Gender differences in the adoption of agroecological practices: Evidence from northern Nicaragua

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Summary

The transition to more sustainable forms of agriculture, such as the adoption of agroecological practices, is a key point of on-farm adaptation to climate change. The use of agroecological practices has been shown to increase farms' diversity and resilience to the impacts of climate change. Yet, little attention has been paid to differences in how female and male farmers adopt such practices, as well as their underlying personal norms for doing so. Results from a 2014 survey of 121 smallholder farmers (51% female, 49% male) in northern Nicaragua demonstrate that female farmers tend to use a greater number of agroecological practices on their farms than do male farmers. Unlike male farmers, whose use of agroecological practices increased according to their pro-environmental personal norms, female farmers tended to use a consistently high number of agroecological practices, regardless of the strength of their pro-environmental personal norms. A better understanding of differences in female and male farmers' personal norms regarding the adoption of agroecological practices could aid in better targeting policies and interventions aimed at increasing farms' resilience to climate change.

1. Introduction

1.1 Research problem

Transitioning to resilient, productive agricultural systems in the tropics is paramount to ensure food security. Agroecological principles, which valorize ecosystem services, are based in functional diversity, and recognize the multi-functionality of agriculture, can provide the tools for creating and maintaining productive, resilient agroecosystems, and may be a powerful instrument for achieving change towards more equitable food systems with just working conditions for male and female farmers (Gonzalez de Molina 2013; De Schutter 2010; Duru,

Therond, and Fares 2015; Méndez, Bacon, and Cohen 2012; Timmermann and Félix 2015; Wezel et al. 2009; FAO 2015). As farmers are the central actors of the on-farm decision-making that shapes the landscape (Darnhofer, Gibbon, and Dedieu 2012), it is important to understand how their personal norms affect adoption, as well as what practices are adopted - and how this may differ across genders. Research has shown that climate shocks and climatic disasters negatively impact gender equality, particularly in countries in the Global South (Eastin 2018). Hence, it is even more important to understand how female farmers can be better supported in adopting and using farming practices that contribute to increasing farms' resilience to the impacts of climate change, such as has been shown to be the case for agroecological practices (Holt-Giménez 2002).

This exploratory study analyzes gender-disaggregated data regarding farmers' pro-environmental personal norms and their adoption of agroecological practices from smallholder mixed systems (bean and maize) farmers from the dry tropics in northern Nicaragua, an area which is already impacted by changing climate patterns (IAASTD 2011; Gourdji et al. 2014; Läderach et al. 2017).

1.2 Research gap

Although transitions are understood to be enacted through multi-actor processes (Köhler et al. 2017), actors' roles and functions have been understudied in socio-technical sustainability transitions research (Upham et al. 2015). None of the main strands of transitions frameworks (Multi-Level Perspective, Technological Innovation Systems, Strategic Niche Management, Transition Management) (Köhler et al. 2017) give space to examine individual actors' agency (Upham et al. 2015). As such, a closer examination of the roles played by both users and consumers in driving sustainability transitions has been highlighted as an avenue of research (Köhler et al. 2017).

Scholarship in socio-technical sustainability transitions has focused more on institutional entrepreneurship (Jolly, Spodniak, and Raven 2016; Sotarauta and Mustikkamäki 2015; Hung and Whittington 2011) than on the role of individuals as entrepreneurs in enacting sustainability transitions. Rather than being defined through human terms, agency has been

understood as organizations' 'institutional work' (Fuenfschilling and Truffer 2016; Bohnsack, Pinkse, and Kolk 2014; Binz et al. 2016), seen through the lens of entrepreneurial firms (Alkemade 2011), and has been shown to be both distributed among, and embedded in, organizations (Garud, Karnøe, and Karnoe 2003). Rather than focus on individuals, change agents have been identified as institutional entrepreneurs, e.g. by (Sixt, Klerkx, and Griffin 2017). Several authors have argued for including a stronger focus on agency through niche actors pushing niche innovations and supporting regime changes (Smith, Stirling, and Berkhout 2005; Genus and Coles 2008; Kern 2015), e.g. through different actors strategically joining forces to leverage common goals (see e.g. (Musiolik, Markard, and Hekkert 2012; Farla et al. 2012). Adding entrepreneurship to agency, (Hassink, Grin, and Hulsink 2018) further unpack the notion of individuals' roles in socio-technical transitions. Additionally, actors' pro-environmental awareness has been seen to be important in motivating individuals' behaviors towards sustainability transitions (Upham et al. 2015).

As outlined in (Köhler et al. 2017), both users and consumers play important roles in enacting sustainability transitions. In agricultural sustainability transitions, farmers are both users and consumers of transitions goods, and as such take a central role in transition processes (Darnhofer, Gibbon, and Dedieu 2012). Although micro-level analyses such as this one may run the risk of 'zooming in' too far and losing sight of the larger transition picture (as warned by (Köhler et al. 2017), we uphold that they are nonetheless important lenses to forge a deeper understand of the processes involved in socio-technical sustainability transitions. This paper adds to this nascent discussion by examining possible links between actors' pro-environmental personal norms and their adoption of pro-environmental practices.

Farmers' decision-making regarding the adoption of novel technologies and practices is considered to be driven by a combination of factors that are extrinsic and intrinsic to the farmer (Meijer et al., 2014; Price and Leviston, 2014). We follow here the distinction by Meijer et al. (2014), who refer to socio-economic, bio-physical, political, and technological factors as 'extrinsic', and psychological factors such as knowledge, attitudes and perceptions as intrinsic. Although much research concerning the adoption of technologies and practices focuses on explanatory characteristics that are extrinsic (such as socio-economic characteristics of the

farmer (e.g. age, education) and the farm (e.g. asset position, size, location), and the technical characteristics of the innovation (e.g. trialability, compatibility)), the importance of intrinsic factors (e.g. processes of learning and experience, farmers' perceptions of the risks of the innovation) is increasingly recognized (Marra et al., 2003; Pannell et al., 2006a; Pattanayak et al., 2003), as farmers' perceptions of new technologies and practices influence their attitude and propensity to change and connected to that, their adoption actions (Ahnström et al., 2008; Jansen et al., 2009; Meijer et al., 2014; Niles et al., 2013; Prokopy et al., 2015).

Perhaps because the term agroecology is a contested term, because there are so many agricultural practices that are 'agroecological', or because the use of agroecological practices is highly dependent on agro-environmental context, studies exploring the adoption of a system of practices remain few and far between; case studies from the Global South are rare, and case studies involving gender rarer. Although research has shown that farmers' attitudes play central roles in determining the outcome of the adoption of pro-environmental practices (Ahnström et al. 2009), "relatively few studies focusing on factors of a social psychology type in decision making have been conducted to date regarding small-scale farming in developing countries" (Martínez-García, Dorward, and Rehman 2013, p. 237). Particularly the psychological constructs underlying farmers' decision-making regarding their adoption of agroecological practices remain understudied (Hansson, Ferguson, and Olofsson 2012; Rossi Borges et al. 2014). Another factor that has henceforth remained (surprisingly) understudied – especially considering social justice is one of the pillars of agroecology - is the impact gender may have in the adoption of agroecological technologies (Akram-Lodhi 2015; Sarrouy Kay, Lemke, and Pimbert 2016). Of adoption studies concerning gender and the adoption of packages of technologies in the Global South, some revolve around the adoption of practices that cannot be considered agroecological, such as improved maize-related practices (e.g. Mutenje et al. 2016; Fisher and Carr 2015) or sustainable intensification practices (Ndiritu, Kassie, and Shiferaw 2014; Theriault, Smale, and Haider 2017).

This research uses the Values, Beliefs and Norms theory (VBN, (Johansson, Rahm, and Gyllin 2013; Steg, Dreijerink, and Abrahamse 2005; Stern 2000)), which explicitly includes an environmental component (Price and Leviston 2014), to explore farmers' adoption of

agroecological practices. VBN theory provides tools to measure farmers' pro-environmental behavior and has showed strong results in the Global North yet has rarely been applied in a Global South setting. We draw on literature that has shown farmers' personal norms and their perception of their ability to change to be central factors influencing their intentions to implement pro-environmental behaviors (Lokhorst et al. 2011, 2014; Lynne et al. 1995; Price and Leviston 2014; Martínez-García, Dorward, and Rehman 2013). Used widely [in Europe] to explore how farmers' values, beliefs, and norms influence their participation in non-subsidized conservation practices (Lokhorst et al. 2014), biodiversity conservation schemes (Johansson, Rahm, and Gyllin 2013), and pro-environmental land management practices (Price and Leviston 2014), VBN is considered "one of the most elaborate theories of environmentally significant behavior that accounts for moral aspects of behavior" (Johansson et al., 2013:297).

1.3 Research questions

- Which agroecological practices are being adopted by farmers?
- Are there differences in adoption patterns and factors between female and male farmers?
- What does an actor focus add to socio-technical systems analyses?

2. Theory

In this paper, we focus on two terms: adoption and personal norms. 'Adoption' itself is a contentious term, and the adoption of new (agricultural) technologies happens along a spectrum (Kiptot et al. 2007). To avoid a static snapshot of a moment in time, and to capture the complexities of adopting systemic technologies involving multiple individual practices, authors who examined the adoption of systems of sustainable agricultural technologies have done so using three aspects: the adoption status (the decision to adopt or not), adoption intensity (the field acreage on which implemented), and the depth of adoption (how many of a number of practices are adopted) (Noltze, Schwarze, and Qaim 2012). This case study follows this framework, but instead of viewing adoption intensity as the field acreage on which the practice is used, we define adoption intensity as the frequency of use of a particular practice.

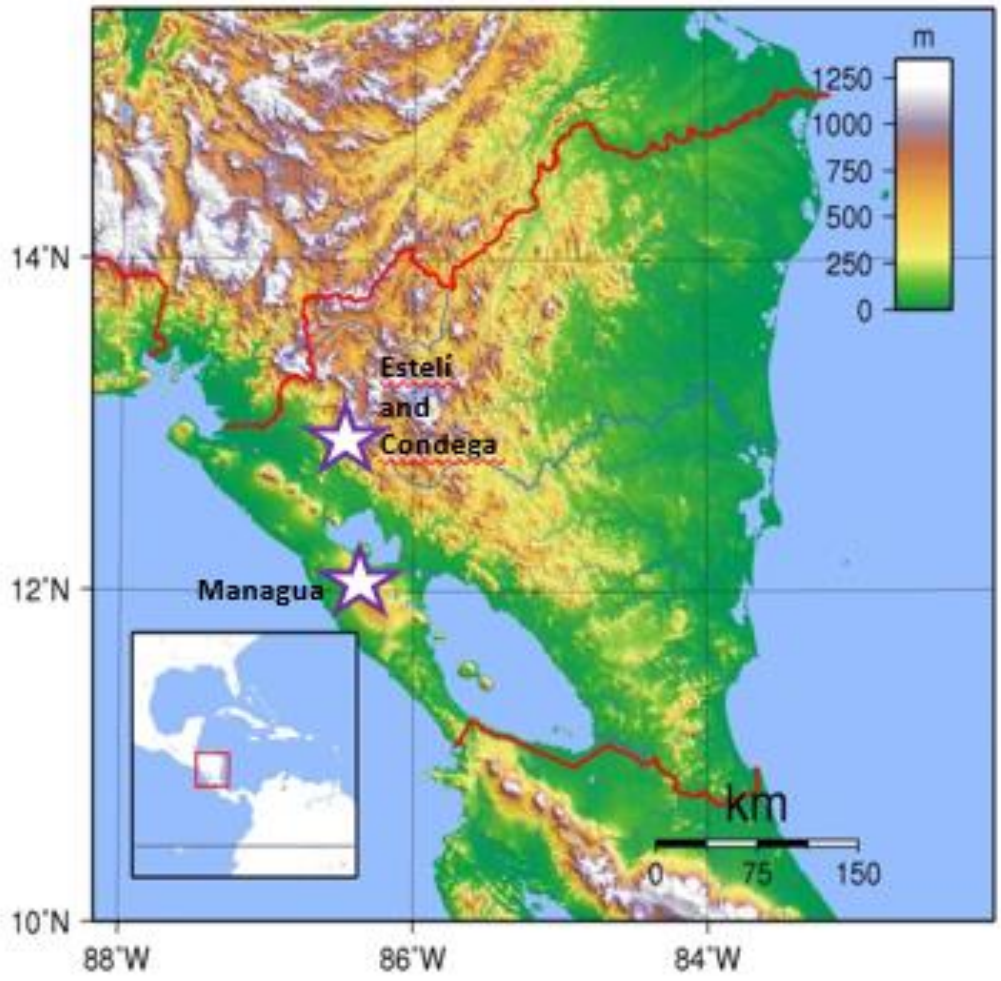
For this case study, we analyze the relationship between farmers' adoption of agroecological practices, and their pro-environmental personal norms for doing so. Personal norms are defined as the 'sense of obligation to move towards environmentally sustainable, e.g. agroecological, production methods'. VBN theory gives us a tool set to explore farmers' pro-environmental norms. According to Price and Leviston, "pro-environmental personal norms are activated by beliefs regarding environmental threats, and personal ability to address threats, which in turn prompts behaviours" (Price and Leviston 2014, 67).

3. Methods

3.1 Sample and design

Data was collected from smallholder farms in two areas of northern Nicaragua, around the municipalities of Estelí and Condega, in October 2014 (see **Error! Not a valid bookmark self-reference.**). Farms selected were typical of smallholder farming systems in this region of the dry tropics – farms averaged under 5 hectares in size, are based on basic grain production, and producing for the household or for local sale (Rodríguez et al. 2013). Five local organizations that work with producers were asked to identify two areas in which they were active: one with more and one with less advanced implementation of agroecological practices. The organizations facilitated access to key informant farmers and the villages; in the villages, snowball sampling and 'spontaneous recruitment' (Peek and Fothergill 2009, in Boone 2016) were used to identify and recruit study participants. In total, 121 farmers participated in the survey.

Figure 1: Map of research areas in northern Nicaragua (mapsof.net 2014)



3.2 Procedure

The closed-question survey was divided into three parts: farm and household information; adoption and frequency of use of agroecological practices; and, to explore participants' personal norms related to the adoption and use of agroecological practices, a social-psychological part based in Values, Beliefs and Norms theory (Steg, Dreijerink, and Abrahamse 2005). The survey questions followed this order; one qualitative question at the end gave participants an opportunity to give feedback on the survey, or to impart other information they felt was pertinent to the researchers. Respondents were asked to indicate their agreements with questions relating to agroecological practices and statements relating to personal norms

on a 5-point Likert scale (graded from 1: not important/not used to 5: very important/used a lot).

A list of agroecological practices was compiled prior to conducting the survey. Initially based in a literature review (e.g. Wezel et al. 2014; Altieri 2002; Altieri and Nicholls 2012), the list of agroecological practices was refined to reflect practices in use in northern Nicaragua after preliminary discussions with key informant farmers in the study area and our local research assistants. Initially written in English, the survey was translated to Spanish by the main researchers and edited for proper usage by two local research assistants. The survey was pre-tested with nine key informant farmers and tweaked according to their input and for time management. The finalized survey was conducted, in Spanish and face-to-face in farmers' homes, by the two local research assistants.

3.3 Measures

Participants were asked about their use and frequency of use of 29 agroecological practices (see *Table 1*). Three of these practices were 'negative' practices – burning of fields, using chemical pesticides, and using chemical fertilizers. Pro-environmental personal norms were assessed using an 11-item scale, with statements based on Steg et al. (2005) and tailored to the current research context. A sample statement is "I feel personally obliged to increase on-farm diversity".

Table 1: Agroecological practices used in study area, clustered according to which agroecosystem process they most strongly support (following (Altieri 2002)). 'Negative' practices are italicized.

Cluster of agroecological practices	**Practices (as used in survey)**
Recycling on-farm biomass / saving nutrients	Contour lines, live barriers, hedgerows, conservation tillage, biofertilizers, organic inputs, windbreaks, compost, recycling manure for use as fertilizer, fallow, mulching, *burning*
Biological pest & disease control	Integrated pest management, integrated disease management, *chemical pesticides, chemical fertilizers*
Enhancing biological activity / interactions	Cover crops, legume cultivation, increasing soil biomass, enhancing soil microorganisms, using plants to attract beneficial insects, trap crops, soil inoculation with mycorrhiza

Saving on-farm water	Water harvesting, minimizing use of water, soil and water retention barriers, sources and methods used in irrigation
Enhancing biodiversity / diversifying genetic resources	Crop rotation, native seeds, agroforestry (use of trees and shrubs), companion planting

3.4 Analysis

Survey responses were digitalized and analyzed using the software SPSS. We used descriptive statistics to characterize the prevalence of agroecological practices being used on the respondents' farms: this included both the adoption of each practice as well as how frequently it was used, based on the Likert scale rating from respondents. We tallied how many agroecological practices were used on each farm, and the average frequency of use of each practice across all farms. We explored these results according to age, gender, and years of agroecological experience of the respondent. As differences in the adoption and frequency of use of agroecological practices were the most defined according to the gender of the respondent, we targeted gender as a possible key explanatory variable. In a second step, we explored the relationship between personal norms and the adoption of agroecological practices and investigated whether this association differed between male and female farmers.

4. Results

4.1 Farm and farmer characteristics

Of the 121 survey participants, 70 (57.9%) were female and 51 were male (42.1%). Of the respondents who were head of their household, N (56.2%) were female and N (43.8%) were male. Participants' ages ranged from 16 to 70 years old (with a mean of 37, SD=14). On average, farmers had been using agroecological practices for nine years (with answers ranging between one and 25 years, SD=6). They had been farming on their land for an average of 15 years (ranging between two and 50 years, SD=9.5).

Farm sizes ranged from 0.25 manzana[1] (mz) to 67 mz, but the mean of 5.17 mz (SD=7.55) shows that larger farms are not that common. 76.9% of farmers grew maize and beans, the

[1] Manzana is the unit of land measurement used in Nicaragua. 1 manzana = 0.7044 hectare = 7,044 m^2

predominant local staple crops, and 44.6% grew coffee, the predominant local cash crop. Looking specifically at crop diversity, participants grew an average of 23 crops, with the most respondents (n=16) growing 26 different crops (see Figure 2). Participants mentioned that they produced 22 types of fruits, 14 types of vegetables, plus quinoa, cacao, sugar cane, and medicinal plants. 75% of farmers kept livestock, with chickens being the most prevalent, followed by cows, pigs, and horses. 40% of participants indicated that they had an area dedicated to forest, with areas ranging from 0.1 mz to 11.5 mz (mean of 2.13 mz; SD = 2.48). Increasing farm size correlated to increasing forest size (.782**, p = .000). Participants mentioned shade-grown coffee as a principal reason for agroforestry.

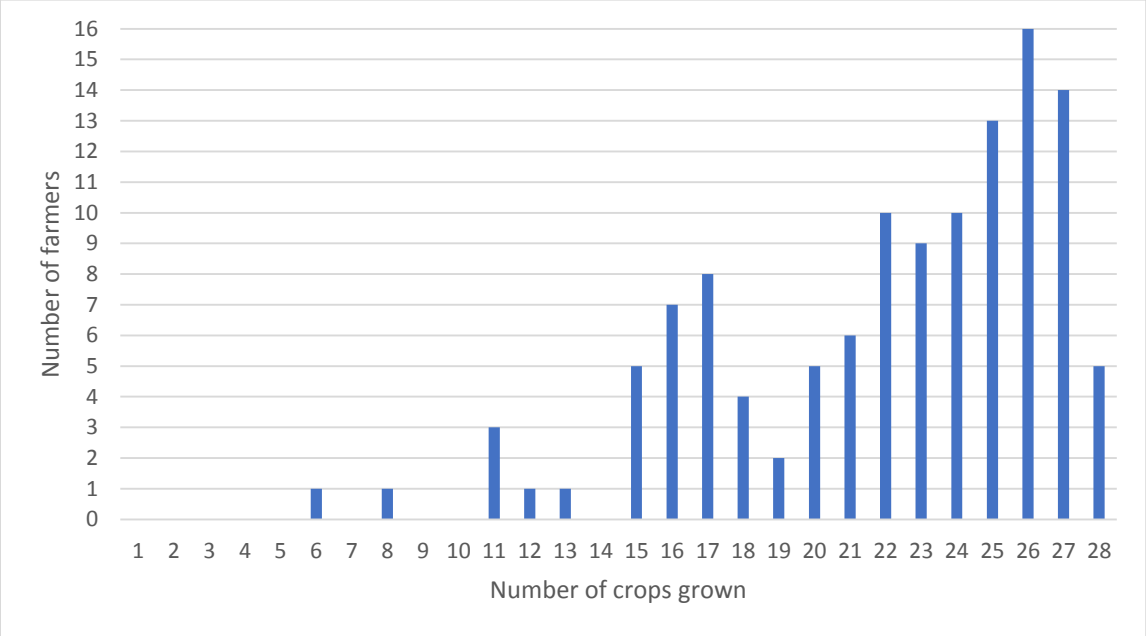


Figure 2: Number of crops grown by individual farmers

4.2 Adoption and frequency of use of agroecological practices

Participants used an average of 22 different agroecological practices on their farms (see Figure 3). The most widely used practices include agroforestry on a part of the land, the use of native seeds, water-saving practices, companion planting, contour lines, and the use of conservation tillage.

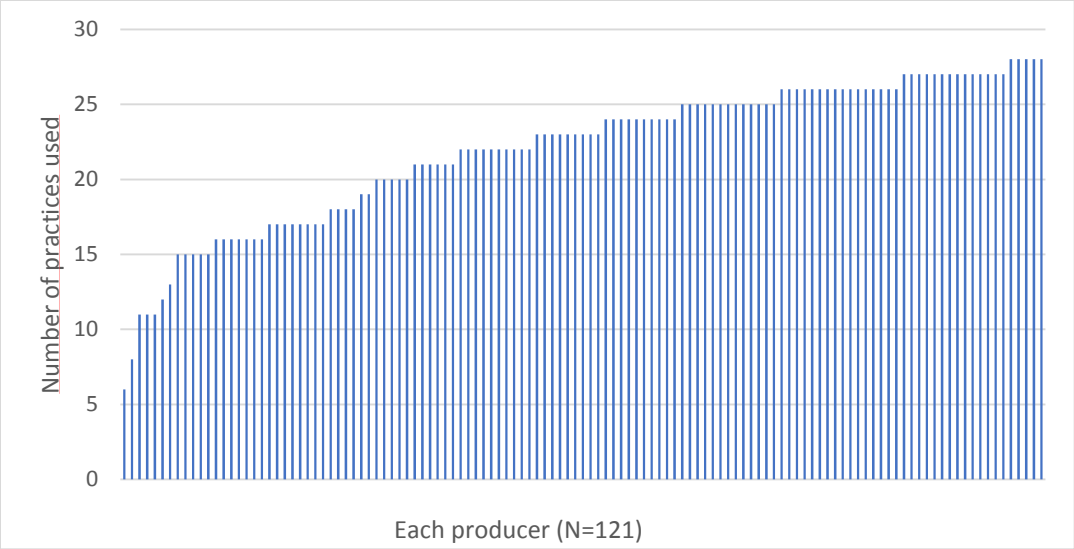


Figure 3: Number of practices used by each farmer (N = 121)

Interestingly, the practices used by the largest amount of farmers (see Figure 4) are also the ones used with the greatest frequency by those farmers, and the least used practices are the ones used least frequently (see Figure 5).

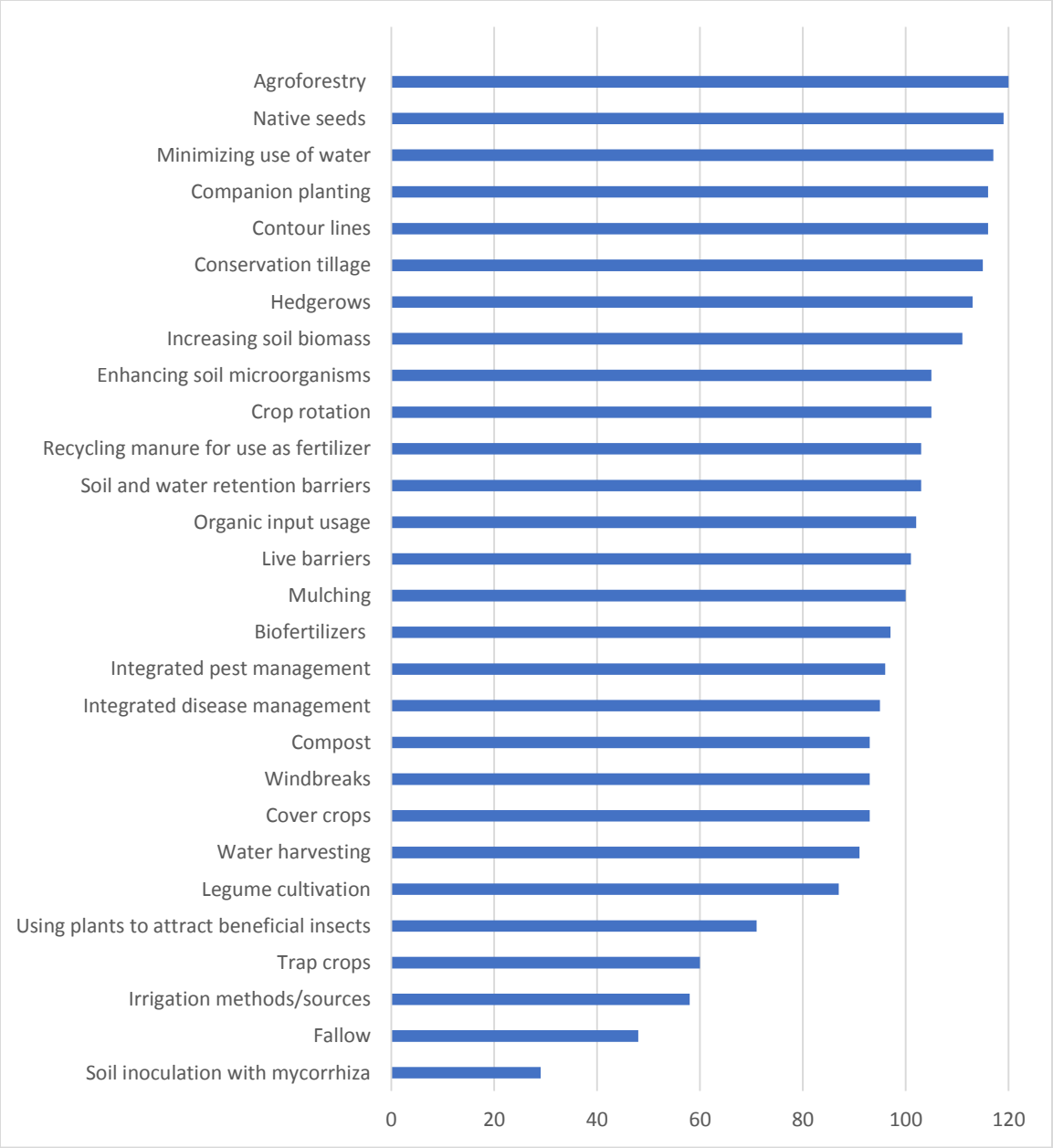


Figure 4: Farmers' adoption of agroecological practices (N = 121)

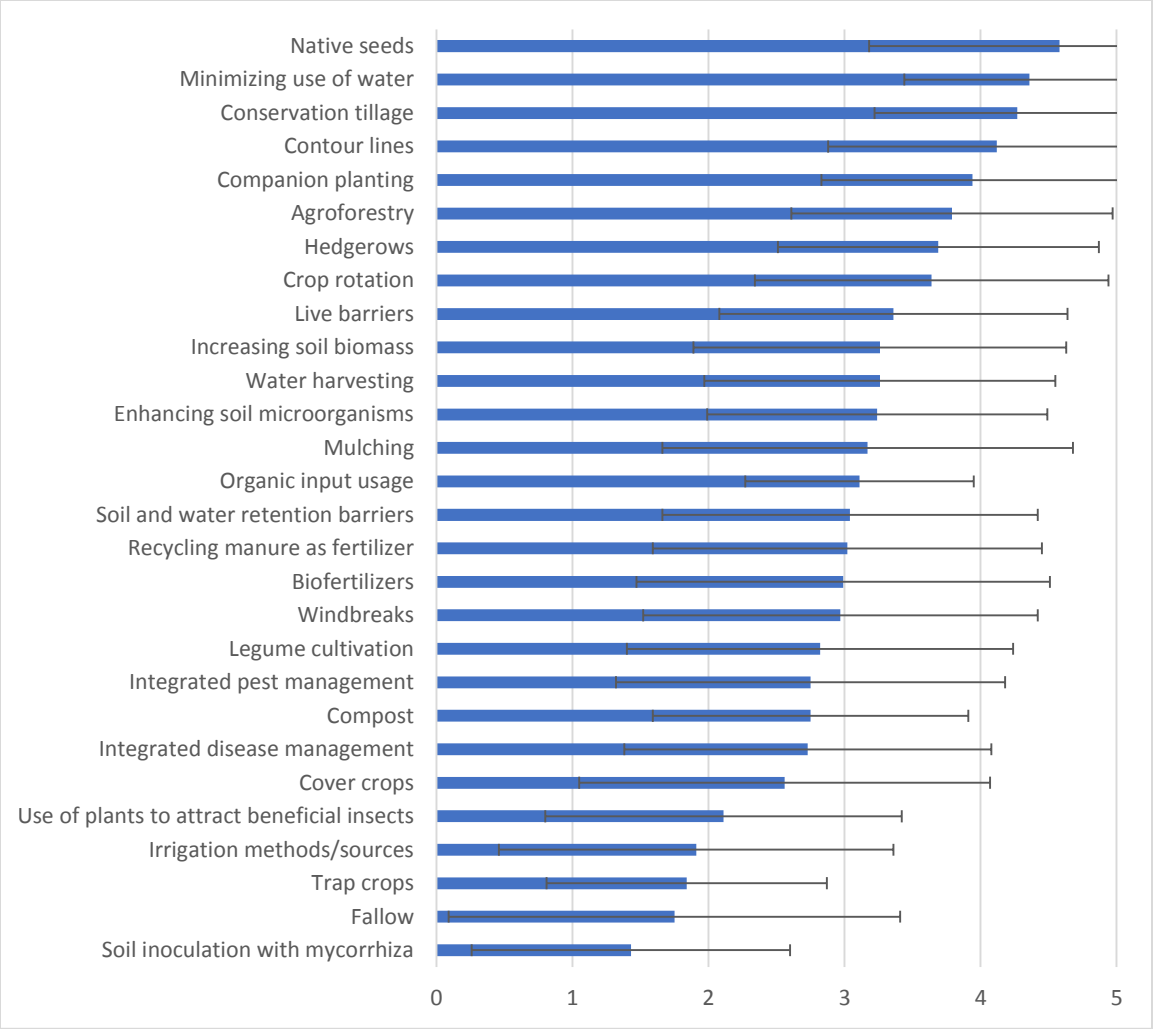


Figure 5: Farmers' frequency of use of agroecological practices (N = 121)

We clustered practices into five categories, depending on which ecosystem services are most enhanced by the particular technology (Altieri 2002). The practices in each cluster are detailed in Table 1. As Figure 6 shows, the cluster 'enhancing biodiversity' is practiced the most frequently: farmers reported using these practices between "a lot of the time" and "always" (4 and 5, respectively, on the Likert scale). This cluster includes the use of crop rotation, native seeds, use of trees and shrubs in agroforestry (which around 40% of farmers practiced), and companion planting.

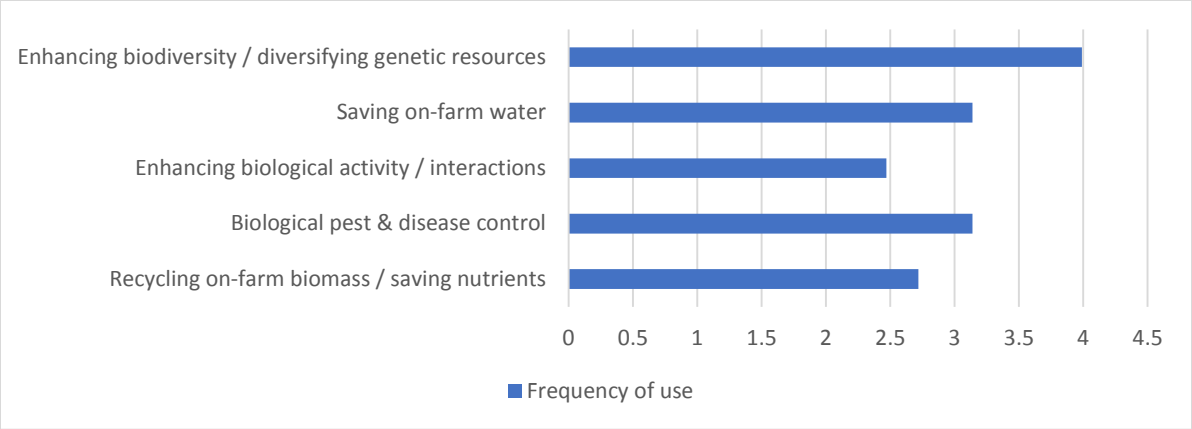


Figure 6: Frequency of use of agroecological practices grouped according to enhancing ecosystem services (N = 121)

To conclude, the survey results show that:

1) many farmers are using a wide variety of agroecological practices to grow a large diversity of crops;

2) the most widely used practices are related to enhancing on-farm biodiversity and diversifying genetic resources on the farm;

3) the most widely used practices are also the ones used with the highest frequency.

4.3 Gender differences in adoption of practices

When the previously discussed results are divided according to gender, some interesting patterns emerge. As can be seen in Figure 7, the adoption of practices follows similar trends for both male and female farmers – those practices adopted by the most male farmers mirror the practices adopted by the most female farmers. However, what is striking is that, with the exception of soil inoculation with mycorrhiza, every practice is adopted by a larger percentage of female farmers than male farmers.

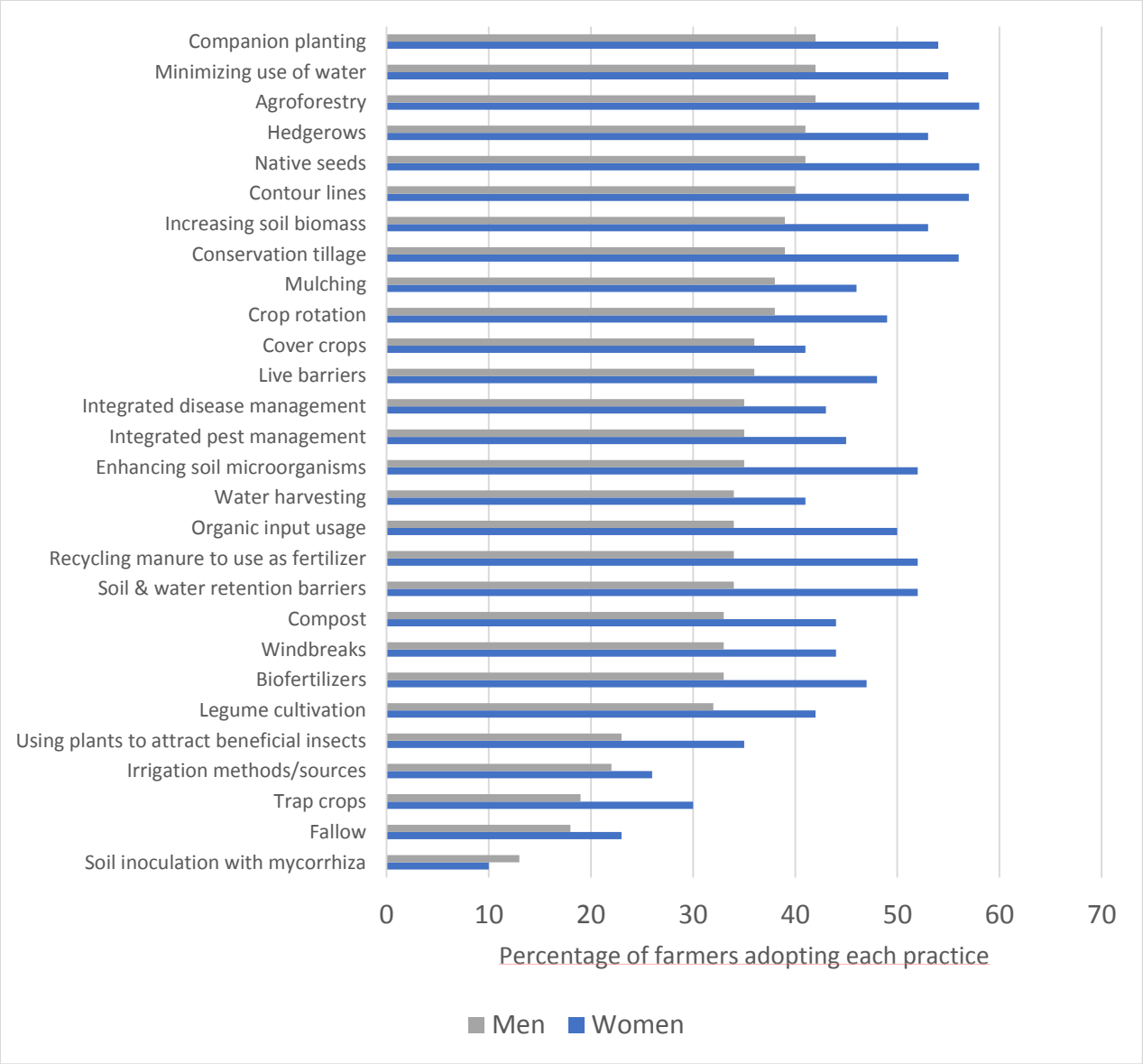


Figure 7: Practices adopted by farmers (N=121), disaggregated by gender (men: N=51; women: N=70)

In *Figure 8*, each practice's Intensity of use by female and male farmers is listed according to its ranking in Figure 7, which depicts how many farmers of each gender adopted each practice. As Figure 8 shows, the adoption intensity of agroecological practices differs from the frequency of use of each practice. However, once a practice is adopted, female and male farmers reported similar intensities of using each practice.

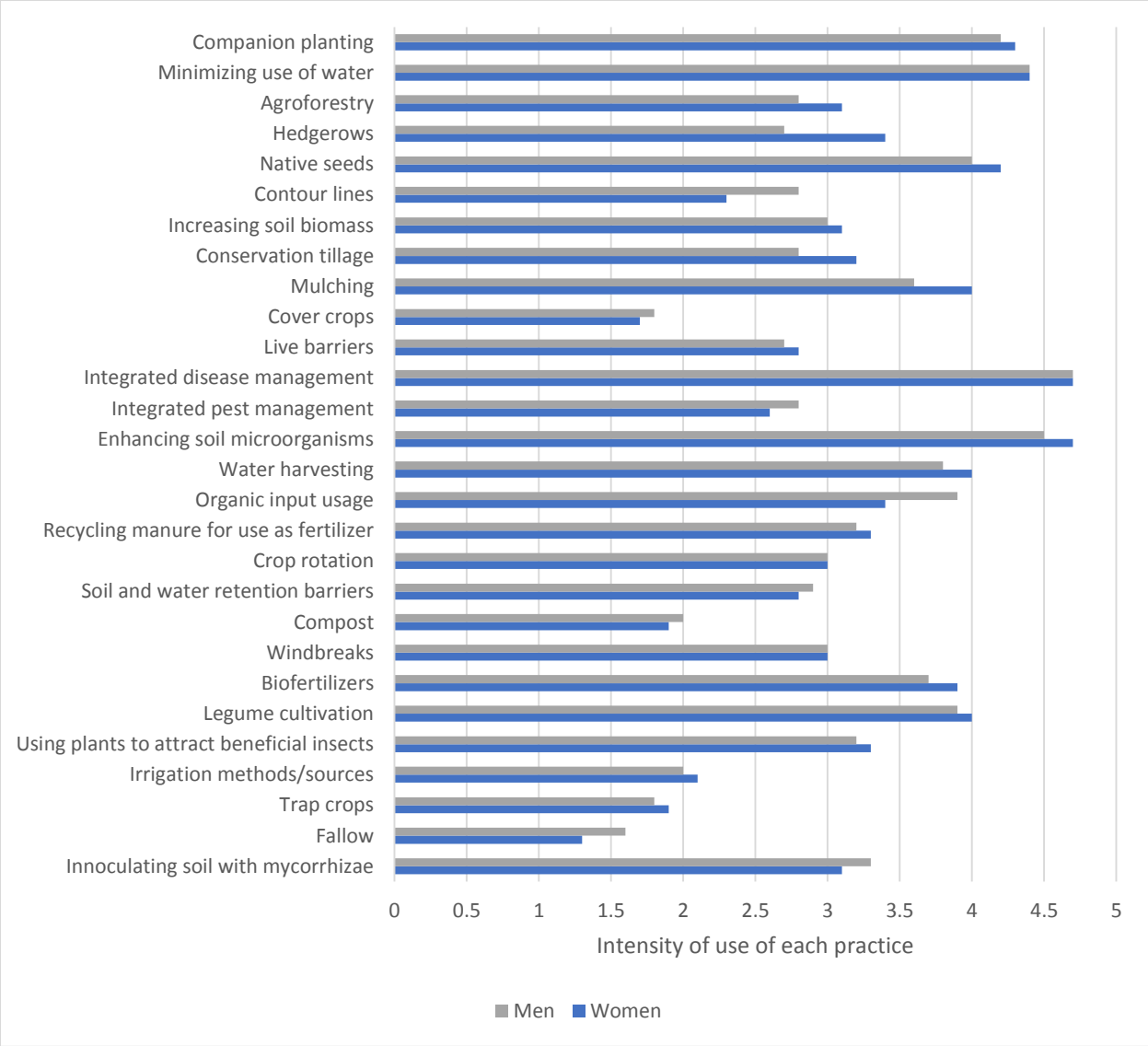


Figure 8: Female and male farmers' frequency of use of each agroecological practice, disaggregated by gender (men: N=51; women: N=70)

4.4 Explanations for gender differences in adoption of practices: personal norms

Our survey results showed that farmers' pro-environmental personal norms predict the adoption of agroecological practices – but that this association is qualified by the farmer's gender. The analysis highlighted striking differences regarding male and female farmers' feelings of pro-environmental personal obligation to use agroecological practices on their farms (see Figure 9).

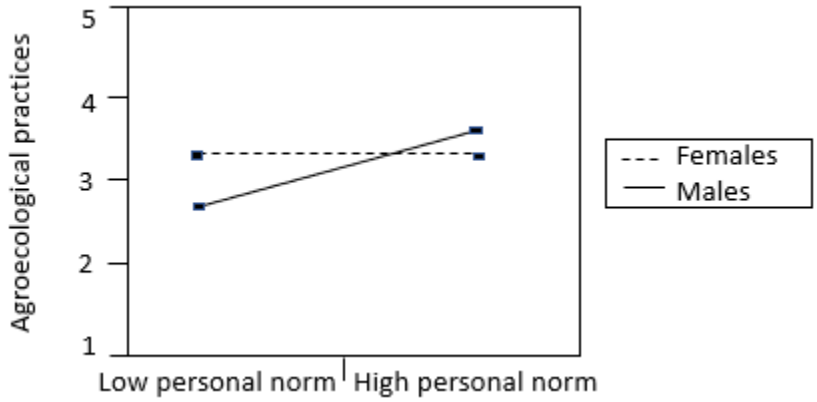


Figure 9: Female and male farmers' personal norms regarding the use of agroecological practices on their farms

Female farmers tended to show a steady high level of adoption frequency of agroecological practices, with the average frequency of use of all practices scoring 3.2 out of a possible high of 5 on the Likert scale. The adoption frequency was not impacted by the women's pro-environmental personal norms: women scoring low on the pro-environmental personal norms scale adopted and used agroecological practices as frequently as did those that reported strong pro-environmental personal norms. Male farmers' frequency of use of all agroecological practices show a different pattern: as Figure 9 illustrates, males with low pro-environmental personal norms tended to adopt and use agroecological practices with a frequency of 2.9 on the 5-point Likert scale. With increasingly strong pro-environmental personal norms, males' frequency of use increased to almost 3.5 out of a possible high of 5 on the Likert scale. This indicates that the stronger their sense of obligation to protect the environment, the more frequently they adopt and use agroecological practices.

To conclude, our analysis showed that personal norms predict adoption of agroecological practices, but that this association is qualified by the farmers' gender. That is, for men the stronger their personal norms, the more practices they perform, but for women this is not the

case - they report a consistently high level of adoption and frequency of use of agroecological practices, regardless of the strength of their pro-environmental personal norms.

5. Discussion and conclusions

5.1 The adoption of agroecological practices by male and female farmers in Nicaragua

The most widely used practices include agroforestry on a part of the land, the use of native seeds, water-saving practices, companion planting, contour lines, and the use of conservation tillage. Biophysical, financial, cultural, and political reasons can be found to explain this. Considering the research area is in the dry tropics, and in a hilly area of the country, water-saving measures, contour lines, and conservation tillage are practical responses to the biophysical context. Agroforestry tends to be connected with the growth of shade trees for coffee, or for cocoa production, both of which are high-value export goods. The use of native seeds is seen as a connection to one's heritage, but also has contemporary political and social significance, considering the current national debate on the introduction of genetically modified seeds into the country. Practices involving on-farm diversification are both the most widely adopted and the most frequently used. Our study highlighted that diversity - both of practices used, and of crops grown - is already being practiced by many farmers, particularly resource-poor subsistence farmers. Since diversification is a central tenet of agroecology, and farmers are already doing this, we learn that they need to be better supported - particularly in terms of whole-farm knowledge, critical decision-making, and input and output markets for a diversity of crops - in tending to and maintaining this diversity. In this, our results support Horlings and Mardsen's call to turn the 'problem' of diversity and context of agricultural practices into a real ecological and social virtue (Horlings and Marsden 2011) though using these results as entry points for positive systemic growth.

The analysis showed that a greater percentage of female than male farmers tended to adopt most agroecological practices, while the intensity of each practice's use tended to be similar amongst female and male farmers. The VBN analysis showed that although a farmer's pro-environmental personal norms predicted the adoption of agroecological practices, this

association is qualified by the farmer's gender. Female farmers demonstrated a consistently strong adoption of agroecological practices, regardless of their pro-environmental personal norms, while male farmers reported that the stronger their pro-environmental personal norms, the more agroecological practices they adopted. The analysis supports Akram-Lodhi's 2015 call for "the fostering of sustainable gender-responsive biotechnological change and agroecological farming practices" (Akram-Lodhi 2015). This includes the systematic integration of gender as a base element of discourse and action (Park et al. 2015) – but not just through e.g. institutionalization of social protection programs and policies aimed at women (Jones et al. 2017). The results suggest that to further grow the adoption of agroecological practices, it would be important to also increase male farmers' pro-environmental attitudes through e.g. increasing knowledge about the importance of environmental protection and conservation (Caron, Biénabe, and Hainzelin 2014; Duru et al. 2015).

5.2 Enriching socio-technical systems analyses through a micro-perspective

Conceptualizing and understanding individual actors' contributions to sustainability transitions has remained a thorny issue in socio-technical transitions literature *REF_). This article explores the use of social psychological theories (such as VBN) to better understand actors' motivations and actions in enacting sustainability transitions at the individual level. To not lose sight of the bigger picture of the agroecological transition, it is important to view these micro-level results in context of the broader national agroecological transition. Beyond exploring niche-regime linkages (e.g Bui et al. 2016; Diaz et al. 2013), such boundary-spanning analyses have been recently been suggested by (Hassink, Grin, and Hulsink 2018). Although VBN theory may not be suitable for all micro-level socio-technical systems analyses, our research shows that the use of VBN may aid in identifying important entry points, which can be supported by policy, to further motivate actors to enact sustainability transitions in their daily lives.

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