Title: "Co-Design and Experimentation of a Prototype of Agroecological Micro-Farm Meeting the Objectives Set by Climate-Smart Agriculture".

Authors: Stan Selbonne, Loïc Guindé, François Causeret, Thierry Bajazet, Lucienne Desfontaines, Mathieu Duval, Jorge Sierra, Franck Solvar, Régis Tournebize and Jean-Marc Blazy.

Affiliations:

Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE), Research unit ASTRO, F-97170 Petit-Bourg, Guadeloupe, France; shimrith.selbonne@inrae.fr (Stan Selbonne); loic.guinde@inrae.fr (Loïc Guindé); francois.causeret@inrae.fr (François Causeret); thierry.bajazet@inrae.fr (Thierry Bajazet); lucienne.desfontaines@inrae.fr (Lucienne Desfontaines); mathieu.duval@inrae.fr (Mathieu Duval); jorge.sierra@inrae.fr (Jorge Sierra); franck.solvar@inrae.fr (Franck Solvar); regis.tournebize@inrae.fr (Régis Tournebize)
* Correspondence: jean-marc.blazy@inrae.fr (Jean-Marc.Blazy)

ANNEXES

Table S1: Short description of 11 indicators used for the diagnosis of farms with regard to the tree pillars of climate-smart agriculture.

INDICATORS	CALCULATION METHODS	OBSERVATIONS
GROSS MARGIN ($/ha/yr)	$GM = \dfrac{Gross\ product +\ Subsidies - Variable\ costs}{Ta}$ *Gross product = value of commercialized products ($/yr)* *Variable costs: labor, fuel, fertilizer etc. ($/yr)* *Ta: total area of the farm (ha)*	
LABOR REQUIREMENT (persons/ha/yr)	$LR = \dfrac{Labor}{1650 * Ta}$ *Labor: total labor (including direct services) (hr/yr)* *Ta: total area of the farm (ha)*	1650 hours per year correspond to the conventional full time equivalent job in the study site.
LABOR PRODUCTIVITY ($/hr)	$LP = \dfrac{GM}{Household\ labor}$ *Gross margin (GM) = GP – variable cost ($/yr)* *Gross product (GP) = value of commercialized products ($/yr)* *Household labor: non-salaried household labor (hr/yr)*	
AVERAGE NUTRI. PERF.		Sugarcane

(fed persons/ha/yr)	$$PR = \frac{(PA - INPUT_{PA}) * \delta A + (PV - INPUT_{PV}) * \delta V}{Ta * w_P * 365}$$ $$CC = \frac{CAC - INPUT_{CAC}}{Ta * w_{CAC} * 365} \qquad SC = \frac{CAS - INPUT_{CAS}}{Ta * w_{CAS} * 365}$$ $$SL = \frac{LIS - INPUT_{LIS}}{Ta * w_{LIS} * 365} \qquad UL = \frac{LIU - INPUT_{LIU}}{Ta * w_{LIU} * 365}$$ *P: edible animal (PA) and vegetal (¨V) proteins production (g/yr)* *CA: edible complex (CAC) and simple (CAS) carbohydrates production (g/yr)* *LI: edible saturated (LIS) and unsaturated (LIU) lipids production (g/yr)* *INPUT: inputs of edible animal (INPUT_{PA}) and vegetal proteins (INPUT_{PV}), simple (INPUT_{CAS}) and complex (INPUT_{CAC}) carbohydrates, and saturated (INPUT_{LIS}) and unsaturated (INPUT_{LIU}) lipids (g/yr)* *w: proteins (P), complex (CAC) and simple (CAS) carbohydrates, saturated (LIS) and unsaturated lipids (LIU) reference intake (g/pers./day)* *δ: Assimilation rate for animal (A: 95%) and vegetal (V: 80%) proteins for human* *Ta: Total area of the farm (ha)*	was not considered as food production for this indicator. The minimum (limiting) value of the five indicators could be used as "nutritional performance", but the assumption is that a balance of the nutrients production can be achieved through inter-regional exchanges. We considered the average value of those five indicators $\frac{PR+CC+SC+SL+UL}{5}$ as the average "nutritional performance", which is a useful value to interpret other indicators.
CLIMATE POTENTIAL IMPACT (%)	Vulnerability to climate change is a function of *Sensitivity * Exposure *Adaptive capacity* [68]. The adaptive capacity was not taken into account for the present indicator because it depends on many variables mainly social, technological, and economic from field to national scale [69,70] that should be specifically studied in relation with stakeholders like industrials, insurers, politics, associations, information media, schools or consumer communities. The indicator used here is a function of Sensitivity * Exposure. Those two variables were evaluated with a "semi-quantitative" approach on a –*High (3) – Medium (2) – Low (1) – Negligible (0) –* scale for the five following hazards: flooding, drought, heat waves, sea level rise and tropical cyclones. The "climate potential impact" indicator is a semi-quantitative indicator that measures the potential impact of the climatic context (considering the 5 above-mentioned hazards) for different climate change and practice adaptation scenarios. It depends on 4 types of variables: climatic variables reflecting the *exposure* to the 5 climatic hazards, and variables of *sensitivity* of the cultivated plot related to the ecophysiology of the crop, the agricultural practices and the environment of the plot. The threshold values that give the extent of sensitivity to the hazard considered were set based on bibliography and expertise. The *exposure* indicator takes values from 0 to 3. A value of 0 for climate hazard X means that agricultural activity A has a zero	

probability of being exposed to this hazard each year. A value of 3 for climate hazard X means that agricultural activity A has a maximum probability of being exposed to this hazard each year. The *sensitivity* indicator is composed of 3 sub-indicators related to the ecophysiology of the plant, the agricultural practices and the environment of the plot. This indicator takes values from 0 to 3. A value of 0 for climate hazard X means that agricultural activity A has a zero probability of experiencing a significant impact on its productivity if exposed to this hazard. A sensitivity value of 3 for climate hazard X means that agricultural activity A has a 100% probability of experiencing a significant impact on its production if exposed to this hazard.

Multiplying sensitivity * exposure yields values ranging from 0 to 9. Therefore, the maximum value is 3*3 =9 for each of the 5 "climatic hazard" (theme), and then the final indicator is calculated considering the average value of the potential impact indicators across the five themes, divided by the maximum value (9).

A value of 0% for the indicator *climate potential impact* means that the considered plot has a zero probability of having a significant negative impact on agricultural activity A. Inversely, a value of 100% means that this plot has a 100% probability of having a significant negative impact due to climatic hazards on agricultural activity A.

This indicator calculated for each plot, is then aggregated at the regional scale with the calculation of an average value weighted by the size of each plot (Supplementary materials).

ECONOMIC DIVERSITY	$$ED = -\sum_i p_i * log_2\, p_i$$ $$With\; p_i = \frac{GM_i}{GM_T}$$ *GMi: the annual gross margin derived from crop species i ($/yr)* *GMT: the total annual gross product ($/yr)*	The indicator proposed here is an adaptation of the "Shannon diversity index" and gives a measure of crop diversity in relation to economic value, i.e., gross margins.
PESTICIDES ACTIVE INGREDIENTS (kg/ha/yr)	$$PE = \frac{\sum_i A_i}{Ta}$$ *Ai: annual active ingredients input from the pesticide i (Kg/yr)* *Ta: total area of the farm (ha)*	
INORGANIC NITROGEN (kg/ha/yr)	$$IN = \frac{N}{Ta}$$ *N: total inorganic nitrogen input (Kg/yr)* *Ta: total area of the farm (ha)*	

%RENEWABLE	$$\%Renewable = \frac{(\sum Em_i * \%Renewable_i)}{Y}$$ *Y: the total emergy released (sej/yr)* *Emi: the emergy content of input i (sej/yr)* *%Renewablei: the renewable fraction of input i (%)*	This indicator was calculated following the methodology of of H.T. Odum [71] and also accounting for the renewable fraction of purchased inputs as proposed in [72]. Using the emergy baseline of 12.0E+24 seJ y^{-1} [73].
GHG EMISSIONS (tCO$_{2eq}$/ha/yr)	The GHG Protocol Corporate Standard classified GHG emissions into three 'scopes' [74]. Scope 1 emissions are direct emissions from owned or controlled sources; scope 2 emissions are indirect emissions from the generation of purchased energy, and scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the system. Moreover, for various categories of emission activities, the IPCC guidelines [75] provided several options for calculating the emissions, described as "tiers". There are three levels of tiers: tier 1, tier 2, and tier 3, referring to calculation method accuracy. GHG emissions were measured using "tiers 1" methods. Tiers 1 methods are less accurate than higher tiers 2 and 3 but *"(for all categories) are designed to use readily available national or international statistics in combination with the provided default emission factors and additional parameters that are provided, and therefore should be feasible for all countries"*[75]. As for "IN" and "AC", this indicator is meaningful when comparing it with nutritional performances.	
SOC VARIATION (tCO$_{2eq}$/ha/yr)	The soil organic carbon (SOC) stock change is an unmissable indicator giving information about soil sustainability and future evolution of farm health and dependency regarding fertilizers. Moreover, carbon sequestration in soils is an important strategy of GHG mitigation, spotlighted as part of the "4/1000 initiative" project [64,76]. It is "a less easy to calculate" indicator (often excluded from GHG accounting) due to the requirement of data on soil mineralization, erosion and biomass humification. When experimental data are missing, those three variables should be estimated from literature. It was calculated from the model described by Sierra et al. [37]. We applied this indicator to each farm's cropping system for a whole crop rotation over a 30 years period. $$SOC\ variation = \frac{(C_n - C_0)}{C_n} * 100$$ $$C_{n+1} = C_n - (K_m * C_n) - (K_e * C_n) + (K_h * A_m) + (K_{h'} * Res)$$ *Cn: soil organic carbon the year n (t/ha)* *C0: soil organic carbon the year 0 (t/ha)* *Km: soil mineralization rate (%)*	Based on a recent review [77] we made the approximation that SOC in cropland and pasture of our study site was exclusively emitted through CO$_2$. Fluxes of other gas (CH4…) were neglected and the SOC change was converted in terms of CO$_2$ fluxes.

	Ke: soil erosion rate (%) Kh: amendment humification ratio (%) Kh': crop residues humification ratio (%) Am: carbon inputs from amendment (t/ha) Res: carbon inputs from crop residues (t/ha)	
PLOUGHING INTENSITY (passages/ha/yr)	$$PL = \frac{\sum_i PL_i * A_i}{\sum_i A_i}$$ PL_i: Number of ploughing per year on the field i A_i: Area of the field i (ha)	

Figure S1: Typology of the farming systems found in the study region of the North Basse-Terre.

SUGARCANE	SUGARCANE-PASTURE	EXPORT-ROTATION	DIVERSIFICATION
FARMS: 560	FARMS: 183	FARMS: 72	FARMS: 34
TOTAL AREA: 2745 ha	TOTAL AREA: 906 ha	TOTAL AREA: 1287 ha	TOTAL AREA: 97 ha
MEAN AREA OF FARMS: 4,90 ha	MEAN AREA OF FARMS: 4,95 ha	MEAN AREA OF FARMS: 17,90 ha	MEAN AREA OF FARMS: 2,85 ha
MEAN SLOPE: 5,6%	MEAN SLOPE: 9,4%	MEAN SLOPE: 12,7%	MEAN SLOPE: 10,7%