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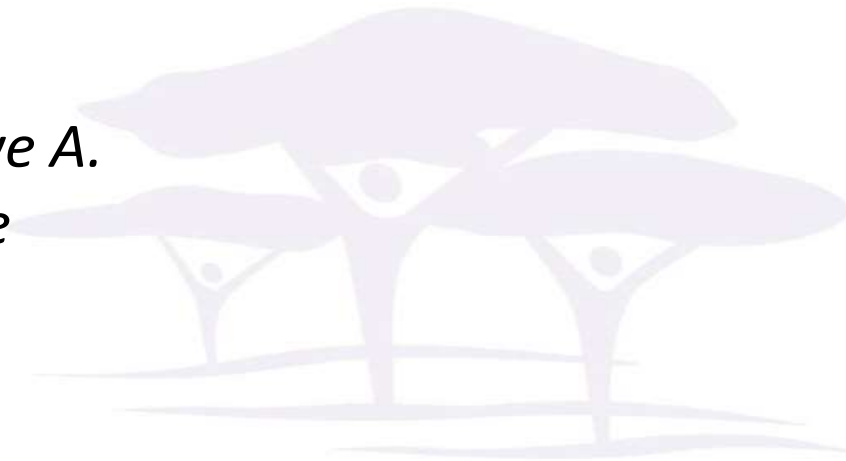
RESEARCH
PROGRAM ON
Forests, Trees and
Agroforestry



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Effects of local institutions in the adoption of agroforestry innovations: Evidence from farmer managed natural regeneration and its implications on rural livelihoods in the Sahel

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Introduction

The purpose of this presentation is to:

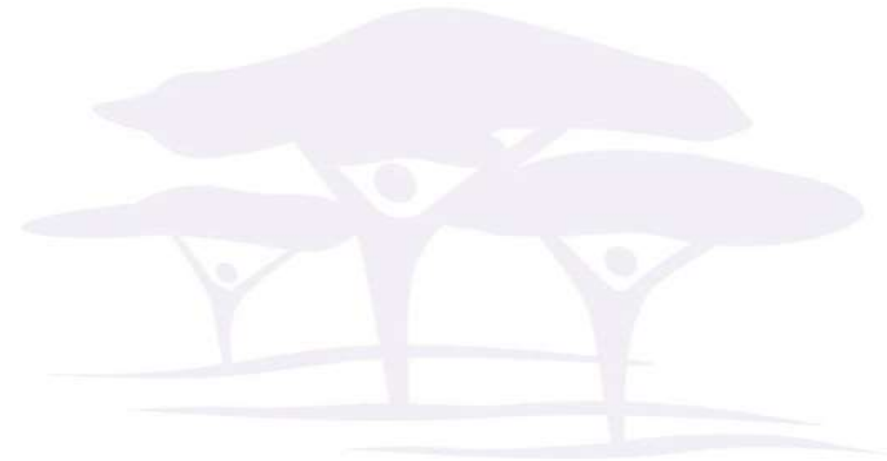
- Review the concept of FMNR and the ES provided by agroforestry parklands
- Introduce an institutional perspective in our understanding of Institutions and ES
- Discuss the concept of institution governing NR as appearing in the Sahel
- Discuss the factors affecting investment on trees in farm through FMNR
- Discuss the effects of the practice on livelihoods
- Draw lessons from the results



Research Methods

Lessons presented here are drawn from

- Literature Review
- Exchange and interactions with farmers
- Data analysis
- Experiences from the field



FMNR is a very descriptive name of the practice

It involves regeneration of trees on farms, where farmers are actively involved to manipulate the natural biological regeneration into one that suits them

The types of activities that farmers carry out which would define FMNR include:

1. Thinning of unwanted emergent trees
2. Protection of desired emergent trees from grazing through micro structures or fencing,
3. Managing water for the young trees, taking action against insects and disease,
4. Retention of mature trees so that the rootstock may regenerate more young trees,
5. Ploughing practices that preserve emergent trees, and annual care of the regenerated trees

Although in a strict definition of FMNR, it may be possible to classify farmers into practitioners or not, in the drylands, it can be argued that virtually all farmers practice FMNR to some degree (e.g. all farmers will actively thin trees from their fields). It is rather the degree to which it is done which differs considerably.

Thus farmer managed natural regeneration can be perceived as an improved land-use management practice that is also essential to promote ES



Ecosystem services provided by the parklands (Bayala et al., 2014)

Category	Group	Observations
Provisioning services	Food, feed, medicine	<ul style="list-style-type: none"> ➤ Variation in yield: from -0.54t/ha under <i>Balanites aegyptiaca</i> to +0.24 t/ha under <i>F. albida</i> and biomass yield difference from -1.31 t/ha under <i>P. biglobosa</i> to +4.07 t/ha under <i>Prosopis Africana</i>. Tuber (<i>Colocasia esculenta</i>) is rather improved under trees (+0.4 to +1.67 t/ha) ➤ Tree fruits and other edible tree products constitute an important source of micro-nutrients and vitamins that complement the cereal-based diet of the Sahelian population (<i>Lannea microcarpa</i>, <i>P. boglobosa</i>, <i>Saba senegalensis</i>, <i>V. paradoxa</i>, <i>A. digitata</i> etc...)—qty consumed/day equivalent to 0.4-18.8% for energy, 0.3-11.6% for proteins, 0-2.3% for lipids, 0.7-80.1% for calcium, 0.6-68.7% for iron. ➤ Trees also make up a large proportion of high quality fodder intake by livestock and crucial in the dry season
Regulating services	Micro-climate, ground water recharge, reduce runoff, erosion and flooding,	<ul style="list-style-type: none"> ➤ Crops under trees are less exposed to excessive temperatures of above 40 °C with 1-9h/week under <i>vitellaria</i> and <i>parkia</i> against 27 h/week in the open field. ➤ Trees can also reduce wind speed and while increasing soil and air humidity as well as diseases like fungal attacks. ➤ Recent studies of sahelian agroforestry parklands have revealed a decrease in soil bulk density and as consequence, soils under trees displayed higher porosity compared to adjacent open areas
Supporting services	Carbon in soil, nutrient cycling and fauna	Trees in the parklands contribute to the reduction of carbon in the atmosphere by accumulating biomass via photosynthesis

Our understanding of understanding of institutions and Ecosystem services

The linkage between institutions and Ecosystem services can be underpinned within the framework of the NIE

The NIE borrows liberally from various social science disciplines but its primary language is economics. Its goal is to explain what institutions are, how they arise, what purposes they serve, how they change and how they should be reformed if necessary (Geraldi, 2007).

There are core concepts and principles in IE theory.

Ownership and property rights

The main argument of the *property right theory* is that besides the value of good itself, the value of the property right is to be considered, that is: (1) the right to use (*usus*), (2) the right to change (*abusus*), (3) the right to make profit or losses (*usus fructus*) and, (4) the right to transfer. Indeed ownership and property rights are the foundations of IE theory.

Norms and social conventions

Institutions are bodies of rules, both formal and informal and often explicit and that are built out of property rights and structure social conduct by defining the rules of the economic game and resources, constraints, opportunity sets, incentives, and strategic interdependencies faced by economic agents (North, 1990). One approach is to interpret social conventions as non-cooperative Nash-equilibrium solutions to a variety of repeated games faced by individuals in social settings (Kaufman, 2010).

Overview of Institutions governing NR in the Sahel

Institution governing farmlands

Generally, control over access to farmland is in the hands of the lineage that started farming first in the village, personified in the male-head or lineage.

The head of the family can grant strangers temporary access to land (secondary right)

Pastoralists tend to have a host in the community who will help them to secure their secondary rights to pasture and crop residues as well as rights of passage.

Institutions governing common lands

In the semi-arid zone of West Africa, forests, pastures and fallows are resources that are used by multiple groups for herding cattle, cutting wood, gathering, hunting, bee keeping etc... but with competing interests.

In principle, the new forest codes go some way towards recognizing customary rights and, in some cases, devolving management of certain forest resources to local populations. In practice, even if farmland technically falls outside the forest domain, because rural landholdings are often non-registered, they continue to fall under the state control.

Institutional change

current local governance institutions managing access and use of natural resources in Sahel

Many Sahelian countries have undergone and institutional shift within the last decades. Communities in rural areas display a wide diversity of cultures and type of livelihoods pursued. As noted by Hilhorst (2008) here is a juxtaposition of various formal and informal authority structures and laws.

Customary authorities

The legitimacy and authority of these leaders is based on a mixture of customary and religious laws as well as social agreements
Leader chosen through customary decision-making processes and expected to act as custodians

Village land Mgt commissions

Since 1993 in Niger and 2000 in Burkina Faso, the establishment of more formal governance institutions was developed to play a significant role in natural resource management and even land administration.
It was expected that these changes in natural resource governance will contribute to reconcile the various, and sometimes contradictory land tenure regimes and eliminate tenure-related obstacles to socio-economic development

Local conventions

These are more or less formalized negotiated agreement designed and formulated to regulate access and use of common natural resources. Existing in many Sahelian countries including Burkina Faso, Mali and Niger, the defined rules and regulations formulated through a process of stakeholder consultation and dialogue may address bushfire surveillance brigades, marking out livestock tracts, fixing periods for harvesting wild fruits or entering grazing lands, quotas for resource use, protection of regenerating forest etc...

Investment on trees: Do institutions really matter?

The dependent variable, practice of FMNR, is measured by the density of trees kept and managed by the household in his farmlands

To ascertain the effects of formal and informal institutions on investment in agroforestry through FMNR, the data collected in 2012 from 1,080 households in four different countries, namely Burkina Faso, Mali, Niger and Senegal, are used

Factors influencing investment on trees

The investment on agroforestry innovation is influenced by various factors, some of them have little to do with policy/institutions while others are directly linked with the existing policy

Thus for each household, in addition to institutional variable, we have a set of many other covariates.

In addition, a number of covariates are specified to reflect the potential effects of those variables on investment in trees. Factors that may influence a household's decision in agroforestry practices are classified into three constructs: household structure, household endowment (access to assets), and access to information.

There are several institutional related factors that have been identified as limiting the potential for FMNR, such as fire setting, free grazing and rights and regulations over trees.

These factors are generally regulated through governing formal and informal structures overwhelmingly defined by codes of conduct, norms of behavior and conventions. In this study, we are interested on local conventions (LOCONV) and formal village land management commissions (COFO/CVGT)

Investment in trees: Do institutions really matter?

To identify the factors influencing investment on trees and assess the effects of FMNR on the selected outcomes, we borrow the conceptual framework developed by Hirano and Imbens (2004) and further performed by Bia and Mattei (2008) in a setting with the continuous treatment labelled as GPS estimator or propensity score with continuous treatments

Step 1

Modeling the conditional distribution of the treatment given covariates

Step 2

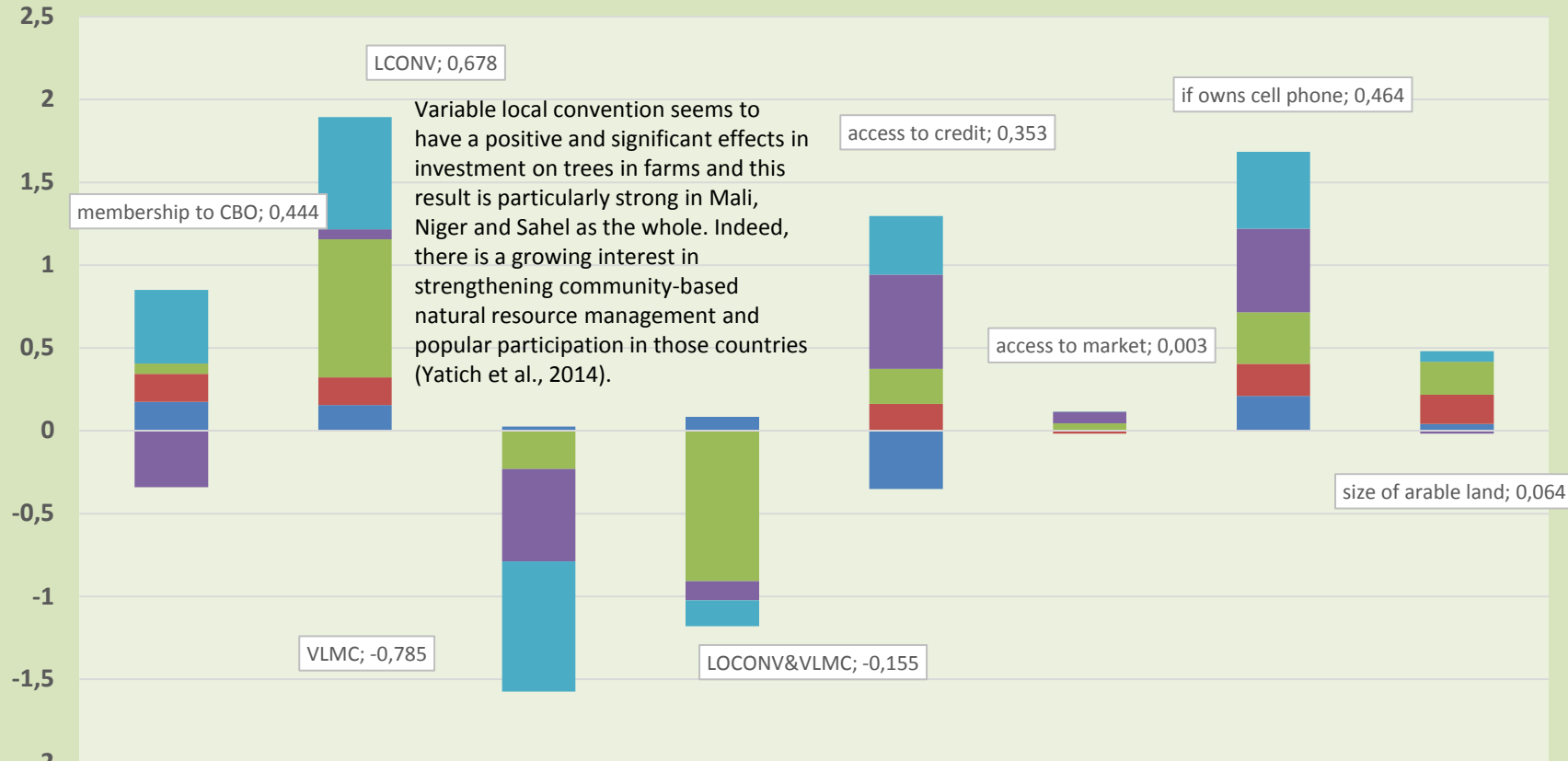
Estimating the conditional expectation of the outcome given the treatment and GPS

Step 3

Estimating the dose response function to discern treatment effects as well as their 95% confidence bands

Results: Factors influencing investments on trees in the farm

Figure 1: Factors influencing investment on trees in the farmlands



	membership to CBO	LCONV	VLMC	LOCONV&VLMC	access to credit	access to market	if owns cell phone	size of arable land
Sahel	0,444	0,678	-0,785	-0,155	0,353	0,003	0,464	0,064
Senegal	-0,34	0,06	-0,559	-0,116	0,569	0,069	0,505	-0,017
Niger	0,063	0,833	-0,23	-0,908	0,212	0,045	0,31	0,199
Mali	0,169	0,167			0,162	-0,017	0,194	0,176
Burkina Faso	0,174	0,156	0,025	0,085	-0,351	0	0,211	0,042



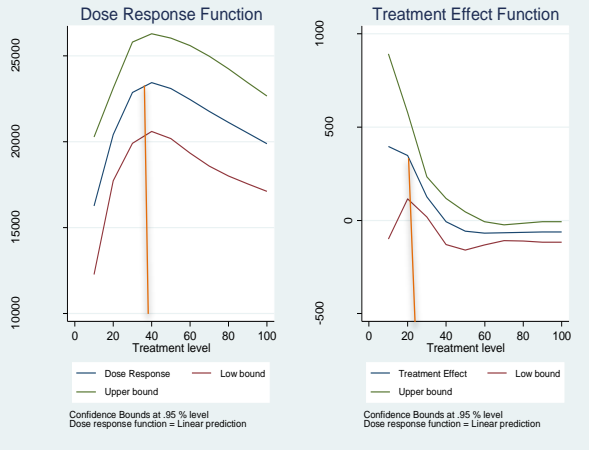
In areas where the village land management commissions work well and because of their flexibility such as in Burkina Faso where the local populations can view those commissions as a legal provision that they must adapt to, there is a lot of buy-in and populations in some villages seem to have adopted through a better collaboration with the local government in developing the village development plan and natural resource protection.

The results also seems to indicate that there is a need to develop a more integrated institutional frameworks and find ways to enhance effective participation across institutions. It appearing from the results that some villages we are interested in are governed by different agencies that don't always communicate, with diverse and sometimes conflicting regulatory structures and overlapping jurisdictions.

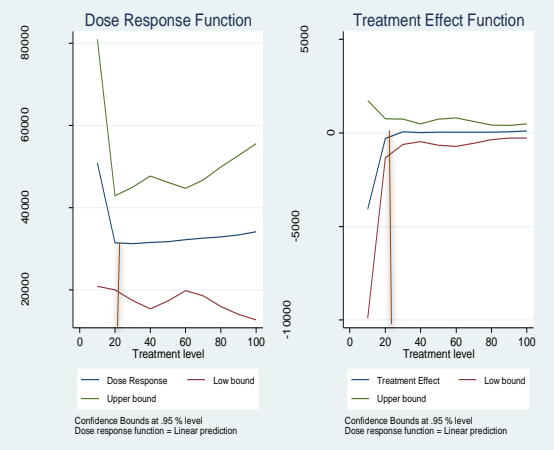
Results: Assessing the effects of FMNR on livelihoods--Income



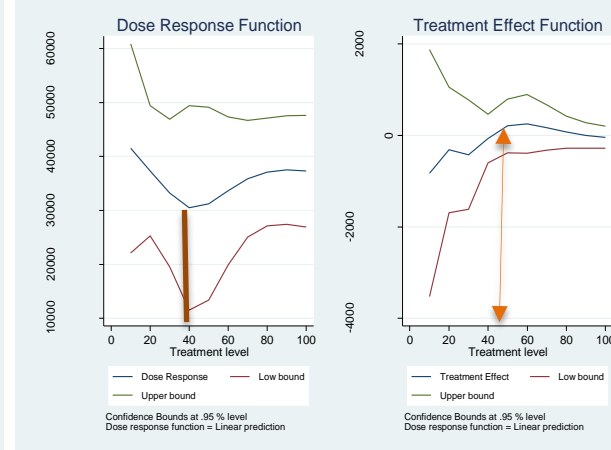
Sahel



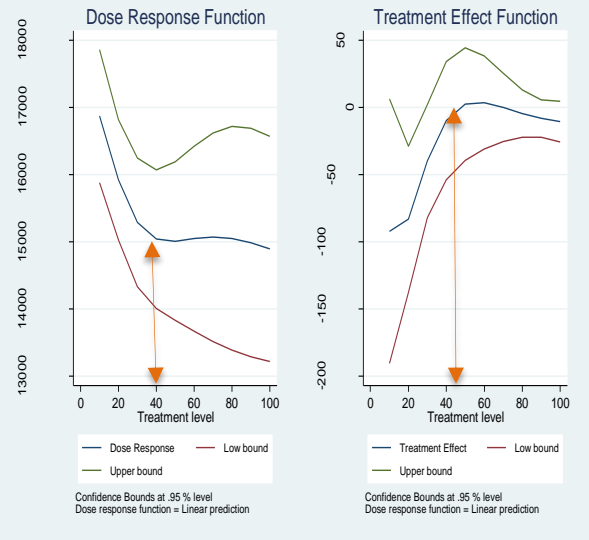
Burkina



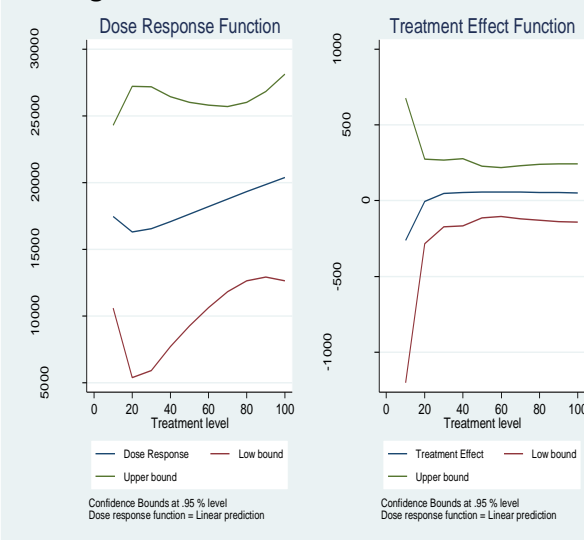
Mali



Niger



Senegal



2. The marginal effects again show that farmers who are less involved in the practice of FMNR (i.e. farm with less than 40 trees/ha) are more sensitive to income change than those with more trees (i.e. higher than 40/ha) as the effects of changes in income tend to be stable as it appeared in the plot.

1. Taking the dose-response function results, generally speaking in the Sahel, it appears that there is a sharp increase of income received from marketed trees products when the number of trees kept and managed in the farmland ranges from 10 to 40/ha. After the threshold of 22000 CFA benefit, the total amount earn from selling trees products harvested on farm decreases up to 20000 CFA when the number of trees ranges from 45 to 100/ha.

3. The findings may suggest that in order to earn more income from the FMNR practices, there is an optimal number of trees needed to be kept and managed in the farm. For future research it would be interesting to see the distributional pattern of species and assess the optimal combination species/density that can optimize the amount of revenue received from tree products.

Results: Assessing the effects of FMNR on livelihoods—Crops yield



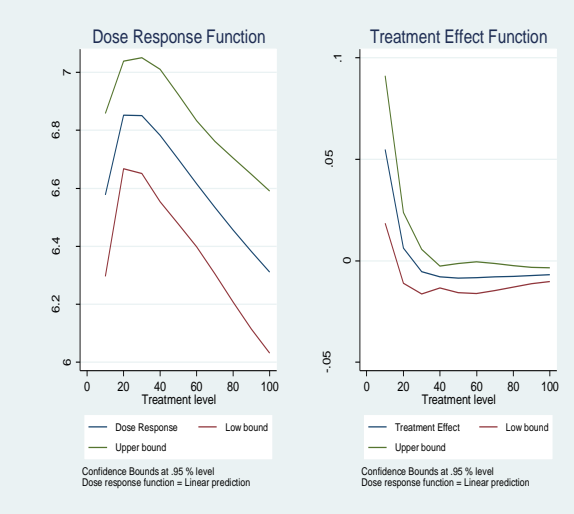
1. Considering the dose-response results in figure 3, there is a sharp increase in crop production when the density of trees ranges 15 to 20 trees/ha; after the density level of 20 trees/ha, when the density range from 20-40/ha the effects on crop production tend to be constant; after the density level of 40 trees/ha, the crop production decrease as the density levels increase

2. As appearing from the dose-response plots, the maximum effects is noted when the density of trees ranges from 20 to 40/ha, indicating an increase of crop production by 915.985kg ($=e^{6.82}$) or 274.25kg/ha ($=915.985/3.34$) in the Sahel

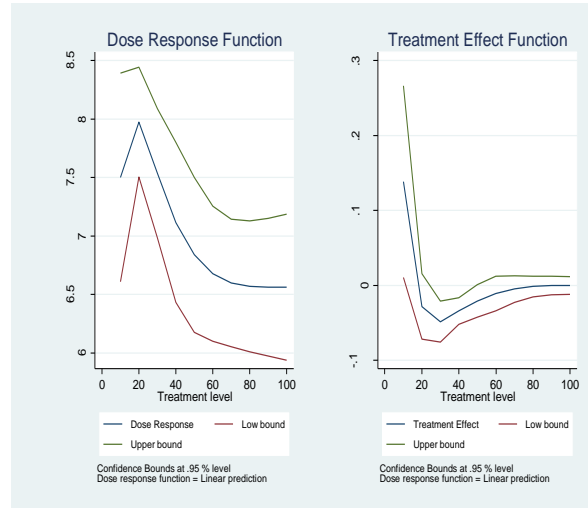
3. The same calculations can be done for all countries indicating an increase of the expected quantity of cereals produced by 401.38 kg/ha in Burkina Faso; 198.9kg/ha in Mali; 112.76 kg/ha in Niger and; 132.12 in Senegal.

4. These findings are in line with what is found in the literature. In fact, past studies on tree-crop interactions have clearly shown that trees have highly varying effects on the associated crops when comparing the yield of associated crops in the influence zone of trees with that of a treeless monoculture control plot (Bayala et al., 2012; 2014).

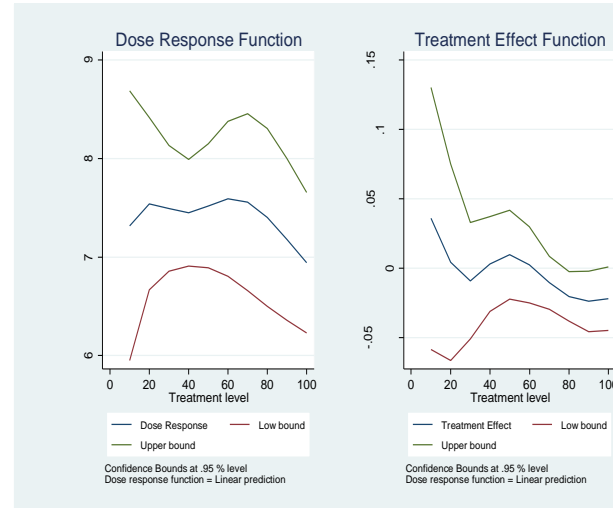
Sahel



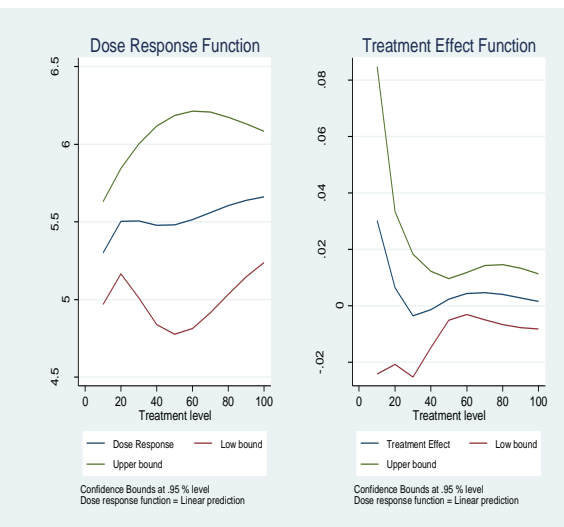
Burkina



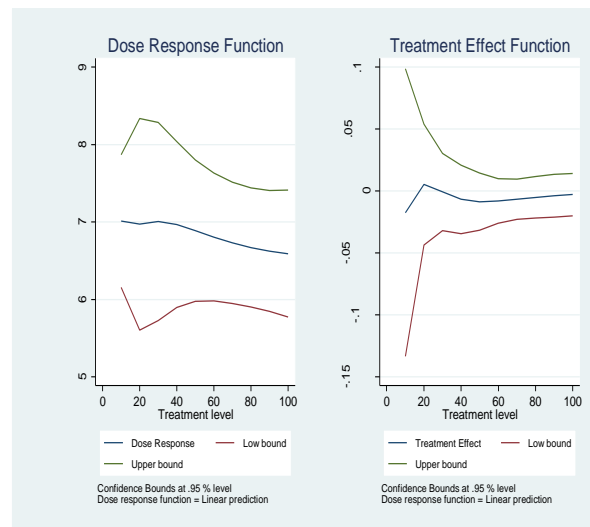
Mali



Niger



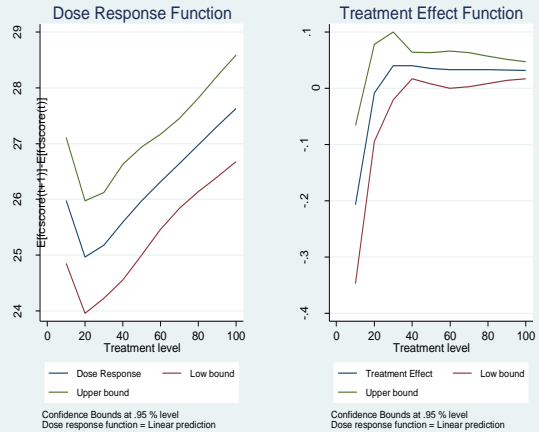
Senegal



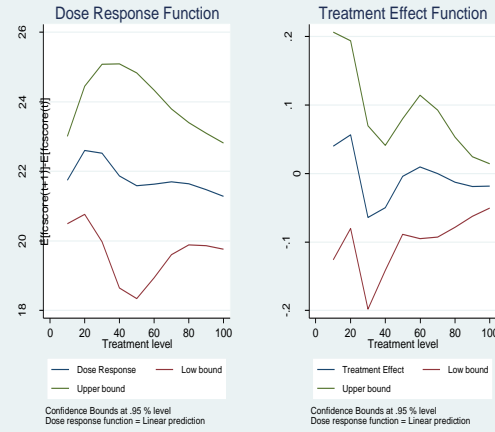
Results: Assessing the effects of FMNR on livelihoods—Food security



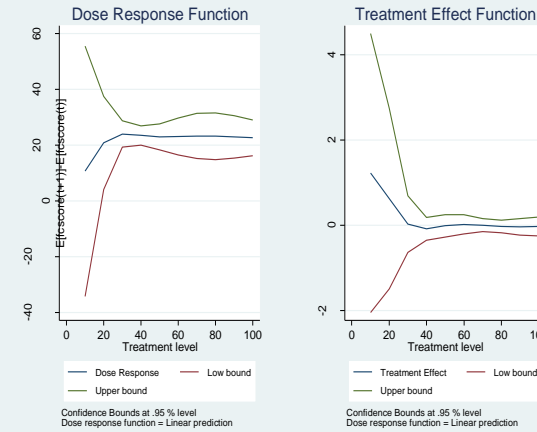
Sahel



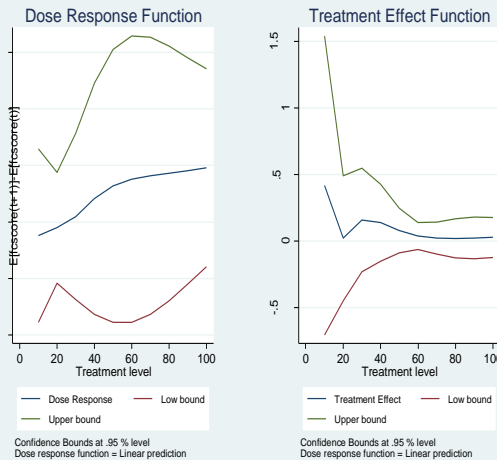
Burkina



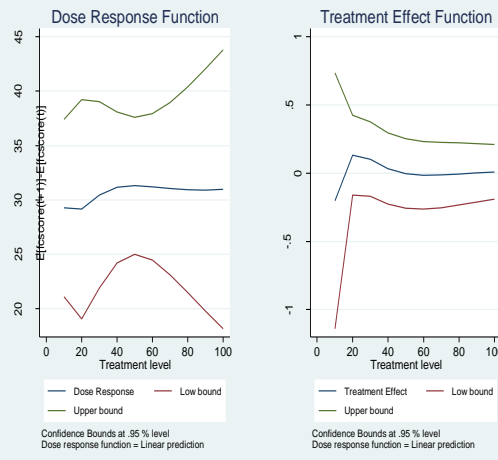
Mali



Niger



Senegal



2The score tends to be constant at 22 points increased when the minimum density is 20 trees/ha in Burkina Faso and Mali. The effects tend also to be constant at 30 points increased of the food consumption score in Senegal.

1. According to the treatment effects plots, the contribution of trees on food security tends to decrease when the density ranges from 15-20 trees/ha, after the 20 trees/ha threshold, and increase in the number of trees kept and managed in the farmland increase the food consumption score gradually with every unit increase in the number of trees managed by the farmers to a maximum score of 30 points increased in Niger and Sahel and the whole.

3. Definitely, these results suggest that tree products can serve as a safety-net in times of crises (e.g. income shortages from other income sources, e.g. crop failure) as they may be ready for harvest to serve as emergency food or to be processed and sold.

Conclusion and outlook

This study demonstrated that regeneration of trees on farms, whereby farmers play an active role in the types of trees and their densities, is important as a practice and also essential in ensuring provisional ES to rural households in the drylands

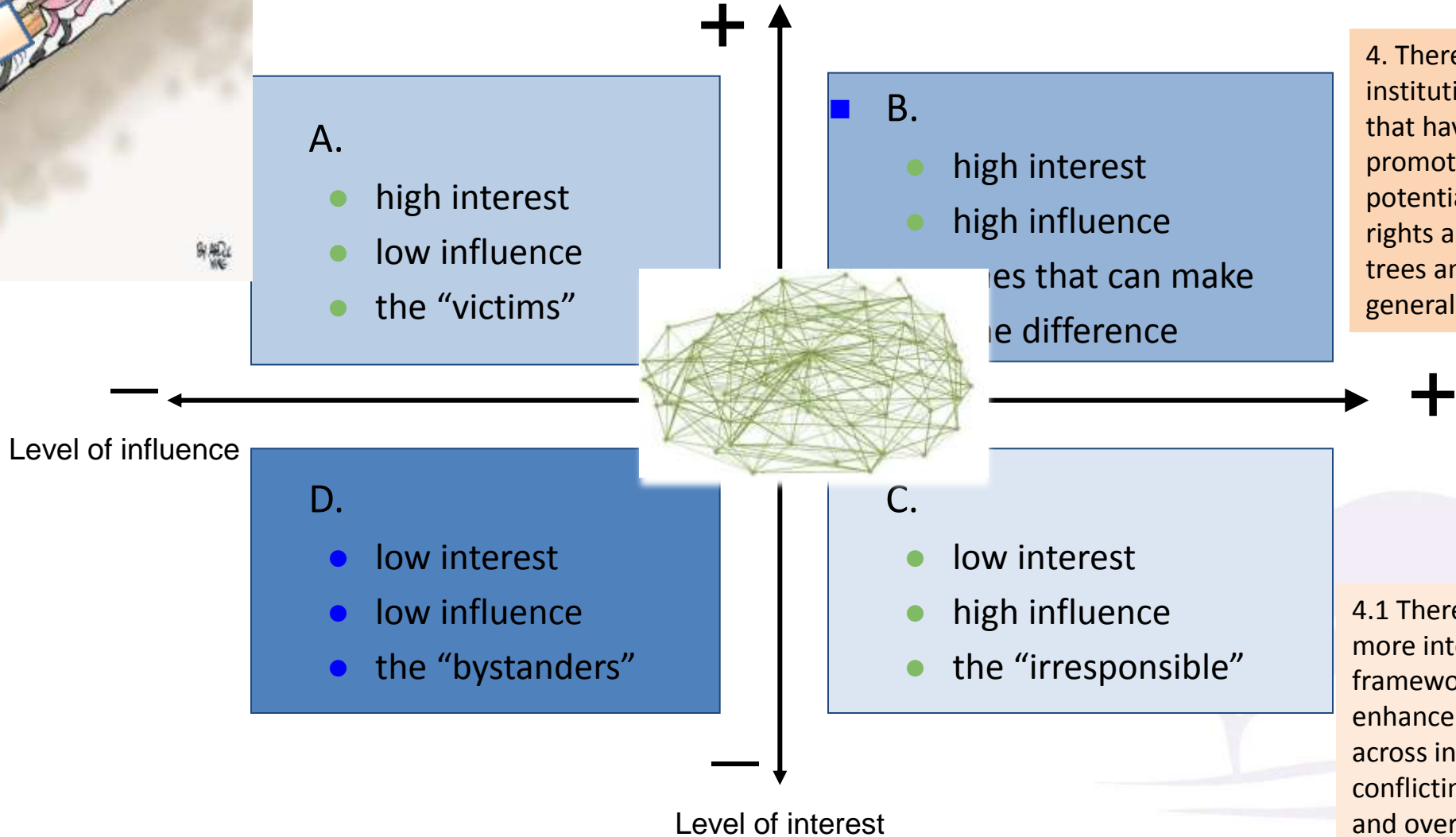
At a coarse scale, FMNR cannot be excluded as a recommendation in any geographical region or in any of the dryland zones. FMNR will continue to support the largest number of established trees on farms in the drylands.

Factors affecting investment on trees

1. The study of factors affecting investment in trees through FMNR in the Sahel did not find many household constraints to be significant.
2. Land tenure would be a factor, but in the study area, over 85% of all land parcels were inherited in each of the countries.

3. Capacity building, communication, information on the immediate, medium and long term individual and public benefits simultaneously need to be well-communicated to many stakeholders.

Conclusion and outlook



4. There are several institutional related factors that have been identified as promoting or limiting the potential for FMNR, such as rights and regulation rules over trees and natural resources in general.

4.1 There is a need to develop a more integrated institutional frameworks and find ways to enhance effective participation across institutions to avoid conflicting regulatory structures and overlapping jurisdictions