneity is necessary to correctly simulate the impacts of innovations. A first regional survey is aimed at characterising farmers diversity through the building of a farm typology. This typology is used in a prototyping program to design a set of innovations supposed to be relevant to improve the sustainability of each farm type. Then each farm type is deeply analysed to design a bio-economic farm model to simulate the impacts of the adoption of each innovation on each farm type in terms of agronomic performances, environmental pressure and economic performances. These simulations differentiated by farm type are then used in a second farm survey in which each farmer is asked whether he would adopt each innovation. These answers are then analysed to build an econometric adoption model that yields an utility function able to explain individual adoptions as a function of farmer and innovation characteristics. The results are finally used to define a set of adaptations of the innovations or/and of the policies, in order to maximize the compatibility beetween innovations characteristics, farmer's preferences and societal goals.

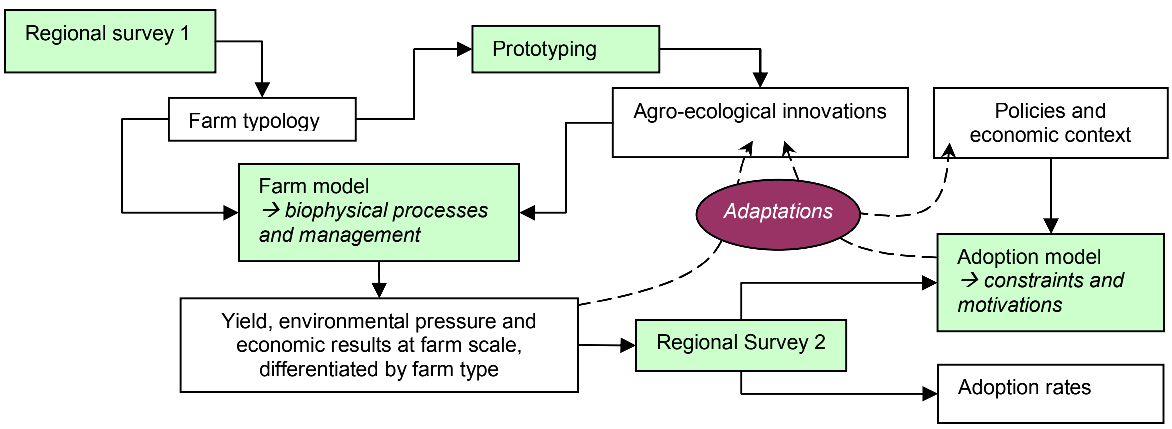

Figure 1. Overview of the method to assess ex ante the potential of adoption of agro-ecological innovations.

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Results and discussions

We applied this approach to agro-ecological innovations for banana farms in Guadeloupe, French West Indies (Blazy et al., 2009 ; 2010). The main impacts of these innovations and their potential of adoption are presented in **Table 1**. 87% of the farmers stated to have confidence in simulations of impacts. The innovation "intercropping" has the best potential of adoption for farm types A and C, whereas innovations "pest tolerant cultivar" and "improved fallow" are more easily adopted by farm type B. The potential of adoption of "organic system" is low for each farm type (about 30%), despite being the most profitable innovation (+1.4k€ ha^{-1} yr^{-1} at regional level). Results of the econometric adoption model revealed that adoption decisions can be mainly explained by constraints on work management and the perceived riskiness of innovations. Adoption is influenced by farmer's perceptions of the utility of the characteristics of innovations and of policy and economic context. The impacts of innovation and their potential of adoption may vary greatly among farm types depending on their biophysical and socio-economic characteristics. In most cases, agro-ecological innovations lead to an increase in work load which is problematic when farmers are constrained on work management. The innovations that are associated with the most important reduction of pesticide use are less productive (new cultivar and organic system), but can be profitable given the expected gain allowed by the increase in sale price. These characteristics could lead farmers to perceive this innovation as more risky to adopt.

Although a considerable amount of data and models are mobilized and required to implement the method, this last one helps a better understanding of innovations impacts and adoption pathways.

Agro-ecological innovations	Assessment level	Yield (t $ha^{-1}yr^{-1}$)	Net income (k€ $ha^{-1}yr^{-1}$)	Pesticides AM (kg ha^{-1} yr^{-1})	Work (d ha^{-1} yr^{-1})	Potential of adoption (% of farmers)
Current situation "Statu-quo"	Farm Type A	20	1.4	29	130	-
	Farm Type B	34	4.9	26	130	-
	Farm Type C	18	0.1	6	116	-
	Regional level	28	3.2	23	127	-
Adoption "Intercropping with legume crop Canavalia ensiformis" → *control weeds, reduce herbicides use, provide nitrogen*	Farm Type A	+30%	-0.4	-30%	+73%	64%
	Farm Type B	+14%	-1.3	-29%	+45%	54%
	Farm Type C	+83%	+1.7	-54%	+79%	72%
	Regional level	+30%	-0.5	-33%	+58%	59%
Adoption "pest-tolerant cultivar 91Y" → *tolerant to fungs and nematode, reduce fungicide and nematicide use, and increase of sale price*	Farm Type A	-42%	+0.8	-70%	-14%	55%
	Farm Type B	-45%	-1.0	-71%	-9%	68%
	Farm Type C	-36%	+0.6	-21%	-6%	58%
	Regional level	-43%	-0.3	-62%	-10%	63%
Adoption "Improved fallow with Crotalaria juncea" → *control nematodes, reduce nematicide use*	Farm Type A	+69%	+6.8	-22%	+29%	52%
	Farm Type B	+13%	+1.7	-8%	+8%	63%
	Farm Type C	+17%	+1.5	-21%	0%	58%
	Regional level	+27%	+3.0	-14%	+12%	59%
Adoption "organic system" → *combination of innovations above, stop pesticides use, and increase of sale price*	Farm Type A	-9%	+6.7	-100%	+63%	28%
	Farm Type B	-44%	-0.7	-100%	+44%	29%
	Farm Type C	-22%	+1.0	-100%	+55%	37%
	Regional level	-32%	+1. 4	-100%	+51%	30%

Table 1. Main impacts and potential of adoption of the agro-ecological innovations.

Note: Impacts are expressed in terms of relative or absolute changes compared to the current systems. Farm Type A = Familial smallholder flat lowlands intensive; Farm Type B = Industrial farms flat lowlands intensive ; Farm Type C = Familial smallholder uplands extensive ; Regional level = average of the three farm types weighted by their cumulated spatial importance at regional level.

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