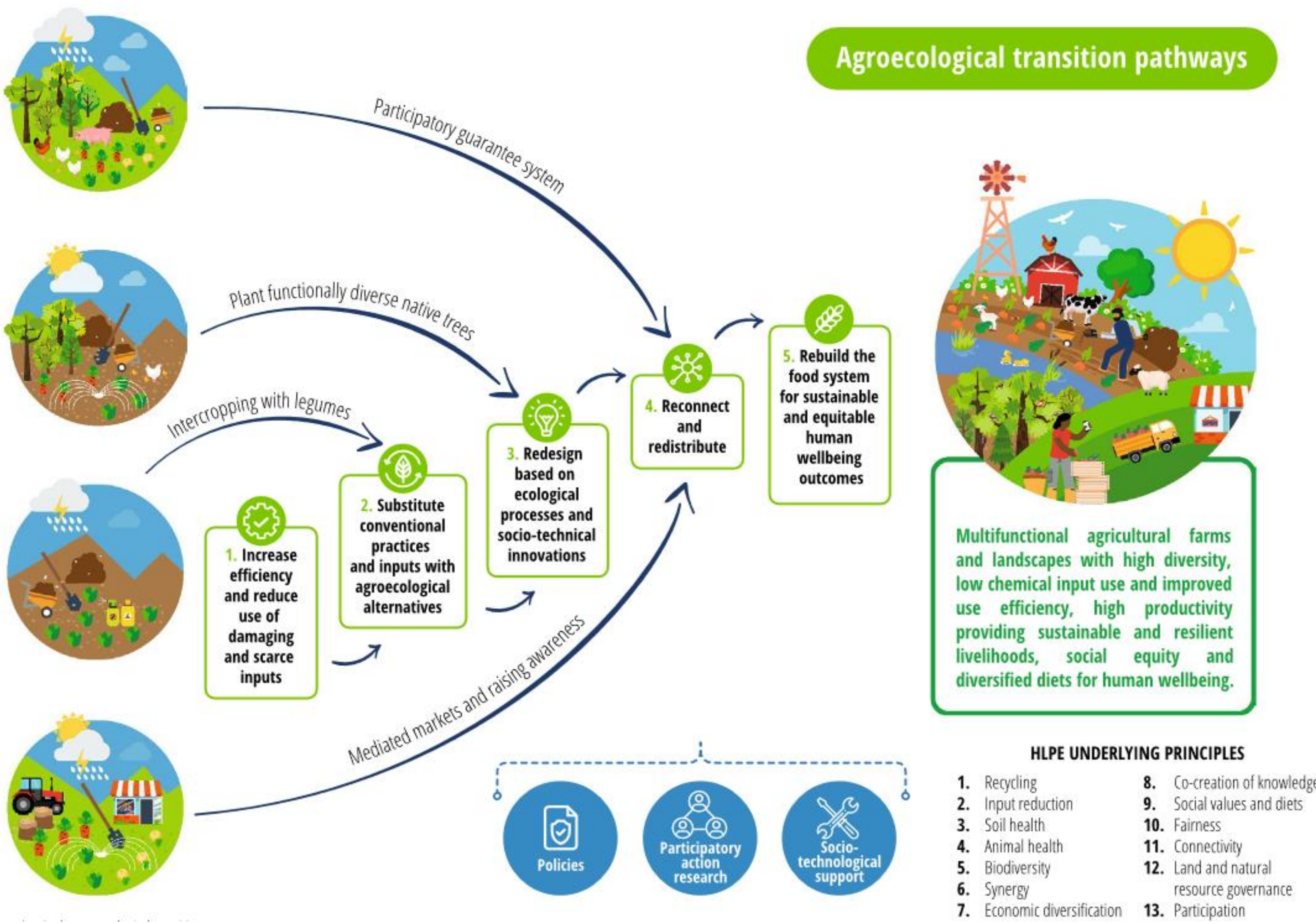
INSTITUTE OF MATHEMATICS AND PHYSICAL SCIENCES(IMSP)

Rsif Regional Scholarship and Innovation Fund

Mens Agitat Molem
UNIVERSITE D'ABOMEY-CALAVI

PASET
Partnership for Skills in Applied Sciences, Engineering & Technology

TITLE: ASSESSMENT OF FARMS AGROECOLOGICAL TRANSITION IN BURKINA FASO : PROPOSAL OF AN EMPIRICAL APPROACH



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Outline

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Background

Burkina Faso, like other countries in the West African sub-region, continues to face the challenge of food insecurity among its population. For many years, conventional farming practices based on the principles of the Green Revolution were seen as a means of intensifying agricultural production, but they have now reached their limits in many parts of the world, and in Burkina Faso in particular.

Burkina's enthusiasm for agroecology has its roots in the Burkinabe revolution of 1983-87 (Rabhi, 1986). However, the objectives set by the first authorities of that period in favor of agroecology were immediately abandoned in 1987 with the abolition of the revolution. It is only in recent years that agroecology has started to gain importance again. However, we are still not succeeding in getting agroecology adopted on a large scale (national or regional).

To achieve a genuine agroecological transition, one of the current challenges is to prove that agroecological production systems can achieve results that are better than or at least equal to those of conventional agriculture in economic, social, and environmental terms (Caquet et al., 2020; FAO, 2021; Gascuel-Odoux et al., 2022; Levard and Mathieu, 2018).

Objectives

The objectives of this study are to:

- *Assess the extent to which automatic learning methods are adopted in the analysis of agroecological transitions;*
- *Propose a classification of farms in order to situate the state of adoption of agroecology at national level using automatic learning methods;*
- *Assess the socio-economic and environmental performance of the different classes of farms;*
- *Propose an automation of farms' food security status and analyze the link between their food security status and their agricultural status;*
- *Propose a model of the agroecological transition process for farms.*

Activities completed

Activities already completed include:

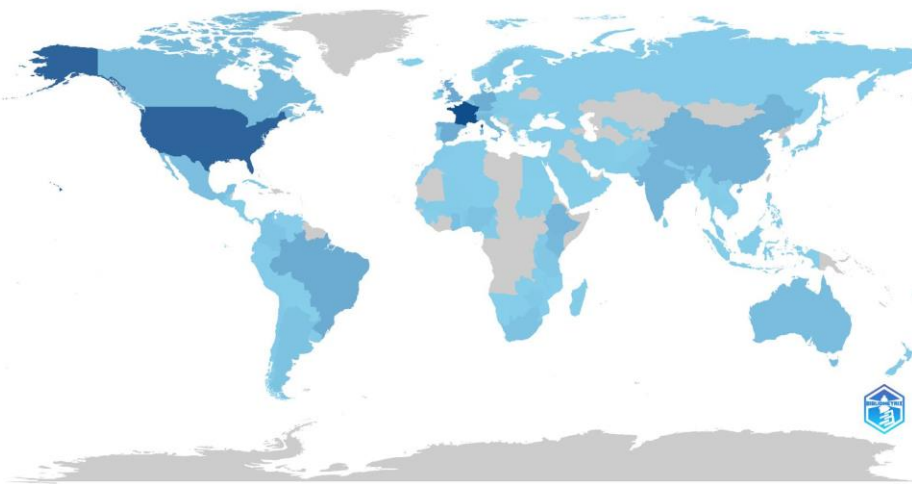
- *Study data recovery;*
- *Multiple training courses (including agronomy, data science, agroecology, etc.);*
- *Production of articles related to the achieved objectives;*
- *Participation in seminars, webinars and conferences related to our topic*

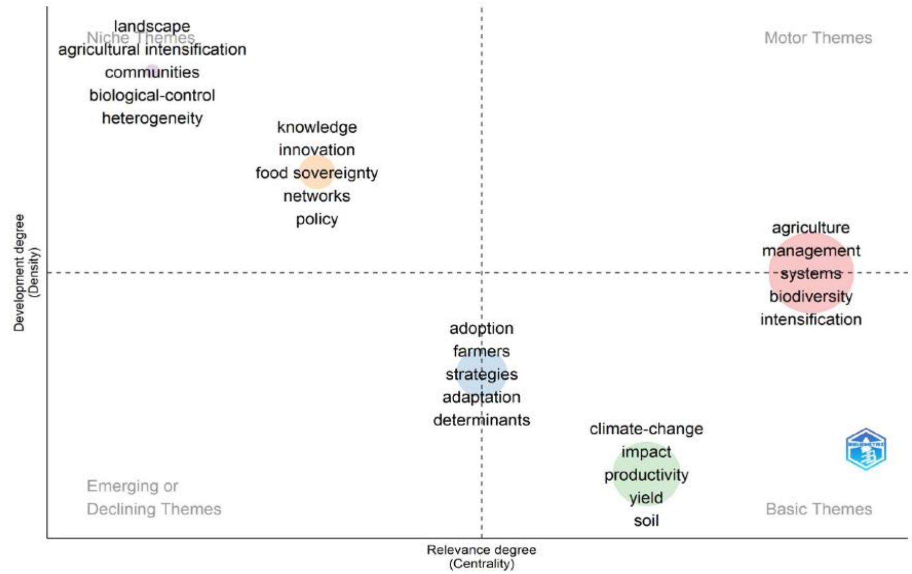
Generally speaking, this study has national coverage. To carry it out, we received a scholarship from the Regional Innovation and Research Fund (RSIF). Because of the coverage of the study, we are working in collaboration with Burkina Faso's Ministry of Agriculture to recover the data.

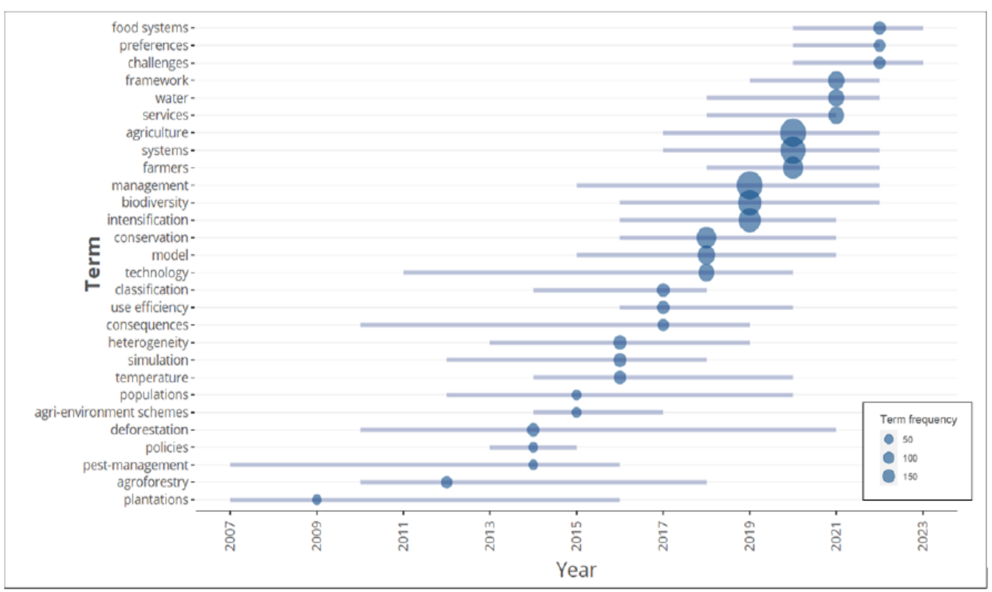
Results achieved

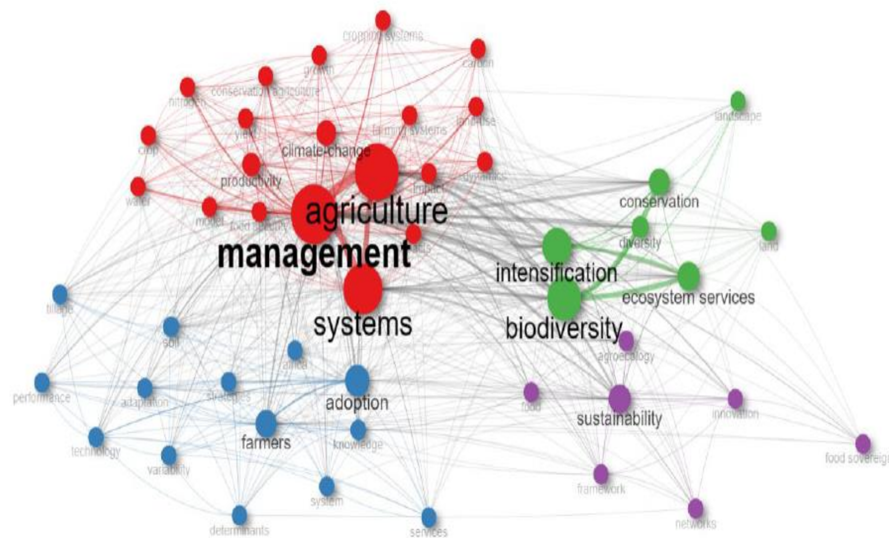
*Proposal of an article to assess the extent to which automatic learning methods are not yet well adopted for the analysis of agroecological transitions. Sustainability **2023**, 15, 15616. https://doi.org/10.3390/su152115616*

Country Scientific Production









CLASSIFICATION OBJECTIVE

FOCUS ON XGBOOST ALGORITHM STEPS

Require: Attach data import packages and model training packages

Input: Attach the Global data set

Ensure: Global data set is clean, formatted and labelled

Ensure: Split Global data set into train and test set

For k=1 to nround do

1: Initially, XGBoost builds a simple tree model, making predictions on training set.
2: It then calculates errors between these predictions and actual values.
3: Next, XGBoost builds another tree to predict and correct the previous tree's error
4: The process is repeated until the specified number of iteration is reached.
5: Then, predictions of all trees are aggregated sequentially

Ex: Xgboosting ⇐ xgboost(data = Xmatrix, nround =50, objective = "multi:softmax", eta = 0.25, num class =3, max depth = 10)

End

Output: Final class

Performance metrics of the model

MATHEMATICAL FOUNDATIONS OF THE XGBOOST MODEL

Mathematically, the model can be written like:

$$\hat{y}_i = \sum_{k=1}^{K} f_k(x_i), \quad (1)$$

$$obj^{(t)} = \sum_{i}^{n} l(y_i, \hat{y}_i^{k-1} + f_t(x_i)) + \Omega(f_t) \quad (2)$$

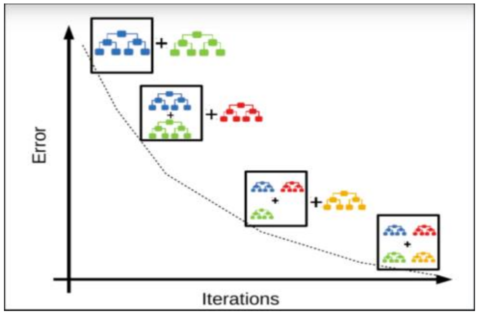
Following Equation(1) configuration, K is the number of trees, f belongs to the set of decision trees space and x_i denotes the input features and $\widehat{y_i}$ denotes the prediction.

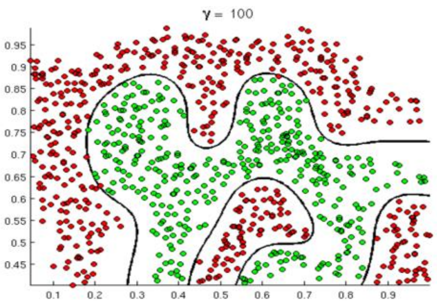
Referring to Equation(2), $\Omega(f_t) = \gamma T + \frac{1}{2}\lambda \sum_{j=1}^{T} \omega_j{}^2$

,ω is the vector of scores on leaves of tree, T the number of leaves. The first term of objective function is the loss function which measures difference between prediction $\widehat{y_i}$ and target y_i, while the second is the regularization parameter. The goal being to optimize the objective function $obj^{(t)}$. Using limited developments (e.g.Taylor series), we can get an alternative form of this function.

Results achieved

- *Proposal of an article to situate the state of adoption of agroecology in BF and to automate next classification processes.(**publications in progress**);*
- *comparison of socio-economic and environmental performance between conventional and agroecological farms (there are really no economic losses in adopting agroecology)*





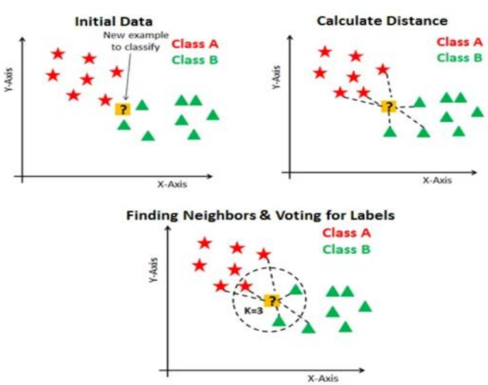


Table 3 Models Performance Comparison

	Accuracy	Kappa			Precision			Recall			F1-score		
Classes levels		**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**
NB	0.39	0.21	0.18	0.24	0.44	0.16	0.88	0.96	0.85	0.18	0.6	0.27	0.29
KNN	0.80	0.49	0.44	0.55	0.72	0.51	0.83	0.62	0.27	0.91	0.67	0.35	0.87
LRM	0.94	0.87	0.84	0.90	0.95	0.8	0.96	0.94	0.75	0.97	0.94	0.78	0.96
SVM (Radial)	0.96	0.90	0.87	0.93	0.98	0.90	0.96	0.92	0.81	0.99	0.95	0.85	0.97
SVM (Polynomial)	0.96	0.90	0.87	0.93	0.98	0.83	0.96	0.94	0.81	0.98	0.96	0.82	0.97
RF	0.95	0.88	0.84	0.91	0.99	0.98	0.94	0.93	0.58	0.99	0.96	0.73	0.97
XGBOOSTING	0.99	0.99	0.98	0.99	0.99	0.97	0.99	1	0.98	0.99	0.99	0.98	0.99

Table 5 Mean and Standard Deviation(SD) of others main features describing the various farms groups

Variables	**Description**	**Conventional Farms**		**Farms in transition**		**Agroecological farms**		**Units**
		Mean	SD	Mean	SD	Mean	SD	
Vente_pluviale	Value of pluvial sales	189576	791748	198804	1581080	59724	214873	Fcfa
Dep_tot	Total farm household expenses	292977	529501	306533	474890	287071	294162	Fcfa
Cout_mainoeuvre	Labor costs	5914	21075	5443	20772	3147	11192	Fcfa
Qte_homm_jour	Number of men use per day	4	16	4	16	5	19	Units
Montant_intrant_credit	Credit gained for inputs acquisition	30067	113230	46093	187429	18834	94970	Fcfa
Production_princ	Production of the farm's main product	1,67	2,23	1,67	2,01	1,61	2,01	in tons
Nb_animaux_traction	Number of draught animals	1,28	1,79	1,71	2,10	1,56	1,84	units
Total_animaux	Total number of animals	47,01	141,09	51,54	99,00	41,48	41,39	units
Duree_dernierejacher	Duration of last fallow	0.84	4,00	1.06	4,13	2.12	6,00	years
Prop_utilisesemencep	Proportion of rainfed production used as seed	0,16	0,19	0,18	0,19	0,21	0,16	percent
Prop_creditintrant	Proportion of credit used in total amount allocated to input purchases	0,10	0,26	0,10	0,25	0,05	0,18	percent

Source: Permanent Agricultural Survey, 2019/2020, Author outputs.

SD: Standard Deviation

Recommendations

- *In general, a number of variables have been identified as levers for agro-ecological transition: gender, membership of FOs, marital status, labor costs and many others. Decision-makers and financial partners will be able to draw on these variables to motivate more farmers to make a success of their transition.*

- *We have also observed that the gap between the economic performance of agroecological and conventional farms is not very wide. This may encourage producers who are still hesitating*

Outlook

Future works could focus on how to:

- *quantify the contribution of agroecological practices to climate change;*
- *Propose an objective method for modeling the agroecological transition;*
- *In-depth analysis of the link between employment and the adoption of agroecology;*
- *Propose approaches able to federate all players in the agricultural production chain around agroecology: agricultural policies essentially focused on agroecology;*
- *Raise awareness of agroecology among stakeholders, at the same time as halting subsidies for chemical inputs.*

Acknowledgements

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