Women's Participation in Intrahousehold Decision-making: A Case in Rural Smallholder Farm Households in West Java Indonesia

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Contents

List of Tables

List of Figures

Abstract

The United Nations Sustainable Development Goals (SDGs) Goal 5, “Achieve gender equality and empower all women and girls”, highlights the importance of women’s empowerment and gender equality. Empowering women contributes to faster economic growth, better social development, more stable and just societies, and enhanced food security. As a form of empowerment, increasing women’s participation in decision-making within the household (intrahousehold) is believed to result in better outcomes for women and their families, and is widely recognised as an important pre-condition for agricultural growth. However, studies have shown that the extent to which this condition holds, is context specific.

In Indonesia, especially in rural communities where agriculture is the foundation of people’s livelihood, women play important roles in agricultural production. Despite their profound involvement in providing labour and management to activities within the broader production system, their participation is often under-recognised.

This thesis attempts to understand the extent, determinants, and outcomes of women’s participation in intrahousehold decision-making in smallholder farm households. The objective of this thesis is to investigate women’s participation in intrahousehold decision-making, to assess the instruments that are used to measure this participation, and to study how this participation correlates with agricultural technology adoption in the context of rural smallholder farm households in West Java, Indonesia.

This work is informed by the theories of women's agency developed by Kabeer (1999) and intrahousehold cooperative models of decision-making by Chiappori (1992). It is also informed by the conceptual frameworks that try to explain instrumental agency and how it is measured (Ibrahim & Alkire, 2007).

The thesis has three main analytical chapters, which address the research objectives through a combination of descriptive analysis and econometric estimation. The study utilised two cross-sectional surveys: 500 couples of crop farming households and 600 couples of dairy farming households in West Java, Indonesia.

The first analytical chapter investigates how men and women perceive women's participation in 21 agricultural activities. Using a women's participation in decision-making index, this paper further examines the correlation between social norms and these perceptions. Results show there are differences between men's and women's perceptions about women's decision-making in agricultural activities; and that spouses' perceptions of decision-making participation are influenced by social norms about gender roles.

The second analytical chapter investigates the spousal discrepancies in responses to 39 farm and non-farm decision-making participation questions within six domains. This paper examines whether these discrepancies are explained by random or asymmetric measurement error, or by information asymmetry. Using pairwise t-tests and multivariate mean tests, in accordance with the existing literature, the results suggest that the differences in response vary based on the type of activities. The results suggest that spousal discrepancies likely portray the separate-sphere gender-based involvement in different activities.

The final analytical chapter examines how women's participation in dairy farming activities and decision-making correlate with the adoption of dairy farming technology. Using linear probability model regressions, the analysis finds that women's participation in dairy farming activities and decisions have a positive correlation with the adoption of improved dairy cow nutrition, specifically on the adoption of feeding legume forages and improving drinking water availability for the milking cow.

Thesis declaration statement

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Sara Ratna Qanti

May 2023

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Publication and presentations from this thesis

Published article

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Conference papers and seminars

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Chapter 1: Introduction

The United Nations Sustainable Development Goals (SDGs) Goal 5, "Achieve gender equality and empower all women and girls", highlights the importance of women's empowerment and gender equality. Empowering women can bring faster economic growth, better social development, more stable and just societies, and enhanced food security (Agarwal, 2018; Bayeh, 2016; Duflo, 2012; FAO, 2011; Stevens, 2010). As a form of empowerment, increasing women's decision-making participation within the household (intrahousehold) can increase their bargaining power, lead to better outcomes for women and their families, and is widely recognised as an important pre-condition for agricultural growth (Acosta et al., 2019; Alwang et al., 2017; Anderson et al., 2021; Doss, 2013; Duflo, 2012; Quisumbing, 2003).

The recent literature has paid more attention to instrumental agency, understood as women's participation in decision-making, and the different ways of measuring this participation using household surveys. However, less had been done to understand what questions about women's participation in decision-making mean, for both men and women, and what type of information is being captured. Moreover, discrepancies in responses by men and women have been used to study women's bargaining power, with a lack of consideration of survey data issues such as measurement errors of different kinds and information asymmetries between spouses. In addition to this, despite the recognise participation of women in agricultural activities and decision-making in agriculture, this role and influence in decisions, women's preferences and roles tend to be ignored when studying agricultural technology adoption.

This thesis aims to understand the drivers of men's and women's answers to intrahousehold decision-making questions in household surveys, how social norms regarding gender roles explain these answers, what explains discrepancies between

spouses' responses to these questions, and the correlation between participation in intrahousehold decision-making and technology adoption in rural smallholder farm households in West Java, Indonesia.

This thesis is informed by the theory of agency developed by Kabeer, cooperative intrahousehold decision-making models about decision-making, bargaining power, and agricultural technology adoption.

1.1 Background

Despite the importance of women's role in sustainable development, many policies and interventions are biased toward men as household heads (Lecoutere et al., 2019). In agriculture, for example, many empirical studies show that men have wider access to asset ownership related to certain government programs and interventions (Agarwal, 1997; Johnson et al., 2016; Kabeer, 2005; Staudt, 1978). Targeting men relies on the assumption that the benefits from the intervention would be jointly attained by the whole family, which stems from the idea of a unitary model of decision-making in the household: households are groups of individuals who have the same preferences and fully pool their resources (Quisumbing & Maluccio, 2003). However, this is often violated as found in empirical studies (Akter et al., 2017; Anderson et al., 2017; Chiappori, 1988; Haider et al., 2018; Kazianga & Wahhaj, 2013; Quisumbing et al., 1996; Udry, 1996). It is shown that household members have heterogeneous preferences and unequal bargaining power within the household (non-unitary). The non-unitary model suggests that better outcomes may be achieved if the male head does not monopolise the access to and support from development programs (Doss & Quisumbing, 2018).

The last three decades are characterised by significant research on the role of women in agriculture (Agarwal, 2018; Anderson et al., 2017; Behrman, et al., 2014; Doss, 2013; Doss, 2018; FAO, 2011; Kabeer, 2005; Peterman et al., 2014; Quisumbing et al., 1996;

Weltbank, 2011; Young, 1993). These studies have challenged the belief that women's roles are unimportant and that they have little participation in farm management decisions. Moreover, in countries experiencing rapid economic growth and structural transformation, off-farm labour opportunities are increasing, and farming systems are changing, and therefore, the roles of men and women are changing as well (Doss, 2013; Weltbank, 2011).

A strand of literature on women's participation in intrahousehold decision-making often suggests that increasing human capital (e.g. education) and asset ownership (e.g. land ownership) lead to better women's participation in decision-making (e.g. Akter et al., 2017; Anderson et al., 2017; Frankenberg & Thomas, 2001; Reggio, 2011). However, this literature often neglects the context in which the household makes decisions (Agarwal, 1997; Bernard et al., 2020; Mabsout & Van Staveren, 2010). It specifically ignores social norms, as the prescribing social roles and power relations between men and women in society (UNDP, 2020). Some studies suggest that the role of social norms is key to understanding the process of intrahousehold decision-making (see e.g. Agarwal, 1997; Jayachandran, 2020; Laszlo et al., 2020; Lundberg & Pollak, 1996; Mabsout & Van Staveren, 2010; Maiorano et al., 2021) because social norms affect people's perception of themselves and others and directly affect individuals' choices, freedoms, and capabilities (UNDP, 2020; Nationen, 2014). Therefore, ignoring this aspect can undermine women's empowerment interventions (Anderson et al., 2021). Despite the importance of social norms, empirical studies on how social norms around gender affect women's participation in decision-making are still limited.

Women empowerment and participation in intrahousehold decision-making are typically measured by survey questions where men and women are interviewed separately in an attempt to better describe the decision-making roles (e.g. Akter et al.,

2017; Alwang et al., 2016; Frankenberg & Thomas, 2003). However, it is commonly found that there are differences in men's and women's responses to the questions, raising concerns about the reliability of this approach (Ambler et al., 2022; Liaqat et al., 2021; UNECE, 2021).

Several studies have associated the difference in responses with individual characteristics (Anderson et al., 2017; Kilic & Moylan, 2016; Twyman et al., 2015). On the other hand, some studies consider that the differences may arise from distinctive personal perceptions, which tell the respondent's feeling of power or its absence (UNECE, 2021) and indicate the underlying power dynamics within households (Ambler et al., 2022; Annan et al., 2021; Peterman et al., 2021; Seymour & Peterman, 2018). If answers vary among respondents, they can provide useful information about the perspective of the respondent important in affecting their ability to act (UNECE, 2021). This clearly demands improved knowledge as women's agency; as defined by Kabeer (1999) as the ability to define one's goals and act upon them; could vary substantially depending on whether disagreement assigns more or less decision-making power to the woman (Annan et al., 2021). Thus, to interpret intrahousehold decision-making, rigorously exploration of the reasons behind the difference in responses is needed.

In the agricultural sector, women's participation in agricultural technology adoption decisions is one of the key indicators of their empowerment (Aryal et al., 2020; Giller et al., 2009; Quisumbing et al., 1996; Weltbank, 2011). Recent studies have found that technology adoption at the household level is not always the result of a single decision-maker (Doss & Morris, 2000; Doss, 2013; Haider et al., 2018; Mohapatra & Simon, 2017; Shibata et al., 2020; Ragasa, 2012; Rola-Rubzen et al., 2020). This strand of literature observes that agricultural technology adoption is a process that constitutes a series of

intrahousehold decisions which are strongly affected by existing decision-making patterns (Bekele & Drake, 2003; Shibata et al., 2020).

Studies on women's participation in decision-making and technology adoption have yielded mixed results. A strand of the literature shows that women's participation encourages agricultural technology adoption (e.g. Mohapatra & Simon, 2017). On the other hand, other studies find a negative correlation between women's participation in decision-making with agricultural technology adoption (e.g. Fisher et al., 2000; Venter & Mashiri, 2007; Rao, 2002). Consistent with Doss's (2001) findings, Ragasa (2012) suggests gender differences in technology adoption based on the study site, highlighting the importance of institutional and socioeconomic context in shaping constraints and opportunities to adopt agricultural technologies.

Existing literature on intrahousehold agricultural decision-making participation and adoption of technology focuses on Sub-Saharan Africa and South Asia (Arslan et al., 2022; Ragasa, 2012; Quisumbing & Maluccio, 2003). Issues are possibly more prominent in Sub-Saharan Africa, where women are more likely to have independent farming responsibilities and where there are clearly defined men's and women's plots (Peterman et al., 2014; Ragasa, 2012). Little is known about South East Asia (Akter et al., 2017), where men and women farm plots together and couples own and manage assets jointly (Akter et al., 2017).

In Indonesia, most areas follow a patrilineal system, where the male head of the household is believed to be the one who takes the most decisions. However, history suggests that this is not always the case. Moreover, with the structural transformation and rapid growth of the Indonesian economy (Kis-Katos et al., 2018), increasing roles of women in farming activities, and the transformation of farming systems, these traditional

beliefs are likely to contradict the current reality of intrahousehold decision-making. This overlooked conflict also motivates the current thesis.

1.2 Research objectives and research questions

The overall objective of this research is to explore women's participation in intrahousehold decision-making, assess the instruments used to measure such participation correlate with social norms about gender, examine the reasons behind spousal agreement in responses to decision-making questions in household surveys, and study how participation in agricultural decisions correlates with agricultural technology adoption. This study is conducted in the context of rural smallholder farm households in West Java, Indonesia. To achieve these objectives, several research questions were formulated as follows:

1) How do men and women perceive women's participation in household decision-making and how women's participation is associated with social norms?
2) To what extent do men and women differ in answers to individuals' decision-making participation and what are the possible sources of the differences in spouses' responses?
3) Does women's participation in decision-making correlate with agricultural technology adoption?

1.3 Thesis contributions

The main objective of this thesis is to contribute to the understanding of intrahousehold decision-making dynamics in the context of rural areas of developing countries. The first analytical chapter gives an overall overview of the determinants of women's participation in intrahousehold decision-making, especially on how men and women perceive women's participation in agricultural decisions and how social norms

determine women's participation in these decisions. The second analytical chapter investigates the sources of the differences between men's and women's responses to survey questions about intrahousehold decision-making. It offers an alternative tool for measuring men's and women's participation in intrahousehold decision-making. The last analytical chapter examines the outcomes of women's participation in intrahousehold decision-making, it explores the relationship between women's participation in agricultural decisions and the adoption of agricultural technology.

This thesis contributes to the body of knowledge of intrahousehold decision-making in several ways. First, Chapter 2 of the thesis extends the limited research on the importance of incorporating social norms in intrahousehold decision-making studies. Using 439 complete paired husband-wife surveys, this thesis specifically applies a fine-scale quantitative responses tool and constructs a women's participation index (WPI) to measure men's and women's perceptions regarding women's participation in decisions about 21 agricultural activities. The tool explores the extent to which decisions are made "jointly" and allows us to compare responses from husband and wife. This thesis further examines the correlation between social norms and the WPI. To the best of the author's knowledge, this is the first study that explicitly explores social norms and intrahousehold decision-making in the context of rural Indonesia.

Second, Chapter 3 of this thesis contributes to the development of survey questions to elicit intrahousehold decision-making dynamics. Previous studies use survey questions about the identity of the decision-maker rather than the decision-making process. Recent literature (e.g., Mabsout & Van Staveren, 2010; Peterman et al., 2021; UNECE, 2021) suggests that responses to survey questions about the identity of the decision-maker (who decides) tend to be biased due to social norms about the role of men and women at the household. This study suggests an alternative survey question regarding how often

decisions are made. This type of question is more likely to reflect women's and men's participation in the decision-making process and are hypothesised to be less likely influenced by social norms about gender roles. This study contributes to the emerging literature on the design of questions that are more likely to reflect decision-making dynamics (Liaqat et al., 2022). Moreover, unlike the existing literature that mostly uses binary response options in measuring individual participation in intrahousehold decision-making, this thesis utilises a complete paired husband-wife survey that asks both spouses the same questions separately and applies a fine-scale quantitative responses tool (0-10 Likert-type scale). Using these more flexible ways of measuring participation in decision-making, this thesis provides a measurement alternative that is likely to improve the understanding of the meaning of joint decisions and the observed differences in perceptions about men's and women's involvement in intrahousehold decision-making processes.

Third, Chapter 4 of this thesis investigates the extent of women's participation in dairy farming activities and decisions and presents empirical evidence of how women's agency, specifically their participation in decision-making as an essential dimension of women empowerment, correlates with agricultural technology adoption. By incorporating women's participation in decision-making measures from 563 paired primary and secondary decision-makers within the households, this thesis is one of the earliest studies that incorporate women's participation in dairy farming decision-making and assesses how this participation links to the adoption of improved animal nutrition technology and practices, in the context of Indonesia where dairy farming holds an important role in supporting rural livelihoods.

1.4 Description of data

This thesis utilises two primary data sets collected from farm household surveys, to capture a wide variability of rural farm households in West Java Indonesia. The first data set focuses on crop-based farm households, while the second data set focuses on dairy farmers.

The first data set were collected under a multi-year project on agricultural policy research to support natural resources management in Indonesia's upland landscape (IndoGreen) and the second data set was collected under the Indonesian smallholder dairy development project (IndoDairy). Both projects were funded by the Australian government through the Australian Centre for International Agricultural Research (ACIAR). The IndoGreen project was led by the Centre for Global Food and Resources (CGFAR) at the University of Adelaide and in collaboration with the Indonesian Centre for Agricultural Socio-Economic and Policy Studies (ICASEPS), the World Agroforestry Centre (ICRAF), World Wild Foundation (WWF) Jakarta, and University of New England. The IndoDairy project was led by CGFAR the University of Adelaide in collaboration with ICASEPS, and the Institute Pertanian Bogor-Indonesia. The ethics approval for both projects can be found in Appendix 1 and 2.

IndoGreen survey presents information on household and farm characteristics, access to credit, organisation membership, and farm and non-farm physical assets ownership. It further includes a gender-specific decision-making module, with questions about 42 agricultural and non-agricultural activities directed to husband and wife separately (the detailed survey instrument can be found in Appendix 3 of this thesis). On the other hand, the IndoDairy survey includes information on household characteristics, dairy farm production characteristics, and a decision-making module related to dairy

farming activities and the adoption of dairy farming technologies (the detailed survey instrument can be found in Appendix 4 of this thesis).

IndoGreen data were collected in July-August 2019 from 500 farm households (1000 respondents) with a multistage stratified random sampling procedure. While IndoDairy data were collected in August-September 2017 from 600 dairy farm households (1200 respondents) and used purposive proportional random sampling. After data cleaning, 439 farm households from IndoGreen and 563 farm households from IndoDairy data were used for the analysis. Both surveys were done in West Java, Indonesia (the detailed sampling frame for the two data sets can be found in Appendix 5 and 6).

1.5 Thesis structure

This thesis consists of five chapters, a combination of published and unpublished works. Going forward, Chapters 2 to 4 address the research questions outlined in sub-section 1.2 and are designed to be stand-alone papers. Chapter 2 has been published in an international peer-reviewed journal, Agricultural and Human Values. Chapter 3 and Chapter 4 are expected to be submitted to two different reputable journals for publication.

Chapter 2 explores the roles of perceptions and social norms in agricultural decision-making. More specifically, the chapter addresses Objective 1 (as outlined in Section 1.2 above). This chapter investigates how men and women perceive women's participation in 21 agricultural activities. Using ordinary least squared regression, this paper further examines the correlation between social norms in these perceptions for 439 couples in West Java, Indonesia. Results show there are differences between men's and women's perceptions about women's decision-making in agricultural activities; and that spouses' perceptions of decision-making participation are influenced by social norms about gender.

Chapter 3 addresses Objective 2 (from Section 1.2) by investigating the differences in spousal responses to 39 farm and non-farm decision-making participation questions within six domains and analysing whether the differences are due to measurement errors, asymmetric information, or whether it indicates an underlying power dynamic within the household members. This chapter utilises an alternative set of decision-making participation questions to capture less gender bias responses from 439 couples. It specifically applies a Likert-type scale response tool from men's and women's perceptions on "how often" the household thinks about a certain decision instead of the "who" makes the decisions question that may be driven by social norms on gender roles. Using pairwise t-tests and multivariate mean tests, in accordance with the existing literature, the results suggest that the differences in response vary based on the type of activities. However, different from the existing literature, in the context of West Java Indonesia, spousal disagreement is not likely caused by measurement errors or asymmetric information in terms of hiding information strategically, but more likely portrays the separate-sphere gender-based involvement in activities at the household due to gender.

Chapter 4 examines how women's participation in farming activities and farming decision-making correlates with the adoption of agricultural technology in the case of smallholder dairy farming (addressing Objective 3 from Section 1.2). It discusses to what extent women's participation in dairy farming activities and dairy farming decision-making determines the adoption of improved cow nutrition technology. Using linear probability model estimation from survey data of 563 couples of dairy farming households in West Java Indonesia, the analysis finds that women's participation in dairy farming activities and decisions have a positive correlation with the adoption of improved

dairy cow nutrition, specifically on the adoption of feeding legume forages and improving drinking water availability for the milking cow.

This thesis concludes with Chapter 5. This chapter also presents a summary of the main findings, key contributions and implications, research limitations and remaining opportunities for future research.

Chapter 2 Statement of Authorship

Title of Paper	Social norms and perceptions drive women's participation in agricultural decisions in West Java, Indonesia	
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Principal Author

Name of Principal Author (Candidate)	Sara Ratna Qanti		
Contribution to the Paper	Conceptualisation, methodology, formal analysis, investigation, methodology, writing – original draft, writing – review and editing		
Overall percentage (%)	60		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	2 October 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

The candidate's stated contribution to the publication is accurate (as detailed above);
Permission is granted for the candidate to include the publication in the thesis; and
The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Alexandra Peralta		
Contribution to the Paper	Conceptualisation, methodology, supervision, writing – review and editing		
Signature		Date	2 October 2022

Name of Co-Author	Di Zeng		
Contribution to the Paper	Conceptualisation, methodology, supervision, writing – review and editing		
Signature		Date	2 October 2022

Chapter 2: Social norms and perceptions drive women's participation in agricultural decisions in West Java, Indonesia

This chapter presents a paper published in Agriculture and Human Values (2021). The paper is included in its published form, with only minor changes to formatting and style to bring it in line with the overall thesis. Consequently, there is some repetition with other chapters of this thesis.

Abstract

Increasing women's participation in intrahousehold decision-making has been linked with increased agricultural productivity and economic development. Existing studies focus on identifying the decision-maker and exploring factors affecting women's participation, yet the context in which households make decisions is generally ignored. This paper narrows this gap by investigating perceptions of women's participation and the roles of social norms in agricultural decision-making. It specifically applies a fine-scale quantitative responses tool and constructs a women's participation index (WPI) to measure men's and women's perceptions regarding women's participation in decisions about 21 agricultural activities. The study further examines the correlation between social norms in these perceptions as measured by the WPI for 439 couples in West Java, Indonesia. We find that first, men and women have different perceptions about women's decision-making in agricultural activities, but the same perceptions of the types of activities in which women have the most and the least participation. Second, joint decisions come in various combinations but overall, the women's role is smaller. Third, social norms influence spouses' perceptions of decision-making participation, which explains most of the variation of the WPI. These results suggest that rigorous consideration of social norms is required to understand intrahousehold decision-making.

Keywords Gender; intrahousehold decision-making; women's participation index; agriculture; social norms; Indonesia.

2.1 Introduction

Women's empowerment and gender equality are paramount in achieving the United Nations Sustainable Development Goals (Maiorano et al., 2021; Nationen, 2014; UNDP, 2020). Empowerment and equality for women are leading to faster economic growth, reduction in social inequalities, and scaledown of environmental degradation around the world (Bayeh, 2016; Duflo, 2012; Stevens, 2010). As a form of empowerment, increasing women's participation in intrahousehold decision-making can increase women's bargaining power and improve development outcomes for women and their families (Acosta et al., 2019; Doss, 2013; Duflo, 2012). For example, women's influence in intrahousehold decisions leads to better education and nutritional outcomes for women and children, and improved access to reproductive and family planning for women (see e.g. Quisumbing, 2003 for a synthesis of the literature).

Empirical studies have intensively explored possible indicators of drivers of women's participation in intrahousehold decision-making (e.g. Akter et al., 2017; Anderson et al., 2017; Frankenberg & Thomas, 2001; Reggio, 2011). For instance, it is usually found that greater human and physical asset ownership increases women's participation in decision-making. However, this literature is criticised for ignoring the context in which the household makes decisions (Agarwal, 1997; Mabsout & Van Staveren, 2010), and the rationale behind who makes the decisions (Bernard et al., 2020). Without understanding the context, these indicators may produce misinterpretable and contradictory meanings (Kabeer, 1999), and knowing who makes a specified decision is insufficient as it does not reveal everything about the decision-making process (Bernard et al., 2020; Seymour & Peterman, 2018).

Invisible barriers retard the attainment of gender equality. These barriers are rooted in persistent discriminatory social norms as the prescribing social roles and power

relations between men and women in society (UNDP, 2020). These norms affect people's perception of themselves and others and directly affect individuals' choices, freedoms, and capabilities (UNDP, 2020; Nationen, 2014). Some studies suggest that the role of social norms is key to understanding the process of intrahousehold decision-making (see e.g. Agarwal, 1997; Jayachandran, 2020; Laszlo, 2020; Lundberg & Pollak, 1996; Mabsout & Van Staveren, 2010; Maiorano et al., 2021). Ignoring gender norms can undermine women's empowerment interventions when too much focus is given to increasing women's asset ownership (Anderson et al., 2021). For example, having property rights to land does not necessarily increase women's empowerment if the access to complementary resources (such as access to market, capital, or hired labour) is limited by social, cultural, or ideological factors (Bhaumik et al., 2016; David, 1998; Petrzelka & Marquart-Pyatt, 2011). Thus, understanding the role of social norms around gender becomes central to closing the gap in gender equality.

Women's empowerment through increased decision-making participation is widely recognised as an important pre-condition for broad based agricultural growth (Alwang et al., 2017; Anderson et al., 2021). Existing studies have highlighted the importance of asset ownership and resource allocation in determining women's participation in agricultural decision-making, and its impact on agricultural outcomes (Akter et al., 2017; Alkire et al., 2012; Anderson et al., 2017; Alwang et al., 2017; Chiappori, 1988; Doss & Quisumbing, 2018; Udry, 1996). However, these studies do not consider how social norms around gender affect their findings.

Measuring participation in decision-making in the household can be challenging. Questions such as the ones included in the Women's Empowerment in Agriculture Index (WEAI) (Alkire et al., 2012) are commonly applied as a proxy for decision-making participation in agriculture (Alwang et al., 2017; Anderson et al., 2017). These questions

usually ask who makes decisions for an agricultural activity, with answers that typically include the following options: myself, my spouse, or jointly (both). Women making decisions by themselves or together with their spouses is an indication of higher bargaining power. This measurement, however, has been criticized for a few reasons. For example, a woman can be making decisions about agricultural activities by herself because her spouse is away or sick, and this could be an additional burden to her (Akter et. al, 2017; Spangler & Christie, 2020). Also, making decisions jointly does not necessarily mean that the interests of each spouse have the same weight (Akter et al., 2017).

Some studies complement decision-making questions in WEAI with qualitative information that improves understanding of the decision-making process (see e.g. Acosta et al., 2019; Malapit et al., 2020). These studies incorporate information not only about who makes the decision but also how decisions are made. However, it is not always possible to collect both quantitative and qualitative information. A recent study by Maiorano et al. (2021) developed a measure of empowerment that included measures of decision-making and the reasoning behind the decision process. The Maiorano et al. (2021) decision-making questions are similar to the ones included in the WEAI, with the same options for the respondents (myself, spouse, joint), but they do not include questions on decisions regarding agricultural activities.

Most of the recent literature on intrahousehold agricultural decision-making participation focuses on Sub-Saharan Africa and South Asia (Quisumbing & Maluccio, 2003). Very little is known about South East Asia (Akter et al., 2017), where family farming systems are substantially different from Sub-Saharan Africa. In South East Asia, men and women farm plots together and couples own and manage assets jointly (Akter

et al., 2017). Whereas in Sub-Saharan Africa, men and women farm separate plots and have differential access to inputs and farm resources (Peterman et al., 2014).

Indonesia is the fourth most populous country in the world and has experienced high rates of growth in agriculture in recent years (Hill, 2018). It is experiencing rapid structural transformation and urbanisation (Kis-Katos et al., 2018). These conditions are likely to influence the roles of men and women in the agricultural sector (FAO, 2019). For example, as men migrate to urban centres in search of labour opportunities, women stay on the family farm and become the farm managers (Mulyoutami et al., 2020). A few studies on women's participation in decision-making and its welfare impacts focus on urban areas (Frankenberg & Thomas, 2001; Jayachandran, 2020; Rammohan & Johar, 2009), while those looking into rural areas are limited and more focused on farm labour division by gender (see e.g. Jha, 2004; Sajogyo et al., 1979; White, 1984).

In this study, we investigate men's and women's perceptions toward women's participation in agricultural decision-making in Indonesia, and the correlation of these perceptions and social norms. Our contribution is twofold. Firstly, we focus on 439 complete paired husband-wife surveys that ask both spouses the same questions separately and apply a fine-scale quantitative responses tool (0-10 Likert-type scale). The tool explores the extent to which decisions are made "jointly", and allows us to compare and contrast responses from husband and wife. Secondly, we empirically measure individual perceptions[1] on women's participation in agricultural decision-making and explore the importance of social norms to understand these perceptions. To the best of our knowledge, this is the first study that explicitly explores the roles of social norms in intrahousehold decision-making in rural Indonesia.

[1] The term of "perception" is used because it is a stated response rather than a direct observation of respondents behaviour.

The remainder of the paper is structured as follows. Section 2 provides a theoretical background. Section 3 introduces the context of women's participation in agriculture in Indonesia. Section 4 presents the data and methods. Section 5 provides the results and discussion. Section 6 presents conclusions and implications.

2.2 Theoretical background

The literature on intrahousehold bargaining power has moved away from the assumptions of the unitary decision-making model of equal preferences among household members (Akter et al., 2017; Doss, 1996, 2013; Quisumbing & Maluccio, 2003). Chiappori (1992) followed by Quisumbing & Mallucio (2003) proposed a collective model that allows different preferences for individuals within the household. This model assumes a household with two members, a man and a woman. The total utility of the household is equal to the weighted sum of the utility of each member's utility[2]. The weights are assumed to represent each household member's bargaining power, which depends on income generation and a credible threat of living in the household. Laszlo (2020) incorporates psychosocial factors such as individual perceptions of self-worth, and social and cultural norms related to the roles of men and women. It is found that a woman's power to influence or control decisions within the household is positively affected by her income, her fall-back position, and her self-esteem, and negatively influenced by social norms that favour men.

Lundberg & Pollak (1993) followed by Browning et al. (2010) and Cherchye et al. (2011) developed a bargaining power model in which a non-cooperative equilibrium emerges that reflects traditional gender roles and gender expectations. Men and women in the household are responsible for specific activities, as determined by their expected

[2] $U_{household}(.) = \alpha U_{man}(.) + (1-\alpha)U_{woman}(.)$; where U indicates utility, α and $(1-\alpha)$ are the weights that indicate the ability of man and woman to influence decision-making within the household.

roles in society and what they are considered to know best. Therefore, each spouse specialises in making decisions and managing resources within their separate spheres.

These models explicitly consider how social norms affect women's bargaining power and how they are likely to determine women's role in the household. According to Agarwal (1994), social norms about the role of women, as justified by tradition and religion, can prevent women from being involved in agriculture. In Indonesia, women are perceived as mostly occupied with child-rearing and domestic activities, women allocate labour to agriculture, but agricultural activities and decisions are considered men's domain (Herartri, 2005; Puspitawati et al., 2019). This further leads to women's lower participation in extension programs and limited access to land and agricultural inputs.

2.3 Women in agriculture in Indonesia

In Indonesia, approximately one-third of the total population is employed in agriculture, with women accounting for approximately 30% of all workers in the sector (ILO, 2019). In rural communities, agriculture is the foundation of livelihood activities and is usually performed at the household level. Approximately 60% of the farming households are smallholders owning less than 0.5 hectares of land, growing multiple crops (e.g paddy and horticultural crops/forestry), harvesting crops for household home consumption and/or for sale locally (Statistics Indonesia, 2018). Generally, both men and women work together in agricultural production (Ekadjati, 1995; Herartri, 2005; Moji, 1980; Sawit & O'Brien, 1995).

Rural Indonesian women play multiple roles in agriculture, from planting and harvesting through post-harvest activities (FAO, 2019). A clear division of labour by gender was observed with women occupied with weeding and pruning and men with land preparation and various chemical input applications, consistent with gender stereotypes

of women being detail-oriented and careful and of men being strong (Koning et al., 2000). Women are also perceived as better at managing financial resources, with women influencing decisions on major household and land investments (Sajogyo et al., 1979).

In general, women's roles in Indonesia are likely influenced by tradition, religious beliefs, plantation politics during Dutch colonialism, and dogmatic government during the New Order era from 1966 to 1998 (Backues, 1992; Koning et al., 2000). In rural Indonesia, men are regarded as the head of the family and the primary decision-maker (Herartri, 2005; Puspitawati et al., 2018). The traditional roles for wives and husbands emphasise that a woman's place is in the domestic sphere; where men are responsible for family income while women run the household and take care of the children (Herartri, 2005; Puspitawati et al., 2018). Although women play a significant role in agricultural activities, their participation is often considered to be merely helping their husbands, and their role is commonly under-recognised due to social norms that limit women's participation in decision-making at both the household and community levels (Herartri, 2005; Puspitawati et al., 2018; Wijers, 2019). The occluded role of gender in intrahousehold decision-making may be profound and requires elucidation.

2.4 Data and methods

This section describes the source of the data used and the analysis method. Measuring participation in intrahousehold decision-making, capturing the role of social norms, constructing Women's Participation Index (WPI), and multivariate analysis are presented in the method section.

2.4.1 Data

This study uses primary data from 439 spouses (878 respondents) in agricultural households in the upper Citarum, the biggest watershed in West Java. This upper watershed is mostly located in mountainous areas and the majority of the study site is

used for agriculture and forestry (Agaton et al., 2016). The rapid transformation of the agricultural sector in this area presents a great variety of agricultural activities. Increasing demand for agricultural products and its proximity to Bandung city, a major urban centre, led to rapid agricultural intensification, increased cultivation of horticultural crops, and increased diversification of agricultural and non-agricultural livelihoods (Agaton et al., 2016; Mulyono, 2010).

The survey applied a multistage stratified random sampling procedure. First, Bandung and West Bandung Districts were selected purposely because 65% of the Citarum Watershed lies in these two districts. Second, six out of eight sub-watersheds were chosen purposely because it was located in rural areas (two sub-watersheds that are located in the urban area were not included due to the lack of farming activities). Third, 22 villages from both districts were randomly selected, representing 10% of all villages in these two districts. Finally, 20 households were randomly selected from each village. The survey was conducted in Bahasa, the local language of Indonesia by local enumerators not from the study site.

The data were collected in July-August 2019. The data set includes information about household members, household and farm characteristics, access to credit, organisation membership, and farm and non-farm physical assets ownership. The survey instrument further includes a gender-specific decision-making module, with questions about agricultural activities directed to husband and wife separately. The survey is thus unique in providing detailed information on intrahousehold decision-making with respect to 21 agricultural activities in six domains (production, conservation practices, processing and marketing, training, credits, and buying and selling assets).

2.4.2 Methods

Measuring participation in intrahousehold decision-making

The survey asked: "Who makes decisions in the following aspects for most of the time in the past year?" for a total of 21 agricultural activities[3]. The responses to these questions correspond to a Likert-type scale from 0 to 10, which 0 means that the spouse decides alone, and the respondent has no participation at all over the decision, and 10 means that the respondent has full participation over the decision and the spouse has no participation at all. If the respondent answered 5, it means that the respondent perceives that both participate equally in the decision. This provides finer-scale responses to decision-making questions and goes beyond most existing studies that include only three choices of decision-making: self, spouse, and jointly (Acosta et al., 2019; Seymour & Peterman, 2018).

Capturing the role of social norms

To incorporate the role of social norms in intrahousehold decision-making we included a question about the rationale for men's and women's reported participation in each agricultural decision. This question, presented after the identification of the decision-maker and the decision-making participation, was: "Why do you think this decision is made this way?" Based on the households' typologies described in Bernard et al. (2020), the responses options included in the survey were:

i. Whoever has better knowledge about the activity (from now on *knowledge*).
ii. This is how decisions are made in the family/village (from now on *family/village*).
iii. Whoever allocates the most resources (from now on *resources*).

[3] The enumerators asked these questions separately to men and women. The survey implemented protocols to ensure privacy of respondents while answering these questions, and that it was appropriate for enumerators of a different sex of the respondent to ask administer the gender survey module.

Knowledge - the most informed individual is the one making decisions about an activity, corresponds to the Bernard et al. (2020) most-informed typology. As discussed by Mudege et al. (2015), there is a wide belief that men are regarded as the ones with knowledge and women are perceived as their helpers (not as farmers). Agarwal (1997) also mentioned that social norms about gender roles in agriculture affect who gets access to information (e.g. who is invited to extension activities and allowed to interact with extension agents).

Family/village - social norms of the community and/or the functions that men and women are expected to perform within the household affect decision-making, corresponds to three household typologies: dictator (one individual, usually the household head, makes all decisions in the households), separate sphere (individuals within the household are in charge of separate domains), and norms (the person who decides is determined by the community norms). These types are all determined by expected gender roles in society (Lundberg & Pollak, 1996).

Resources - the individual who contributes the most resources used for an activity is the one making decisions about the activity, corresponds to contributor household typology. It is not uncommon that women and girls, specifically in agriculture, are perceived to contribute less than men or boys (Agarwal, 1997). Since the response rate to *resources* is less than 7%, implying limited variation in the data, we opt not to incorporate it in further analysis[4]. This limited variation is not surprising since, in the Indonesian context, it is commonly believed that family resources are perceived as belonging to the household after marriage (Akter et al., 2017).

[4] When *resources* was incorporated in the regression equations for women's participation index (as in section 5.3), the R^2 was very low (0.07) and the coefficient was not significant. When the regression using *resources* was run together with *knowledge* and *family/village*, that the variance inflation factor (VIF) was very high (325) which suggesting that *resources* was highly correlated with other independent variables in the equation.

Women's participation index (WPI)

We constructed a women's participation index (WPI) in agricultural decision-making to measure men's and women's perceptions toward women's participation in agricultural decisions. We followed a widely used approach to estimate asset indices similar to Smits and Steendjik (2015) for the International Wealth Index and Almas et al. (2018), who applied this method to estimate a women's empowerment index based on women's perceptions of partner/spouse violence. We adopt this methodology to reduce the dimensionality of our data on intrahousehold decision-making in agricultural activities (Filmer & Pritchett, 2001; McKenzie, 2005) and also to account for the different weights of each decision.

Specifically, we perform a principal component analysis (PCA) on the responses to decision-making questions. We conducted a separate PCA for men's and women's responses. We generated the weights using PCA and used the loadings from the first component, which explains the largest part of the variation in the data, to weight the components of the indices (see Appendix 7 Table A7-1). Using this method, the WPI ranges from 0 to 45. For easier interpretation, we used the squared PCA loadings to transform the WPI to be between 0 and 10, where 0 means that the individual has no participation in the agricultural decision at the household, and 10 means that the individual makes all the agricultural decisions without participation of their spouse[5]. Two resulting indices: WPI_w and WPI_m, where *w* means women and *m* means men, respectively capture women's and men's perceptions of women's participation in decision-making in agricultural activities.

[5] The square of each loading represents the proportion of variance explained by a specific component thus the sum of squared loadings in PCA summing to 1 (Jolliffe & Cadima, 2016).

We understand that we can lose some information by aggregating the data in an index. For this reason, we present sex-disaggregated descriptive statistics for the 21 decisions and the WPI in the results section of the paper.

Multivariate analysis

We analyse the correlation between participation in agricultural decisions and social norms while controlling for individual and household characteristics likely to influence this correlation, using ordinary least squares (OLS) as follows:

$$WPI_{xij} = \alpha + \beta_1 socialnorm_{xij} + \beta_2 individual_{xij} + \beta_3 diffspouses_{ij} + \beta_4 household_{ij} + \beta_5 enumerator_{ij} + \beta_6 district_{ij} + \varepsilon_{ij} \quad (2.1)$$

where WPI_{xij} is the women's participation index for *x* = women, men of individual *i* in household *j*, $socialnorm_{xij}$ represents individual *i*'s perceptions of social norms in household *j* from the perspective of *x*, $individual_{xij}$ represents individual *i*'s characteristics in household *j* from the perspective of *x*, $diffspouses_{ij}$ represents characteristics differences between spouses for individual *i* in household *j*, $household_{ij}$ represents household characteristics for individual *i* in household *j*, $enumerator_{ij}$ represent the gender of enumerator that interviewed individual *i* in household *j* and is used to capture any systematic effect of the enumerator gender, and $district_j$ represent the district location of household *j*, to capture the regional effect. $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ are parameters to be estimated and ε_{ij} as the error term.

Social norms variables are measured using *knowledge*, and *family/village*. *Knowledge* indicates respondent's perception related to the reason on the decision is made based on the person who has better knowledge, and *family/village* measures respondent's perception on the reason is made because it is commonly done that way in the family or village. In our study we have 21 activities, thus if a respondent answers *knowledge* for

all 21 activities, then his/her *knowledge* value will be 21; and 0 if the respondent answers none on *knowledge* for all 21 activities (see Table 2.1 for further details).

The first set of covariates captures a variety of observed individual characteristics which are usually hypothesized to play a role in determining women's participation in decision-making. These include age (e.g. Anderson et al., 2017; Frankenberg & Thomas, 2001; Reggio, 2011), years of education (e.g. Doss, 2013; Kabeer, 2005; Sen, 1999), agricultural organisation membership (e.g. Agarwal, 1997; Lyon et al., 2017) and off-farm activity involvement (e.g. Bayudan-Dacuycuy, 2013; Maligalig et al., 2019). Interestingly, findings regarding these factors are usually mixed, where some studies suggest a significant effect while others do not, offering a further reason to test these factors in the current study.

In addition to individual characteristics, differentials of certain observed characteristics are also included. As suggested by Agarwal (1997), because "inequalities among family members in respect to determinant factors would place some members in a weaker bargaining position relative to others", affecting the level of participation in the decision-making. In this study, differentials in age, years of schooling, and agricultural organisation membership between husband and wife are used, based on literature findings (Brown, 2009; Doss, 2013).

Table 2.1 Definitions of variables used in analysis and summary statistics

Variable	Description	Mean	Std.Dev.	Min	Max
Dependent Variables:					
WPI_w	Women's participation index in agricultural decision-making perceived by wives (0-10)	3.54	1.86	0	10
WPI_m	Women's participation index in agricultural decision-making perceived by husbands (0-10)	2.54	1.63	0	8.21
Independent Variables:					
Individual characteristics:					
Knowledge (wife's perception)	The total number of wife's responses related to the rationale of the decision is made based on the person who has better knowledge.	9.62	7.36	0	21
Knowledge (husband's perception)	The total number of husband's responses related to the rationale of the decision is made based on the person who has better knowledge.	10.57	6.94	0	21
Family/village (wife perception)	The total number of wife's responses related to the rationale of the decision is made because it's commonly made in the village.	10.72	7.63	0	21
Family/village (husband perception)	The total number of husband's responses related to the rationale of the decision is made because it's commonly made in the village.	9.52	7.16	0	21
Wife's age	In years	44.52	11.78	18	75
Husband's age	In years	50.13	12.23	22	84
Wife's education	Wife's years of schooling (years)	6.47	2.67	0	16
Husband's education	Husband's years of schooling (years)	6.27	2.78	0	16
Wife's agricultural organization membership	The wife perceives that she or any person in the household is a member of an agricultural organization (1=yes)	0.44	0.49	0	1
Husband's agricultural organization membership	The husband perceives that she or any person in the household is a member of an agricultural organization (1=yes)	0.56	0.49	0	1
Wife's off farm activity	Wife has off farm activities (1=yes)	0.23	0.42	0	1
Husband's off-farm activity	Husband has off-farm activities (1=yes)	0.37	0.48	0	1
Differences between husband and wife:					
Age difference	Husband's age minus wife's age (years)	5.61	4.45	-4	30
Education difference	Years of schooling difference between husband's and wife's (years)	-.21	2.72	-13	8
Agricultural organization membership difference	Differences in perception[1] between husband and wife related to membership in an agricultural organization (-1= only wife perceives as a member; 0=both husband and wife have the same perception; 1=only husband perceives as a member)	.12	.46	-1	1

Table 2.1 (Continued) Definitions of variables used in analysis and summary statistics

Variable	Description	Mean	Std.Dev.	Min	Max
Household characteristics:					
Women farm production participation	Whether or not women family members participate in farm production (in terms of total responses for 14 farm activities)	2.89	2.49	0	9
Children under 5 years old	Total children with the age of 5 years old or under, in the household	.36	.54	0	3
Men-women ratio	The ratio of men to women (age 17 years old and above) in the household (number of men divided by the number of women)	1.16	.63	0.33	5
Parents/ in-laws living with the household	Has parents/ in-laws living with the household (1=yes)	0.04	0.19	0	1
Land size	The total land size that is owned and managed by the household (Hectare)	.68	.84	0	7.40
Household asset index[2] (wife's information)	Household asset index that is formed using wife information (0-10)	.57	.39	0	3.38
Household asset index[2] (husband's information)	Household asset index that is formed using house information (0-10)	.62	.40	0	2.46
Social Desirability Bias:					
Woman enumerator	Respondent was interviewed by woman enumerator (1=yes)	0.38	0.49	0	1
Location:					
West Bandung	Household located in West Bandung (1=yes)	0.36	0.48	0	1

[1] This variable is generated based on the differences between husband's and wife's answers related to whether or not he/she/the family is a member of any agricultural organization. The value of 0 means that husband and wife have the same answers, which is both said "yes" or both said "no".

[2] This variable is generated using PCA for 14 assets owned by each household (mobile phone, internet, vehicle, and some farm-production-related assets).

Household characteristics are further included to capture variations at this level. Following literature findings, women family farm labour participation (Bokemeier & Garkovich, 1987; Rosenfeld, 1986), the total number of young children up to five that live in the household (in the spirit of Anderson et al., 2017), men to women ratio in the household (e.g. Brown, 2009; Quisumbing & Mallucio, 2003), whether or not parents/parents-in-law living in the household[6] (e.g. Anukriti et al., 2020; Bayudan-Dacuycuy, 2013), land size (e.g. Alwang et al., 2017), and household asset index (e.g. Doss, 2013) are used as variables to capture household characteristics.

Finally, we control for the gender of the enumerator. Alwang et al. (2017) found a tendency that men respondents that are interviewed by women enumerators to give a more positive response to wife's participation in decision-making. We also control for location in West Bandung district, since it is relatively closer to a major metropolitan area (Bandung city). Such proximity provides off-farm paid labour opportunities to women, and more urbanised settings, with less tight-knit communities, "may demonstrate a relaxation in social and gender norms" (Bradshaw, 2013).

In identifying the determinant of WPI_w and WPI_m, we conducted two separate estimations. To adjust for potential heteroscedasticity, standard errors are clustered at the village level (Wooldridge, 2002).

2.5 Results and Discussion

This section discusses the findings and discussions on men's and women's participation in agricultural decisions and the rationale for the decision-making. It also

[6] The study by Bayudan-Dacuycuy (2013) in the Phillippines shows that the presence of the extended families (especially parents) increases the wife's participation in decision-making, in which the existence of parents tend to act as a balancing element in the household. In India the presence of parents in law (particularly of the mother-in-law) in the household can undermine women's participation in decisions and women's agency (Anukriti et al., 2020).

presents the regression results on the determinants of women's participation in agricultural decision-making from women's and men's points of view.

2.5.1 Participation in agricultural decisions

Figure 2.1 presents the kernel probability distributions of the responses to decision-making questions for men and women. Most of the responses are around five and below and vary depending on the agricultural activity in question. Figure 2.1 shows that regardless of the activities (with a couple of exceptions), the spectrum of women's decision-making participation responses is relatively wide, indicating that the "joint" decision is arrived at through various combinations.

In general, compared to women, men hold a quite different perceptions about women's participation in decision-making. First, the kernel distribution for men's responses is below the one for women's responses, indicating that men perceive women's participation to be lower than women perceive it themselves. Second, almost 40% of men perceive that women have zero participation, almost twice the level of women's own perception. The kernel distribution for each activity also shows consistent results (Appendix 7, Figure A7-1 to Figure A7-21 for details).

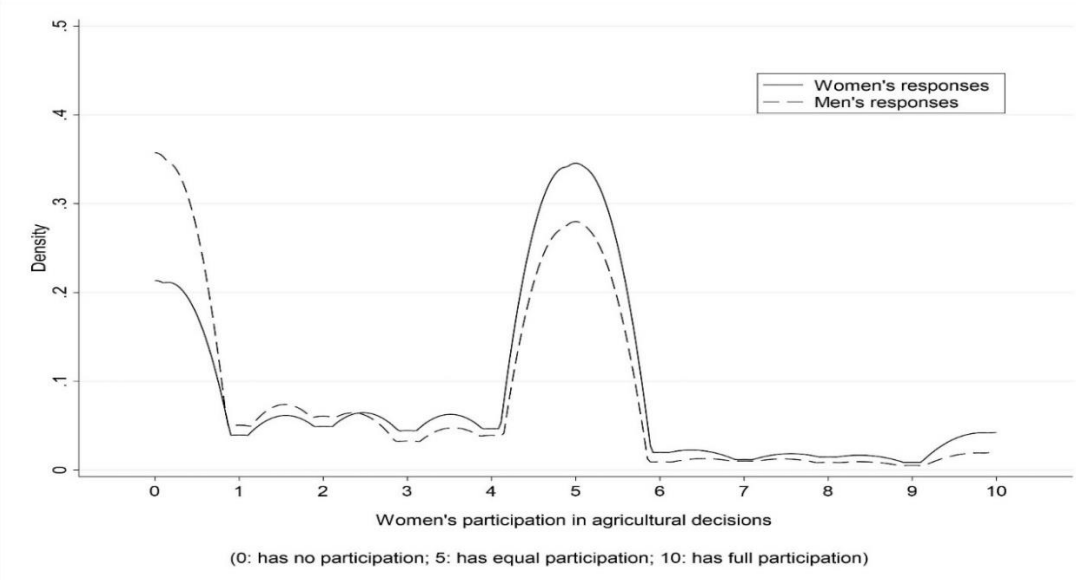

Figure 2.1 Kernel density for women's and men's responses to women's participation in 21 agricultural decisions. Taken from all responses regardless of the activity.

Figure 2.2 shows a very visual representation of the degree of agreement between the women's group and the men's group. It shows that in general, the responses between the 25th and the 75th percentile for the women's group are relatively shorter (more condensed) than the men's. This suggests that the women's group has a high level of internal agreement (more consistent response), while the men's group holds quite different opinions about women's participation[7]. The upper quartiles show that 75% of the women's group and 75% of the men's group perceive that women's participation in agricultural decision-making is less than five, partially explaining why the boxes are between zero and five. The medians (marked by "x") that are shown in the boxplots suggest women's responses are skewed to the right (with most of the medians falling at five), indicating that women's responses are closer together at higher scores. Meanwhile, the men's responses are skewed to the left (closer to the lower scores).

Based on the average values for women's and men's responses, women perceive that their participation is higher than what the men perceive, in every single decision (Appendix 7 Figure A7-22). Women reported less than equal participation in decision-making with respect to their spouses, with average values between 2.9 to 4.3. Men tended to report more that women did not participate in the decision at all. Women reported higher levels of participation in decision-making for when and how to tend the crops, land purchase and sale, and credit requests for agricultural investment. This is consistent with an early study by Sajogyo et al. (1979) who reported that women in West Java were influential in major household investment decisions such as farmland purchases and house improvements. On the other hand, women reported lower participation in

[7] Jhangiani and Tarry (2014) explained that "men are, on average, more concerned about appearing to have high status and may be able to demonstrate this status by acting independently from the opinions of others. Thus, men are likely to hold their ground, act independently, and tend to refuse to conform (to women)". Our findings from the regression results (Table 2.2) also show that men's age and education affect their perception related to women's participation in decision-making.

conservation decisions including building and maintenance of soil and water conservation (SWC) structures, implementation of SWC practices, safety and practice in spraying, and attending agricultural training. Government programs introduced SWC practices in West Java through farmer's groups, mostly formed by men and considered to be the domain of men (Backues, 1992).

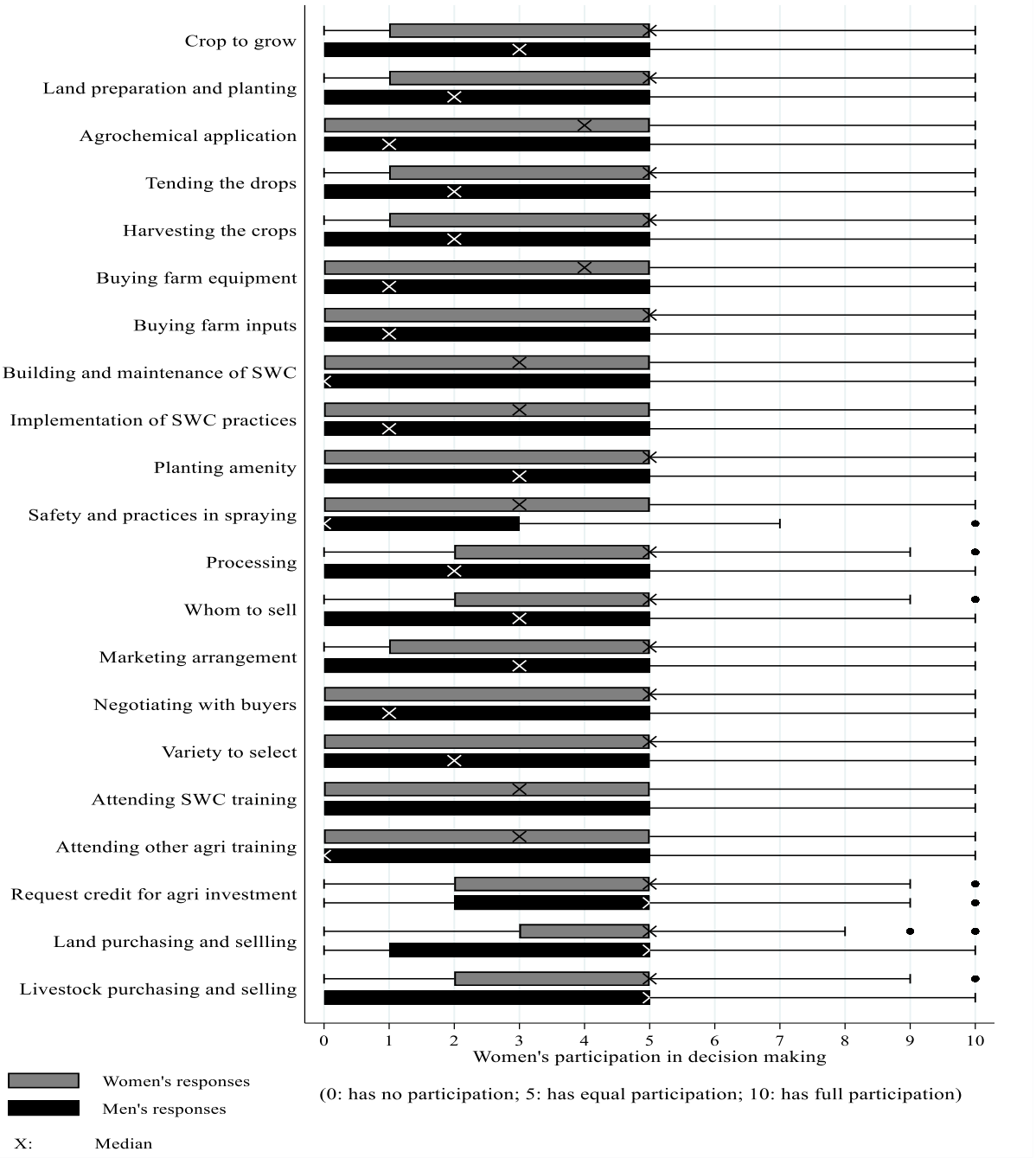

Figure 2. 2 Box plots for women's and men's responses to women's participation in 21 agricultural decisions.

The differences between men's and women's perceptions are all statistically significant at the 0.01 level (see Appendix 7 Table A7-2 for details). This is consistent with the literature: men tend to report that their wives have lower participation in decisions, usually due to intrahousehold information asymmetries (Alkire et al., 2012; Alwang et al., 2017; Anderson et al., 2017). The differences are higher for when and how to tend crops, safety and practices in spraying chemical inputs, and when and how to harvest crops. Whereas the differences are lower for credit requests for investment, livestock, and land purchases and sales. This is consistent with West Java's previously documented division of agricultural activities along gender lines (Backues, 1992; FAO, 2019; Moji, 1980).

2.5.2 Rationale for intrahousehold decision-making in agriculture

Overall, there is a relatively even contribution of *knowledge* and *family/village* to the rationale of agricultural decision-making, with variability depending on the type of decisions (see Figure 2.3). Women tend to respond that decisions are made under *family/village* (i.e. this is how the decision is made in the family/village), whereas men tend to respond that decisions are made according to *knowledge* (i.e. whoever has better knowledge about the activity). Within the female respondent cohort, 33% to 54% of the women responded that decision-making for activities related to conservation practices, for which they reported lower levels of participation, is based on *knowledge*. A possible explanation is that in rural Indonesia, men tend to have more access to information about agricultural technologies when compared to women (FAO, 2019; Meadows, 2013).

Figure 2.3 also shows that there is a tendency for systematic gender differences in perceived reasons affecting the way the decision is made. In all activities except for what crops to grow, the percentage of women who answered *knowledge* is lower than the percentage of men. The difference is statistically significant for the reason for decision-

making related to production (when and how to do land preparation and planting, when and how to tend the crops, buying yield-increasing farm inputs), conservation practices, processing process, and training (attending other agricultural training) (see Appendix 7 Table A7-3 for details).

On the converse, the percentage of women who responded *family/village* is higher than the percentage of men for almost all activities (except for what crop to grow and land purchasing and selling), and statistically significant for 12 out of 21 activities. These results may indicate that women in West Java are highly influenced by social norms related to gender roles: the husband is the head of the family and primary decision-maker, and that agriculture is men's domain (see Herartri, 2005 and Puspitawati et al., 2018), or, that men believe that they are more knowledgeable about agricultural activities and farm management.

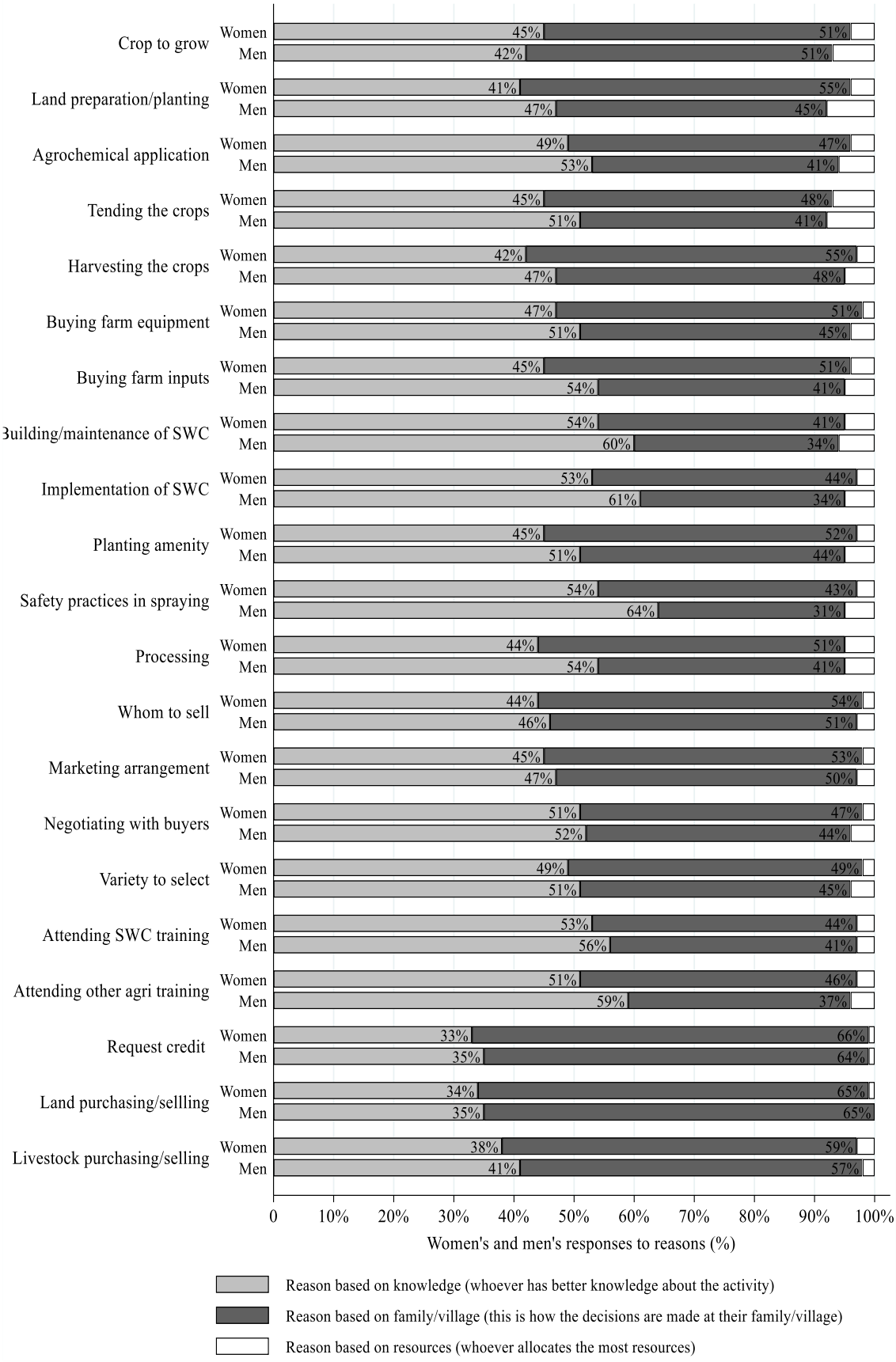

Figure 2.3 Women's and men's reasons for women's participation in the 21 agricultural decisions.

2.5.3 Regression results

The descriptive statistics and definitions for all the variables included in this section are presented in Table 2.1.

Women's WPI in agricultural decision-making

From the women's perspective, factors capturing social norms are important in predicting women's participation in decision-making. Table 2.2 shows the estimation results of WPI_w for three different specifications: Specification 1 excludes variables that capture social norms, Specification 2 includes only *knowledge,* Specification 3 includes only *family/village*[8]. It is first observed that, once social norm factors (*knowledge* and/or *family/village*) are considered (in Specifications 2, and 3) in predicting WPI_w, there are noticeable increases in the R^2 and adjusted R^2, suggesting the explanatory power of these factors and the need to incorporate them in understanding intrahousehold decision-making.

Table 2.2 shows that *knowledge* (in Specification 2) is negative and significantly associated with the WPI_w. Decision made based on *knowledge* is associated with 0.12 point reduction of WPI_w. This implies that for agricultural activities, women perceive their lack of knowledge (relative to men) limits their decision-making participation. This finding is consistent with the findings in the descriptive results in Section 5.1 that on average, women reported lower participation in agricultural decisions relative to their husbands for all agricultural activities. On the contrary, the coefficient for *family/village* (in Specification 3) is positive and significantly associated with the WPI_w, indicating for each decision that is made because of *family/village*, the WPI_w index increases by 0.12 points. This implies that women have higher decision-making authority in agricultural

[8] Variable *knowledge* and *family/village* are run separately as in Specification 2 and 3 because these two variables have a strong negative correlation (Pearson's correlation result shows -0.97) which suggests that if *knowledge* increases, the *family/village* decreases with the same magnitude, and vice versa.

activities if it is something that is commonly practiced in the community. These results cumulatively suggest that women's perceptions of decision-making authority in agriculture are influenced by social norms.

Table 2.2 also shows that women's individual characteristics are not playing a significant role, contrary to the findings of previous research (e.g. Agarwal, 1997; Anderson et al., 2017; Anukriti et al., 2020; Doss, 2013; Frankenberg & Thomas, 2001; Rammohan & Johar, 2009)[9]. Thus, social norms are of utmost importance compared to other observable characteristics. The total number of agricultural activities where women participate is the only household characteristic significantly associated with women's WPI. The more women participate as farm family labour, the higher the amount of decision-making power they have. This result is consistent in both developing and developed country settings (e.g Anderson et al., in 2017 for the case in Tanzania, and Bokemeier & Garkovich, in 1987 for the context of Kentucky farm women in The United States).

[9] For example, previous studies found that in multigenerational households, where women live with their parents-in-law, women's education does not increase their decision-making power (Cheng, 2018). In our study less than 4% of the household are multigenerational households, and for these cases we did not find a statistically significant correlation between *parents/parents-in-law live in the household* and the WPI_m and WPI_w. We also conducted additional t-tests comparing the WPI_m and the WPI_w of multigenerational households and nuclear ones and did not find statistically significant differences (see Appendix 7 Table A7-4 for further details).

Table 2.2 OLS results on women's women's participation index (WPI_w) in agriculture, West Java, 2019

Variable	Specification1[+]	Specification 2[+]	Specification 3[+]
Wife's characteristics			
Knowledge		-0.12***	
		(0.02)	
Family/village			0.12***
			(0.01)
Age	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)
Education	-0.01	-0.03	-0.04
	(0.05)	(0.04)	(0.04)
Agricultural organization membership	0.19	0.08	0.06
(yes=1)	(0.29)	(0.25)	(0.25)
Off-farm activity (yes=1)	-0.32	-0.15	-0.20
	(0.28)	(0.28)	(0.27)
Difference between husband and wife			
Age	0.04**	0.02	0.02
	(0.02)	(0.02)	(0.02)
Education	0.06	0.05	0.05
	(0.04)	(0.04)	(0.04)
Agricultural organization membership	-0.05	-0.27	-0.20
	(0.23)	(0.19)	(0.19)
Household characteristics			
Women farm production participation	0.10**	0.08**	0.07*
	(0.04)	(0.04)	(0.04)
Number of children under 5 years old	-0.05	0.05	0.04
	(0.16)	(0.14)	(0.13)
Men-women ratio	0.25	0.15	0.14
	(0.16)	(0.15)	(0.15)
Parents/in-laws live within the household			
(yes=1)	-0.38	-0.27	-0.17
	(0.38)	(0.25)	(0.27)
Land size (Hectare)	-0.18	-0.13	-0.13
	(0.10)	(0.08)	(0.08)
Household assets index	-0.11	0.00	-0.02
(wife's information)	(0.27)	(0.26)	(0.27)
Social Desirability Bias:			
Woman enumerator (yes=1)	-0.07	-0.10	-0.04
	(0.20)	(0.16)	(0.16)
Other variables:			
West Bandung	0.06	-0.27	-0.31
	(0.17)	(0.19)	(0.20)
Constant	2.95***	4.68***	2.37**
	(0.63)	(0.50)	(0.52)
N	439	439	439
R^2	0.07	0.28	0.27
Prob>F	0.00***	0.00***	0.00***

[+] Specification 1 excludes variables that capture social norms, Specification 2 includes only *knowledge*, Specification 3 includes only *family/village.*

* p<.1; ** p<.05; *** p<.01; Clustered standard errors at the village level are reported in parentheses

Men's WPI in agricultural decision-making

From the men's perspective, social norms are also important factors in predicting women's participation in decision-making. Table 2.3 shows the estimation results for the

correlation of the men's WPI. Overall, there are noticeable increases of R^2 and adjusted R^2 from specification 1 to specification 2, and 3, suggesting the explanatory power of the social norm factors. These findings are consistent with what we found for the correlates of the women's WPI, with the most variation in women's participation in decision-making explained by social norms.

In Specification 2 and 3, WPI_m is negatively correlated with *knowledge* and positively correlated with *family/village*. These findings suggest that men also perceive that lack of knowledge in agricultural activities limit women to participate in decision-making and they also perceive that women can participate more in the domains in which it is compliant with the norms. This is also consistent with the finding from the WPI_w.

In all specifications, WPI_m is correlated with men's education, the higher the husband's education level, the higher the WPI_m. There are some possible explanations for this positive effect. First, education may impose men to a better understanding of the importance of women's role in intrahousehold decision-making (ILO, 2014). Second, related to the off-farm activities. Better-educated men have a higher probability of engaging in off-farm activities thus leaving farm matters to the wives consequently increasing women's decision-making participation in agricultural activities[10]. The positive correlation of men's education with the WPI_m that we found in our study is consistent with the findings of Frankenberg & Thomas (2001) in the context of three ethnicities in Indonesia. They found that an increase in men's education, increasing the probability that decisions in the household are made jointly with the spouse.

Other statistically significant correlations include the age difference between husband and wife, which is positively associated with the WPI (in all specifications).

[10] The correlation between men's years of schooling and off-farm activities participation is positive at $p<.01$

This indicates that the higher the age gap (with younger wife) the higher the WPI_m. This is possibly related to whether the husband is at a non-productive age while the wife is still at a productive age, as in the case of Brown's (2009) findings for China. However, additional analysis suggests that men 50 years of age or younger tend to report lower levels of women's participation in agricultural decision-making when compared to men older than 50 years of age as measured by WPI_m.

Consistent with the findings in the women's WPI, men also perceive that women's participation as family farm labour increases women's participation in agricultural decision-making. This finding is consistent in all three specifications.

In all specifications, we find that in wealthier households, men tend to report that women are less involved in agricultural decisions. It is consistent with Koning et al. (2000) findings for Indonesia, in which the wealthy/high-status families are more likely dictated by tradition in which women are expected to be submissive to their husbands. Another possibility is households' reliance on agriculture to generate income decreases with wealth. In this case, it can be that they use a third party to manage the farm, and thus by nature, it will reduce women's participation in decision-making. On the other hand, a wealthy family can also have a high reliance on agriculture and has sufficient income to liberate one of the couples (woman) from agricultural labour thus reducing women's participation in the decision-making. However, this result contradicts Doss (2013) who stated that wealthier households in developing countries, have better access to information and higher social status, leading to higher levels of participation in decision-making. This finding can therefore be context-specific and points to the importance of considering norms, values, and social context in related studies.

Finally, we conducted robustness checks and estimated equation (2.1) for men and women using Seemingly Unrelated Regressions (SUR) and using instrumental variables

(IV). Further explanation and results are included in Appendix 7 Table A7-5 and A7-6. We find that our results are robust to different estimation methods with different assumptions.

Table 2.3. OLS results on men's women's participation index (WPI_m) in agriculture, West Java, 2019

Variable	Specification 1[+]	Specification 2[+]	Specification 3[+]
Husband's characteristics			
Knowledge		-0.10***	
		(0.02)	
Family/village			0.10***
			(0.02)
Age	0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)
Education	0.07**	0.07***	0.06**
	(0.02)	(0.02)	(0.02)
Agricultural organization membership (yes=1)	0.10	0.08	0.06
	(0.12)	(0.12)	(0.12)
Off-farm activity (yes=1)	-0.11	0.06	0.08
	(0.14)	(0.13)	(0.15)
Difference between husband and wife			
Age	0.03*	0.04**	0.04**
	(0.02)	(0.02)	(0.02)
Education	-0.03	-0.02	-0.01
	(0.03)	(0.02)	(0.02)
Agricultural organization membership	-0.20	-0.22	-0.15
	(0.20)	(0.16)	(0.16)
Household characteristics			
Women farm production participation	0.14***	0.09**	0.09**
	(0.03)	(0.04)	(0.04)
Children under 5 years old	-0.24	-0.14	-0.14
	(0.16)	(0.13)	(0.13)
Men-women ratio	0.03	-0.02	-0.03
	(0.15)	(0.15)	(0.15)
Parents/ in-laws live within the household (yes=1)	0.26	0.20	0.16
	(0.41)	(0.34)	(0.35)
Land size (Hectare)	-0.00	0.05	0.05
	(0.08)	(0.08)	(0.08)
Household asset index (husband's information)	-0.67***	-0.59***	-0.55***
	(0.19)	(0.19)	(0.19)
Social Desirability Bias:			
Woman enumerator (yes=1)	-0.31	-0.13	-0.10
	(0.19)	(0.16)	(0.17)
Other variables:			
West Bandung	0.22*	0.01	-0.06
	(0.12)	(0.13)	(0.15)
Constant	1.72***	2.86***	0.98***
	(0.40)	(0.31)	(0.36)
N	439	439	439
R^2	0.12	0.27	0.27
Prob > F	0.00***	0.00***	0.00***

[+] Specification 1 excludes variables that capture social norms, Specification 2 includes only *knowledge*, specification 3 includes only *family/village.*

* p<.1; ** p<.05; *** p<.01; Clustered standard errors at the village level are reported in parentheses.

2.6 Conclusions and Implications

We investigate sex-disaggregated perceptions of women's participation and the roles of social norms about gender in agricultural decision-making. We constructed a WPI to measure men's and women's perceptions regarding women's participation in 21 agricultural decisions and applied OLS regressions to survey data from 439 couples (878 individuals) in smallholder agricultural households in West Java, Indonesia. First, it is found that while the "joint" decision comes in a wide spectrum of combinations, on average women's participation in the decisions is less than equal. Second, men and women have different perceptions about women's decision-making participation. However, they have roughly the same perception of the types of activities that have the most and the least women's participation in decisions, which seems to be related to gender labour division in Indonesia. Third, from both women's and men's perspectives, the variation in women's participation in decision-making is mostly explained by the variables capturing the role of social norms and context.

These results have implications for the design of decision-making surveys concerning agricultural activities conducted by researchers, government organisations, and NGOs collecting intrahousehold decision-making data. The inclusion of more flexible ways of measuring decision-making can improve our understanding of the meaning of joint decisions, and the observed differences in perceptions about men's and women's involvement in intrahousehold decision-making processes. Similarly, the correlation between responses to decision-making questions and social norms highlights that those interest in collecting these data incorporate questions on the rationale behind decision-making at the household level to better grasp how social norms shape these intrahousehold processes.

Finally, our results provide empirical evidence in the context of West Java, Indonesia that social norms regard men as household heads and primary decision-makers, that agriculture is men's domain and that men are the ones with knowledge about agriculture are deeply rooted in both individual and community viewpoints. Thus, governmental organisations and NGOs promoting women empowerment in agriculture are encouraged to design interventions that promote collective awareness of the role of women in agriculture and the value of their contributions to agricultural activity at the community and the national level. These considerations are needed if we wish to increase gender equality and women empowerment in agriculture in Indonesia and elsewhere.

Several limitations should be kept in mind when considering our results. First, the non-experimental nature of the data prevented us from making any strong causal inferences. Second, we do not know whether or not the current condition is reflecting women's preferences in decision-making participation, which is beyond the scope of the current study. These limitations suggest the need for further research into this important issue.

Chapter 3 Statement of Authorship

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Contribution to the Paper	Conceptualisation, methodology, formal analysis, investigation, methodology, writing – original draft, writing – review and editing		
Overall percentage (%)	60		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	2 October 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

The candidate's stated contribution to the publication is accurate (as detailed above);
Permission is granted for the candidate to include the publication in the thesis; and
The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Alexandra Peralta		
Contribution to the Paper	Conceptualisation, methodology, supervision, writing – review and editing		
Signature		Date	2 October 2022

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Contribution to the Paper	Conceptualisation, supervision, writing – review and editing		
Signature		Date	2 October 2022

Chapter 3: Unfolding the spousal differences in response to intrahousehold decision-making participation questions: Evidence from West Java, Indonesia

Abstract

Recent studies aiming at understanding intra-household decision-making dynamics in rural households collected data by separately asking decision-making questions to men and women in the household. These studies found that men's and women's answers can differ substantially. Some studies examined the correlation between these differences in responses, to individual and household characteristics. However, these studies do not look further into the possible sources of the differences in survey responses, which may indicate underlying power dynamics within the households. Using data from 439 paired husband-wife in West Java, Indonesia, this paper explores spousal differences in response to questions regarding 39 household decisions in six domains, and carefully investigates the source of the differences in responses. Using t-test, multivariate test on means, and the literature in intra-household decision-making, we find that: 1) the level of spousal differences in responses varies based on the domains and the type of decisions; 2) differences in responses are not only attributed to measurement error (random, systematic and asymmetric); 3) differences in responses are not explained by asymmetric information due to strategic concealing of information among spouses. The differences in spouses' responses to decision-making questions are due to information asymmetries linked to intrahousehold division of labour and activities due to gender, and are likely to be context-specific. These findings suggest the need for careful consideration in interpreting the spousal differences in response because depending on the source of the discrepancy, it may or may not explain the intrahousehold decision-making dynamics.

Keywords: intrahousehold decision-making, discrepancy, agriculture, smallholder

3.1 Introduction

Recent literature has shown that women's participation in intrahousehold decision-making, as one of the indicators of women empowerment, may lead to better welfare outcomes for women, their households, and communities (Acosta et al., 2019; Doss, 2013; Duflo, 2012; Quisumbing, 2003). A recent systematic review on the benefit of empowering women in agriculture, finds a large body of evidence that increasing women's participation in decision-making related to agricultural resources, management and production, and income has a positive correlation with more spending allocation for children's education and nutrition, and improve household food security (Anderson et al., 2021).

It is well-recognised that men's and women's preferences influence household decisions to a different extents (Haider et al., 2018; Shibata et al., 2020). To better understand intrahousehold dynamics, collecting data on a single spouse or considering only a single decision-maker when the household has more than one decision-maker (e.g. dual heads) is considered insufficient (Anderson et al, 2017; Annan et al., 2021; Ambler et al., 2022; Chen & Collins, 2014). Hence, survey questions in recent studies have been collected by asking separately decision-making and asset ownership questions to men and women with decision-making roles in the household (Acosta et al., 2019; Ambler et al., 2021).

The literature has found that when men and women were asked the same questions, individually and separately, their responses differ (Alwang et al., 2017; Van Campenhout et al., 2022; Jejeebhoy, 2002; Seymour & Peterman, 2018). Several studies have endeavoured to associate these differences in response with individual and household characteristics (Anderson et al, 2017; Donald et al., 2017; Twyman et al., 2015). However, these studies do not examine the potential cause of the differences in survey

responses. If answers vary between respondents, this can provide useful information about the perspective of the respondent which is important in affecting their ability to act (UNECE, 2021). This clearly demands improved knowledge as women's agency could vary substantially depending on whether disagreement assigns more or less decision-making power to women (Annan et al., 2021). Thus, interpreting intrahousehold decision-making dynamics requires rigorously exploring the reasons behind such discrepancies.

Recent studies suggest that the observed differences between men's and women's responses to intrahousehold decision-making survey questions can be due to random measurement error, asymmetric measurement error, or information asymmetry (Ambler et al., 2021, 2022; Liaqat et al., 2021; Van Campenhout et al., 2022). Asymmetric measurement error refers to the errors that are due to different interpretations of the survey questions, while information asymmetry indicates the difference in response to survey questions where one party may possess more information than the other.

Information asymmetries could result in differing responses to survey questions when spouses hide (voluntarily or involuntarily) information from each other, for example, a woman indicates that she is involved in decision-making but her husband does not because she makes some decisions without her husband's knowledge (e.g. Almas et al., 2018; Ambler et al., 2021; Castilla & Walker, 2013). It is also possible that spouses function within separate spheres (Lundberg & Pollak, 1996), where each spouse makes decisions about certain household activities that are assigned to them because of their gender, in this case, these decisions might not even be relevant to the other spouse or not of his/her interest (Johnson et al., 2016).

Most previous studies ask about the decision-maker identity (who makes the decisions) and relate it to asset ownership to measure women's decision-making

participation (e.g. Alkire et al., 2013; Alwang et al., 2017; Ambler et al., 2021; Anderson et al., 2017). This method, however, is sometimes problematic. Due to cultural reasons, responses may be driven by social norms on gender roles and gender stereotypes (Mabsout & Van Staveren, 2010; Peterman et al., 2021; Qanti et al., 2021; UNECE, 2021; Van Campenhout et al., 2022). In these situations, the method may fail to measure women's empowerment in a robust way (Peterman et al., 2021). Moreover, existing literature largely relies on a limited set of questions and thus sometimes fails to capture the complexities of life experience across agricultural households in a variety of cultural settings (Anderson et al., 2017; Bernard et al., 2020; UNECE, 2021). Most agricultural households produce partly for sale and partly for their own consumption, purchase some of their inputs (e.g. fertilizer, pesticides, and labour), and also provide some inputs (e.g. family labour) (Singh et al., 1986). Therefore, their decisions will not only be regarding production but also consumption and labour supply.

Some literature captured the complexities of the decision-making process within agricultural households in these domains. For example, the widely used Women's Empowerment in Agriculture Index (WEAI) by Alkire et al. (2012) uses five domains (production, resources, income, leadership, and time) and ten general indicators (e.g. input in productive decisions and autonomy in production as indicators for production domain). These general indicators may work for general comparison but may not allow us to unfold more insight into the complexity of women's roles and decision-making participation in specific agricultural activities. Due to the wide gender stereotypes that agriculture is a men's domain (Agarwal, 1997; Herartri, 2005; Puspitawati et al., 2018), the general questions may result in biased estimation of women's participation in intrahousehold decision-making. More specifically, agricultural activities are increasingly considered in the investigation report on women's roles and involvement in

decision-making in these regards (e.g. Colfer et al., 2015; FAO, 2019; Qanti, et al., 2021; Seebens, 2010; Sell & Minot, 2018).

In the following analysis, we contribute to the body of knowledge in three ways. First, we extensively explore to what extent men and women provide similar or different answers to 39 household decisions in six domains (agricultural production, agricultural and household investment, household expenditure, income-generating activities, saving and credit, and training) from 439 paired husband-wife from West Java, Indonesia. Then, we carefully analyse whether the women's and men's differences in response regarding the above decisions are caused by random measurement error, asymmetric measurement error, asymmetric information, and gender of the enumerator.

Second, we use women's and men's responses to "how often do you think your household thinks about the decision, overall, in the past year?" ("how often" from now on) and utilise a 0-10 Likert scale answer option; rather than using "who makes decisions in the following aspects for most of the time in the past year?" ("who decides" from now on). Asking questions regarding "how often" to household members can elucidate whether they participate in the decision-making process (Liaqat et al., 2022). A recent study shows that answers to the question "who decides" are driven by social norms about gender in the study setting (Qanti et al., 2021). In the current study, we hope that "how often" is less influenced by these norms.

Third, to compare our results to other studies in other contexts (e.g Ambler et al., 2021), we also compare responses to questions regarding asset ownership in the household. To help fill the above knowledge gaps, this study focuses on intrahousehold decision-making in the context of Indonesia, a country with a different cultural background from countries in Sub-Saharan Africa and South Asia where most empirical

intrahousehold decision-making studies have been conducted (Annan et al., 2021; Donald et al., 2017; Jones, 2017).

Our results suggest that in the context of Indonesia, the level of spousal disagreement is based on the type of activities within the six domains that we studied. We find that the spousal differences in response are not likely caused by random and/or asymmetric measurement error only, or asymmetric information due to spouses strategically concealing information from each other. Asymmetric information, specifically related to the gendered division of labour/activities due to cultural reasons or norms is suggested as a more likely explanation.

3.2 Motivation and literature review

The literature on intrahousehold decision-making has demonstrated how the unitary decision-making model fails to explain the intrahousehold decision-making dynamic in many contexts (for a review of the literature see Doss, 1996). In many instances, household members bargain for different decisions, and individuals within a household may cooperate or not in deciding some or all decisions at the household level (Doss, 2013; Mabsout & Van Staveren, 2010).

Intrahousehold bargaining power models show how individuals within a household may have different bargaining power or influence over decisions (Doss, 2013). Bargaining power has been associated in the literature with participation in decision-making and asset ownership (Doss, 2013; Quisumbing, 2003). To elucidate intrahousehold decision-making dynamics, household surveys include questions about decision-making for a set of household activities and questions about access to assets and asset ownership. These questions are usually asked separately and individually to female and male heads of households, where households have two household heads involved in intrahousehold decision-making.

The empirical literature has found that when male and female household heads are asked separately and individually about decisions, their answer to the questions can differ substantially; differences vary among decisions, assets, and contexts. For example, in Malawi Fisher et al. (2010) found that only 6% of the couples in their sample agree on the amount of income earned by the wife. A study of five countries in South East Asia by Ghuman et al. (2006) claimed about 25% to 50% of couples disagree on the wife's participation in deciding matters related to their children and the wife's influence in household activities. Seymore & Peterman (2018) found that 6% to 64% of couples in Bangladesh and 67% to 82% of couples in Ghana agree on who normally takes decisions on fourteen agricultural and non-agricultural domains. In India, Jejeebhoy (2002) explored women's and their husband's perceptions of women's autonomy in four reproductive outcomes and found considerable inter-spousal disparity in which 25% to 50% of couples disagree on the wives' participation in the decisions. Alwang et al. (2016) conducted a field experiment in the Ecuador highlands to understand the role of women in six agricultural decisions and found that where the couples were interviewed separately, large differences in perceptions about women's and men's responsibilities were observed. A comprehensive study conducted by Donald et al. (2017) in Sub-Saharan Africa (SSA) also suggests that differences in couple's responses are statistically significant in 17 out of 20 country surveys, and overall 47% of the spouses disagree on the decision-maker over household large purchases.

Some of these studies compared the correlation between spousal disagreement and individual and household socio-economic characteristics. For example, Anderson et al., (2017) examined differences in the wife's authority over 13 household and farming decisions in the context of Tanzanian households and found that self-reports of decision-making authority by older, more educated, and healthier wives, individually, are

associated with less disagreement between wife's and their husband's reports. Their findings also suggest that marginal households are likely to have more spousal agreement. Using data from Ecuador, Twyman et al. (2015), suggest that men tend to report their wives' participation is less in several agricultural decisions than indicated by the wive themselves in four agricultural decisions and that the discrepancies are more likely correlated with the status of land ownership by the wife. Donald et al. (2017) found that spousal disagreement over decision-making roles is positively correlated with the wife not working, the wife being young, and the couple being in a polygamous marriage. However, these studies did not look into the possible explanations for the differences in survey responses.

In a recent study, Ambler et al. (2021) provided a conceptual framework to explain the source of spousal discrepancies in responses to decision-making or assets ownership questions and present testable predictions to differentiate among these reasons. Ambler et al. (2022) used this framework to test spousal concordance in responses to questions about who owns assets and makes decisions in the households where couples reside with their husband's parents and those that do not in the context of Nepalese families. In general, they concluded that the differences in response are more likely explained by asymmetric information in the household. Liaqat et al. (2021) also used the framework to analyse spousal differences in response in the context of the Philippines. They found that the differences are more likely caused by asymmetric measurement due to different understanding between men and women of the survey questions related to what is "a decision-maker". Lastly, using field experiments, Van Campenhout et al. (2022) examined the spousal differences in response to decision-making, asset ownership, and labour contribution in the context of Uganda. Their findings suggest that the discrepancies are more likely due to asymmetric information. To our knowledge, these

four studies are the only ones in the literature considering measurement error and asymmetric information as sources of discrepancies in spouses' responses to decision-making questions and asset ownership.

3.3 Conceptual framework

We follow the conceptual framework from Ambler et al. (2021) in this study and include considerations made by Van Campenhout et al. (2022) and Liaqat et al. (2021) in their use and application of Amblet et al. (2021) framework. These suggest three possible explanations for spousal differences in response: random measurement error, asymmetric measurement error, and asymmetric information.

Random measurement error, as its name suggests, it has no pattern, is unpredictable, and is difficult to avoid. In this case, responses to intrahousehold decision-making survey questions for husbands and wives may differ but not in such a way that women's responses are systematically different from men's responses.

Second, asymmetric measurement, a type of systematic measurement error suggest that discrepancies in response are due to men's and women's different interpretation of decision-making and asset ownership-related questions. In asymmetric measurement error, the answers should differ systematically between the couple, but the magnitude of the disagreement should be similar for different questions asked in a survey (at least for a set of similar questions on decisions and asset ownership). Liaqat et al. (2021) used the term "asymmetric interpretation" to describe asymmetric measurement error due to differing interpretations of survey questions, which are asymmetric if interpretations vary by gender or other respondent characteristics. They also mentioned that individuals may have a different understanding of the decision-making process (e.g. whether there was a conversation and who was involved in the conversation) and the identity of the decision-

maker (e.g. who makes the final decision). They suggest that the spouse will have more agreement in the decision-making process than on the identity of the decision-maker.

Third, information asymmetries which could result in differing responses to survey questions when spouses hide (voluntarily or involuntarily) information about their daily activities or asset ownership from each other. Several lab-in-the-field experiments similarly indicated that household members often conceal some of their resources from each other (for example Ashraf, 2009; Castilla & Walker, 2013; Fiala & He, 2016). Almas et al. (2018) also found evidence of strategic information concealing between spouses. In a survey, a woman may indicate that she is involved in decision-making (e.g. in minor household expenditures) but her husband does not indicate the wife's involvement because she makes some decisions without her husband's knowledge. It is also possible that spouses function within separate spheres (Lundberg & Polluck, 1996) where each spouse makes decisions about certain household activities that are assigned to them because of their gender, in this case, these decisions might not even be relevant to the other spouse or not of his/her interest (Ambler et al., 2021).

In addition to the three possible sources of differences in response mentioned above, Liaqat et al (2021) also mentioned the asymmetric response to enumerator characteristics (enumerator effects) in which responses to survey questions can differ depending on the gender of the enumerator. Similar to the study on agricultural decision-making in Ecuador by Alwang et al. (2016) and studies on the effect of interviewer gender on survey responses by Flores-Macias & Lawson (2008) in Mexico and Huddy et al. (1998) in the US. These studies suggest that due to social desirability bias men and women portray the decision-making process differently to enumerators of their same gender versus enumerators identified of a different gender.

In the cases of random and asymmetric measurement error, the spousal discrepancies to decision-making-related questions are not informative about intrahousehold decision-making dynamics. Therefore, it is worth exploring whether differences in responses are due to measurement error, particularly when it is asymmetric.

3.4 Cultural context

Cultural differences in asset ownership after marriage and religion make Indonesia different from other countries already studied. For example, in Indonesia assets (e.g. land, agricultural equipment) are considered to belong to the household (Akter et al., 2017; FAO, 2019) and men and women work together on the farm and do not farm separate plots as in some countries in Sub Saharan Africa (Akter et al., 2017; Peterman et al., 2014).

Existing literature suggests that in Indonesia many household decisions are shared among household members (Colfer et al., 2015; Herartri, 2005; Koning et al., 2000; Puspitawati et al., 2018; Rammohan & Johar, 2009). However, within Indonesia, there is wide heterogeneity in kinship systems and marriage norms with many following strongly patrilineal or matrilineal kinship systems (Errington, 1990; Rammohan & Johar, 2009) that may influence how family members (e.g. husband and wife) make decisions in the household (Colfer et al., 2015; Mulyoutami et al., 2012; Sayogyo et al., 1979).

In West Java, existing studies mention that Sundanese (the indigenous people of West Java) maintain the tradition of patriarchy but the households are likely more egalitarian compared to other regions of Indonesia (Backues, 1992; Prawiranata, 2013). Men and women are viewed as equal partners, but women have “less authority” on decisions understood as “outside” the house activity (for example, attending village meetings) (Backues, 1992; Frankenberg & Thomas, 2001; Herarti, 2005). Sundanese women are largely involved in managing household expenses on food and routine items

(e.g. utility expenses, children's pocket money, etc) (Frankenberg & Thomas, 2001), and clothes expenditures (Thomas et al., 2002). Women also are greatly involved in making major decisions about household investments such as buying or selling land (FAO, 2019; Sajogyo et al., 1979). Sundanese men tend to share the responsibility for financial decisions (Fernandez et al., 2015), education, and health-related decisions (Frankenberg & Thomas, 2001; Fernandez et al., 2015) with their spouses.

3.5 Data and methods

This section provides a brief description of the data collection and the detailed survey questions. It also presents the method to test the source of spousal differences in response.

3.5.1 Data

This study uses primary data from 439 couples (878 respondents) in agricultural households in the upper Citarum in West Java. The survey applied a multistage stratified random sampling procedure. First, Bandung and West Bandung Districts were selected purposely because 65% of the Citarum Watershed lies in these two districts. Second, six out of eight sub-watersheds were chosen purposely because it was in rural areas. Third, 22 villages from both districts were randomly selected, representing 10% of all villages in these two districts. Finally, 20 households were randomly selected from each village.

The data were collected in July-August 2019. The data include information about household members, household and farm characteristics, access to credit, organisation membership, and production and non-production assets ownership. The survey instrument further includes a gender-specific decision-making module and an asset ownership module with questions directed to the husband and wife. The interview was done by assigning the same enumerator for both husband and wife within a household, but the interview was done in separate sessions. The survey was conducted in Bahasa, the local language of Indonesia by local enumerators not from the study site.

The survey covered detailed information on intrahousehold decision-making concerning 39 decisions within six domains that cover agricultural production, agricultural and household investment, household expenditure, income-generating activities, savings and credits, and training (see Table 1 for details). These domains and decisions are recognised as key indicators in the intrahousehold bargaining power and decision-making literature (Agarwal, 1997; Alkire et al., 2012; Alwang et al., 2017; Anderson et al., 2017; Doss, 1996; Duncan, 1990; Kim et al., 2017; Lecoutere et al., 2019; Lecoutere & Wuyts, 2021; Seebens, 2010; UNECE, 2021).

3.5.2 Survey questions

The survey module on intrahousehold decision-making included the following questions for 39 household decisions: 1. "How often do you think your household thinks about the decision, overall, in the past year?" and 2. "Who makes decisions in the following aspects for most of the time in the past year?" (for details see Appendix 3 Decision-making process within the household module). In this paper, we focus on "how often" instead of "who decides" because certain activities may be considered as men's or women's activities due to cultural reasons or gender stereotypes (Mabsout & Van Staveren, 2010; Peterman et al., 2021; UNECE, 2021), respondents might be inclined to answer that they participate more or less in a decision based on what is expected from them than their actual participation in the decision-making process. We present answers to the questions of "who decides" which allow us to compare our results with those of other studies.

The responses to "how often" correspond to a Likert-type scale from 0 to10, in which 0 means the household does not think about the decision at all, and 10 means that the household thinks of this decision very often, almost all the time. Based on Harpe (2015), this type of response falls into the "numerical rating scale" which can be assumed as

continuous if the distance between choices is equal. The responses to the "who decides" questions are also Likert-type scale from 0 to10, if the response is 0 the respondent does not participate in the decision at all, and 10 if they decide by themselves, without their spouse's involvement.

In addition to these decision-making questions, the gender module includes questions about the number of production and non-production assets owned by the household asked separately to husband and wife. In Indonesia, household assets including production assets, are considered to belong to the household and not to individuals within the household (Akter et al., 2017; FAO, 2019).

3.5.3 Methods

To investigate whether the spousal difference in response to "how often" and "who decides" are explained by random measurement error, asymmetric measurement error, or asymmetric information, we followed the procedure outlined below.

First, we used paired T-test to investigate whether the discrepancy is due to random measurement error only. A significant T-test result means that there is a statistically significant probability that the relationship between the two variables exists and is not due to chance (Hayes, 2022). In our study, if the paired T-test between women's and men's responses shows statistical significance, it indicates that there is a relationship between women's and men's responses and that is not only due to chance. Thus, the discrepancies are not due to random measurement errors only.

To test for asymmetric measurement error, we utilise a multivariate test on means to test for equal differences in response to "how often" for each activity within a domain[11]. If the disagreement is not statistically equal across decisions and the overall disagreement

[11] However, a multivariate test on means does not allow us to differentiate which activities have different or equal means. Thus we conducted paired t-test for each activity within a domain. We conducted this additional analysis and presented in Appendix 8 Table A8-1 to Table A8-6).

is statistically different across decisions, we can conclude that the discrepancies are not due to systematic measurement error only. We use the same procedure to test for equal differences in response to "who decides". We also compare the magnitude of the differences in response to "how often" and "who decides". Following Liaqat et al. (2021), if the differences in response to "how often" (as a proxy to the process of decision-making) are smaller than "who decides" (as a proxy to the identity of the decision-maker), it means that there is a gender-related interpretation on the question, and this may affect men and women responses.

To examine for asymmetric information, we use the literature to interpret the data and explain whether the differences in responses that are statistically significant correspond to activities or assets for which spouses are likely to conceal information from each other, or activities/assets that are considered within men's or women's separate spheres due to gender. The results from the analysis above cannot completely discard the three possible explanations outlined in the methodology. However, it can help to determine whether the spousal disagreement is only due to random or asymmetric measurement error, or if the disagreement reported in the responses to the survey questions is likely to help explain intrahousehold decision-making and asset ownership imbalances.

Lastly, we also explore the enumerator effect, such as the enumerator's gender. We subdivided the sample by gender of the respondent and gender of the enumerator and conducted paired t-test and multivariate test on means across activities within a domain. If the disagreement is not statistically equal across activities and the overall disagreement is statistically different across activities, we can conclude that the discrepancies are not due to the enumerator effect only.

3.6 Results and discussions

In this section, we first present an overview of the differences in response to the "how often" questions and the test results on the source of the discrepancies. We further present the analysis of the enumerator's effect, asset ownership, and the comparison of differences in response to "how often" and "who decides" questions.

3.6.1 Differences in women's and men's responses

Women's and men's responses to "how often" and the mean differences between their responses over 39 decisions within six domains are presented in Table 3.1. In general, compared to women's responses, men tend to respond that the household thinks more often about the decisions. Differences in responses are statistically significant for most decisions, with a few exceptions in the household expenditure domain (durable goods, small durable, parties and ceremonies, school, and health-related expenditures), saving and credit, and the training domain.

3.6.2 Testing random measurement error as the only source of the spousal differences in response

If the random measurement error is the sole explanation of the abovementioned differences, it is expected to see a sufficient variation of statistical significance across decision types, as well as a good mix of both positive and negative discrepancies. As seen in Table 3.1, the mean differences between men's and women's responses are statistically significant for the majority of decisions, suggesting the discrepancies are not only formed by chance. It is hence likely that the discrepancies are not due to random measurement errors only.

Table 3. 1 Women's and men's responses to the question "how often does your household think about this decision" in West Java Indonesia, 2019.

Domain	Type of decision	Women (n=439)		Men (n=439)		Difference (women-men)
		Mean	SE	Mean	SE	Mean
1	2	3	4	5	6	7
Agricultural production	What crops to grow	5.60	0.14	7.06	0.14	-1.45 ***
	What variety to select	5.61	0.16	7.22	0.14	-1.61 ***
	When/how to do land preparation and planting	5.73	0.15	7.30	0.12	-1.57 ***
	When/how to apply agro-chemicals	5.73	0.15	7.45	0.12	-1.72 ***
	When/how to tend the crops	6.01	0.15	7.34	0.13	-1.33 ***
	When/how to harvest the crops	6.12	0.15	7.30	0.13	-1.18 ***
	Planting amenity or natural plants for biodiversity	4.89	0.16	5.83	0.16	-0.94 ***
Agricultural /household investment	Buy farm equipment/machinery	4.54	0.16	6.37	0.16	-1.83 ***
	Buy yield increasing farm input	5.92	0.16	7.64	0.12	-1.72 ***
	Build/maintain soil/water conservation structures	4.61	0.17	6.72	0.14	-2.11 ***
	Implement soil/water conservation practices	3.98	0.17	5.65	0.17	-1.67 ***
	Agricultural land purchasing or selling	3.31	0.16	3.97	0.18	-0.67 ***
	Livestock purchasing or selling	3.95	0.16	4.83	0.17	-0.89 ***
	Purchasing land/house or other large investments	5.62	0.16	6.56	0.16	-0.94 ***
Household expenditure	Housing repairs/improvement expenditures	6.85	0.15	7.52	0.14	-0.67 ***
	Durable goods expenditures	5.61	0.15	5.44	0.15	0.17
	Small durables expenditures	4.68	0.16	4.51	0.16	0.17
	School fees and other school expenditures	6.62	0.18	6.84	0.18	-0.22
	How much to spend on food	7.32	0.14	6.82	0.15	0.50 **
	Vehicle purchase	4.88	0.16	5.63	0.16	-0.75 ***
	Leisure and enjoyment expenditures	3.76	0.16	4.99	0.16	-1.23 ***
	Health related expenditures	7.37	0.13	7.61	0.13	-0.24
	Clothing expenditures	5.50	0.15	4.81	0.15	0.70 ***
	Parties and ceremonies	5.02	0.16	5.31	0.16	-0.29
Income generating activities	Whether to take seasonal off-farm work	3.52	0.17	4.60	0.18	-1.07 ***
	Whether to take long-term off-farm work	2.04	0.14	2.61	0.16	-0.57 ***
	Off-farm economic activities	5.10	0.17	5.78	0.17	-0.68 ***
	Wage salary employment	4.24	0.17	4.83	0.18	-0.59 **
	Produce processing	5.37	0.16	6.02	0.17	-0.64 ***
	Whom to sell	5.53	0.17	6.54	0.16	-1.01 ***
	Where/when to sell	4.98	0.16	6.12	0.17	-1.15 ***
	Negotiate price with buyer/trader	4.91	0.17	6.41	0.16	-1.50 ***
Saving and Credit	How much to save	5.81	0.16	5.93	0.16	-0.11
	Request credit for agricultural investment	3.54	0.17	4.14	0.17	-0.60 **
	Request credit for non-agricultural investment	2.84	0.16	3.12	0.16	-0.29
	Lend to friends or family	4.15	0.16	4.42	0.16	-0.27
	Use of savings/credit	5.17	0.16	5.26	0.16	-0.09
Training	Attend agriculture training	4.19	0.17	5.76	0.17	-1.58 ***
	Attending non-agricultural training	3.57	0.16	3.93	0.17	-0.35

Note: The negative sign shown in column 5 indicates that the mean of women's response to the question "how often does your household think about this decision" is lower than the mean of men's response. ***, ** denote statistical significance at the 1% and 5% levels, from paired t-test results.

3.6.3 Testing asymmetric measurement error as the only source of the spousal differences in response

Table 3.2 presents results from multivariate tests of means results for each domain. Column 4 shows that only decisions in saving and credit have equal means for the differences in women's and men's responses (with prob>F=0.15). Meanwhile, for the other five domains, the test suggests that at least one decision has a different mean difference in response from other decisions within the same domain (with prob>F=0.00). Further pairwise t-test results (as shown in Table A8-1.a to A8-6 in Appendix 8) also suggest that we can reject the equal means for the decisions within a domain. Thus, the chance that spousal differences in response to the "how often" questions are only due to asymmetric measurement error, is minimised.

Table 3. 2 Multivariate test of means results for women's and men's responses to "how often does your household think about this decision" questions, by domain, in West Java Indonesia, 2019.

Domain	Women's responses	Men's responses	Difference (women-men)
	Hotelling's T2	Hotelling's T2	Hotelling's T2
1	2	3	4
Agricultural production	312.47***	131.43***	23.73***
Agricultural/household investment	477.61***	537.55***	44.26***
Household expenditure	861.28***	465.08***	107.99***
Income generating activities	482.74***	446.21***	27.46***
Saving and credit	382.94***	268***	6.89
Training	17.82***	119.28***	33.08***

H_o = all means are equal

*** denote statistical significance at the 1% level, from the multivariate test on means results.

3.6.4 Asymmetric information as the source of the discrepancies

The above results open the possibility of a third possible reason for discrepancies between women's and men's responses, which is asymmetric information. In this case, individuals may hide resources and actions from other household members (intentionally or unintentionally) and it could result in differing responses to survey questions, especially in small durable expenditures (Castilla & Walker, 2013; Ambler et al., 2021; Ambler et al., 2022). This, however, is not the case in our study. As seen in Table 3.1,

the differences in response for the small durable expenditures decision is not statistically significant and the magnitude of the differences is among the lowest.

Looking into the discrepancies in each domain, different patterns are observed. In the agricultural domain, higher discrepancies occur in the decisions related to agrochemical application, land preparation and planting, and type of crops and varieties to plant; but lower discrepancies for the decisions related to tending and harvesting the crops, and planting amenity or home garden. These results are consistent with previous findings in the context of Indonesia (Backues, 1992; Backues, 2000; FAO, 2019; Qanti et al., 2021) and may reflect the division of labour by gender in which some tasks culturally performed by women such as weeding and harvesting the crops (Herartri, 2005; Suhamihardja, 1984).

The gender division of labour stemming from prevailing gender stereotypes and norms may further explain patterns in household expenditures, where women have higher responses than men in food and clothes expenditures, echoing earlier studies (Frankenberg & Thomas, 2001; Thomas et al., 2002). Similarly, in income-generating decisions, the discrepancies may indicate that women are less involved in farm income-generating activities (such as marketing farm produce), which is culturally considered a men's domain (Puspitawati et al., 2018), and more involved in non-farm economic activities (such as running a *warung* -small local shop for daily needs-, or working as a wage salary employment) as an additional income generation for the family. This is further observed in the training domain, where the level of discrepancy for attending agricultural training or extension activities is almost 5 times higher than the discrepancy in women's and men's responses for attending non-agricultural training or extension activities. Consistent with the literature, this finding indicates that women participate less

in agricultural training or extension than men (Puspitawati et al., 2018) as only male heads of households are invited to the training (FAO, 2019).

A clear gender division of labour is, however, not universally applied to decisions in all domains. Rather, women's weaker decision power is sometimes compensated in more important decisions. For instance, regarding agricultural and household investment, the level of discrepancy is lower in capital investment decisions, consistent with Sajogyo et al. (1979) and FAO (2019) about Sundanese women's participation in household investment decisions, especially related to land. In the Sundanese culture, sons and daughters inherit the family properties through both sides (Herarti, 2005), most brides enter the marriage owning some assets, and husbands and wives bring about the same amount to the marriage (Thomas et al., 2002). These backgrounds may explain the lower level of discrepancies, especially in land-related investment decisions. Moreover, in the saving and credit domain, the differences in responses even become insignificant, suggesting equal participation levels across gender (Backues, 1992; FAO, 2019; Moji, 1980; Sayogyo et al., 1979) and shared responsibility for household financial decisions (Fernandez et al., 2015).

3.6.5 Enumerator effect

Looking further into differences in responses due to the enumerator's gender, Table 3.3 presents the average of women's and men's responses and the differences in response to the "how often" questions by the gender of the enumerator. Within the group in which male enumerators were assigned, the spousal differences in response are statistically significant in almost all decisions. On average, the differences (column 5 and 8) have mixed directions (mostly negative, but some are positive), and the magnitude for most decisions varies within each domain. Comparing the spousal differences in response when the interview was done by the male enumerator (column 5) versus when it was

done by the female enumerator (column 8), in most decisions, the magnitudes of the differences in response are relatively lower when the interview was done by female enumerator (except for when/how to do land preparation and planting, livestock purchasing and selling, durable expenditures, how much to spend on food, and attending non-agricultural training).

Table 3. 3 Women's and men's responses to the question "how often does your household think about this decision", by enumerator gender, in West Java Indonesia, 2019.

Domain	Type of decision	Male enumerator (n=269)				Female enumerator (n=169)			
		Women's[1]	Men's[2]	Difference		Women's[1]	Men's[2]	Difference	
1	2	3	4	5		6	7	8	
Agricultural production	What crops to grow	5.71	7.18	-1.47	***	5.41	6.87	-1.46	***
	What variety to select	5.47	7.41	-1.95	***	5.83	6.92	-1.10	***
	When/how to do land preparation and planting	5.83	7.35	-1.52	***	5.59	7.27	-1.69	***
	When/how to apply agro-chemicals	5.59	7.42	-1.83	***	5.94	7.49	-1.55	***
	When/how to tend the crops	5.89	7.38	-1.49	***	6.21	7.29	-1.08	***
	When/how to harvest the crops	6.08	7.57	-1.49	***	6.17	6.89	-0.73	**
	Planting amenities or natural plants for biodiversity	4.57	5.70	-1.13	***	5.39	6.00	-0.62	**
Agricultural /household investment	Buy farm equipment/machinery	4.73	6.81	-2.08	***	4.26	5.65	-1.39	***
	Buy yield increasing farm input	5.77	7.78	-2.01	***	6.15	7.41	-1.27	***
	Build/maintain soil/water conservation structures	4.61	6.91	-2.30	***	4.59	6.39	-1.80	***
	Implement soil/water conservation practices	3.79	5.64	-1.86	***	4.28	5.62	-1.34	***
	Agricultural land purchasing or selling	3.83	4.50	-0.68	***	2.50	3.14	-0.64	*
	Livestock purchasing or selling	4.11	4.99	-0.88	***	3.71	4.60	-0.89	***
	Purchasing land/house or other large investments	5.75	6.80	-1.06	***	5.40	6.15	-0.75	**
Household expenditure	Housing repairs/improvement expenditures	6.69	7.68	-0.99	***	7.10	7.26	-0.16	
	Durable goods expenditures	5.81	5.66	0.16		5.26	5.06	0.20	
	Small durables expenditures	4.89	4.83	0.06		4.39	4.04	0.34	
	School fees and other school expenditures	6.58	7.04	-0.45	**	6.66	6.56	0.10	
	How much to spend on food	7.39	7.15	0.24		7.18	6.28	0.91	**
	Vehicle purchase	5.03	5.82	-0.79	***	4.63	5.33	-0.70	**
	Leisure and enjoyment expenditures	3.95	5.44	-1.49	***	3.43	4.24	-0.81	***
	Health-related expenditures	7.51	7.89	-0.38	**	7.13	7.15	-0.02	
	Clothing expenditures	5.99	5.12	0.87	***	4.71	4.33	0.38	
	Parties and ceremonies	5.06	5.51	-0.46	**	5.00	4.95	0.05	

Note: 1) The mean of female respondents' responses; 2) The mean of male respondents' responses. The negative signs shown in column 5 and 8 indicate that the mean of women's responses to the question "how often does your household think about this decision" is lower than the mean of men's responses.
***,**,* denote statistical significance at the 1% , 5% , and 10% level, from paired t-test results.

Table 3. 3 (Continue) Women's and men's responses to the question "how often does your household think about this decision", by enumerator gender, in West Java Indonesia, 2019.

Domain	Type of decision	Male enumerator (n=269)				Female enumerator (n=169)			
		Women's[1]	Men's[2]	Difference		Women's[1]	Men's[2]	Difference	
1	2	3	4	5		6	7	8	
Income generating activities	Whether to take seasonal off-farm work	3.53	4.80	-1.26	***	3.50	4.26	-0.76	**
	Whether to take long-term off-farm work	2.42	3.03	-0.61	***	1.43	1.92	-0.49	*
	Off-farm economic activities	5.05	5.81	-0.76	***	5.18	5.75	-0.56	*
	Wage salary employment	4.08	4.75	-0.67	***	4.47	4.93	-0.46	
	Produce processing	5.44	6.49	-1.05	***	5.25	5.27	-0.02	
	Whom to sell	5.71	6.96	-1.24	***	5.23	5.86	-0.63	**
	Where/when to sell	4.96	6.38	-1.42	***	5.01	5.70	-0.69	**
	Negotiate the price with buyer/trader	4.92	6.65	-1.73	***	4.88	6.03	-1.15	***
Saving and Credit	How much to save	6.03	6.16	-0.13		5.45	5.52	-0.07	
	Request credit for agricultural investment	3.61	4.26	-0.65	***	3.43	3.92	-0.50	
	Request credit for non-agricultural investment	2.78	3.33	-0.55	**	2.91	2.80	0.11	
	Lend to friends or family	4.16	4.71	-0.56	**	4.12	3.94	0.18	
	Use of savings/credit	5.16	5.40	-0.24		5.19	5.07	0.12	
Training	Attend agriculture training	4.18	5.86	-1.67	***	4.17	5.59	-1.42	***
	Attending non-agricultural training	3.75	4.06	-0.31		3.31	3.74	0.43	

Note: 1) The mean of female respondents' responses; 2) The mean of male respondents' responses. The negative signs shown in column 5 and 8 indicate that the mean of women's responses to the question "how often does your household think about this decision" is lower than the mean of men's responses.
***,**,* denote statistical significance at the 1% , 5% , and 10% level, from paired t-test results.

Table 3.4 further reports the results of multivariate tests of means, for the differences between women's and men's responses to the "how often" question, based on enumerator gender, and for each domain. In the group with female enumerators assigned, three out of six domains fail to reject the equal means for the differences in responses. Meanwhile, only in the saving and credit domain that has statistically equal means for the differences in response in which male enumerators were assigned for the interview. These results suggest that although there are possibilities that men and women portray the decision-making process differently to enumerators of their same gender vs enumerators identified of a different gender, we can not completely claim that the differences in responses are due to the enumerator effect only.

Table 3. 4 Multivariate test of means results for the differences between women's and men's responses to "how often does your household think about this decision" question, by enumerator gender by domain, in West Java Indonesia, 2019.

Domain	Male enumerator, male respondent	Female enumerator, male respondent	Male enumerator, female respondent	Female enumerator, female respondent
	Hotelling's T2	Hotelling's T2	Hotelling's T2	Hotelling's T2
1	2	3	4	5
Agricultural production	16.07**	17.13***	16.07**	17.13***
Agricultural/household investment	38.51***	10.46	38.51***	10.46
Household expenditure	58.09***	25.15***	58.09***	25.15***
Income generating activities	21.67***	11.02	21.67***	11.02
Saving and credit	4.59	5.10	4.59	5.10
Training	28.89***	6.86***	28.89***	6.86***

Source: Author's calculation based on 2019 IndoGreen data.
H_o = all means are equal
***,** denote statistical significance at the 1% and 5% levels, from the multivariate test on means results

3.6.6 Assets

We also asked both husband and wife, individually, about how many assets the household currently owns, for a variety of production and non-production assets[12]. The same test procedures as above were implemented (see Appendix 8 Table A8-7 for details). The paired T-test shows that the spousal differences in response are not

[12] The production assets cover tossa, truck, water pump, generator, hand and four wheels tractor, rice mill, rice trasher, corn sheller, sprayer, storage house, coffee huller, buffalo, goat, and poultry. Meanwhile, the non-production assets consist of mobile phone, motorcycle, car, and computer.

statistically significant overall assets. Additionally, the multivariate test on means rejects the equal means for the spousal differences in response. These two results suggest that there is no difference in spousal response related to the assets owned by the household, and it is not due to random or asymmetric measurement error only. This finding is consistent with Akter et al. (2017) who mention that, in the context of Indonesia, assets or resources are commonly perceived as owned by the family, which leads to higher possibilities for both husband and wife to be well-informed about the family assets. Concern over strategic concealing of information about asset ownership is therefore minimised.

3.6.7 Comparing answers to the question "who decides"

The same test procedure is again performed with responses to "who decides". Very similar results are found. As seen in Table A8-8 in Appendix 8, spousal differences in response are statistically significant for all types of decisions. Men tend to respond that they decide more than women, with a few exceptions in the household expenditure domain (durable goods, food, and clothes expenditures).

The test results show that random and asymmetric measurement errors are not the main source of the differences in response, for all decisions within domains. The magnitude of most decisions varies within each domain (Table A8-8 in Appendix 8). The multivariate tests of means (Table A8-9 Appendix 8) suggest that the means are different within each of the domains (with prob>F=0.00). When comparing spousal differences in response by gender of the enumerator, neither do we find evidence of asymmetric measurement error because on average the discrepancies have mixed directions (mostly positive for the male respondent, and mostly negative for the female respondent), and the mean differences in response for most activities vary within each domain (see Table A8-10 and Table A9-11 in Appendix 8). Comparing these results with the results to the "how

often" questions, the magnitudes of the differences in response in "how often" (as seen in Table 1) are smaller than the magnitudes in the "who decides" (as seen in Table S2 in the Appendix) suggesting there is slightly less gender-related interpretation to the "how often" question, echoing Liaqat et al. (2021) findings.

These findings suggest that in many instances the differences can be due to asymmetric information, but in our case, strategic concealing of information has little role to play. Rather, the process of decision-making is consistent with the assignment of activities and responsibilities in the household due to cultural reasons, norms, or gender stereotypes (as mentioned by Mabsout & Van Staveren, 2010; Peterman et al., 2021; UNECE, 2021).

3.7 Summary and conclusions

We investigate the nature of the spousal differences in response to intra-household decision-making and analyse the possible reasons behind it. Our results suggest that in the context of Indonesia, consistent with the literature, the level of spousal disagreement varies based on the domains and the type of decisions. However, different from the existing literature, we found that in the context of Indonesia spousal disagreement is not likely caused by random and/or asymmetric measurement errors or asymmetric information in terms of hiding information, but more likely because of the gendered division of labour/activities; portraying the separate-spheres gender-based involvement due to cultural reasons, norms, or gender stereotypes. This study shows that exploration of spousal disagreement in answers to decision-making and asset ownership questions in women empowerment studies is warranted.

We also compare the spousal differences in response to the "how often" and the "who decides" questions to investigate the differences in response to decision-making survey questions between men and women. Overall, we find almost similar results

regarding the source of the spousal differences in response. However, we observe a smaller magnitude in the differences in response to the "how often" questions than the "who decides", suggesting the presence of gender-related interpretation, especially to the "who decides" questions. This is similar to Liaqat et al. (2021) finding in which the spouse will have more agreement in the decision-making process than on the identity of the decision-maker.

The results of this research suggest that it is key to analyse the different sources of spousal disagreement because they are likely to be influenced by various factors. It also suggests that the spousal differences in response are not merely due to measurement errors; context and culture are quite relevant in explaining the discrepancies since the gender division of labour in the agricultural household may be influenced by gender norms of the roles of men and women at the household level. Thus, in this study, the spousal differences in response may indeed indicate underlying power dynamics within households (consistent with the findings of Ambler et al., 2022; Annan et al., 2021; Peterman et al., 2021; Seymour & Peterman, 2018) and may provide useful information about the perspective of the respondent which is important in affecting their ability to act (UNECE, 2021). This clearly demands improved knowledge as women's agency could vary substantially depending on whether disagreement assigns more or less decision-making power to the woman.

This study is one of the first studies in the Indonesian context investigating perceived gender roles and intrahousehold perceptual discrepancies in intrahousehold decision-making. Therefore, limitations are existent, given its explorative nature. Even with the rich data set employed above, we still cannot confidently uncover the exact reason(s)behind the discrepancies, which suggests the need for further exploration using a mixed methods approach (for example, by using a qualitative-in-depth study as in

Acosta et al., 2019). Complementing quantitative surveys with in-depth qualitative research can help gaining valuable insight into the possible sources of the spousal differences in response, specifically regarding how intrahousehold division of labour and activities due to gender and the context of the study are linked to the spousal's differences in response to intra-household decision-making survey questions.

Chapter 4 Statement of Authorship

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Principal Author

Name of Principal Author (Candidate)	Sara Ratna Qanti		
Contribution to the Paper	Conceptualisation, methodology, formal analysis, investigation, methodology, writing – original draft, writing – review and editing		
Overall percentage (%)	60		
Certification	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	2 October 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

The candidate's stated contribution to the publication is accurate (as detailed above);

Permission is granted for the candidate to include the publication in the thesis; and

The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Alexandra Peralta		
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Contribution to the Paper	Conceptualisation, methodology, supervision, writing – review and editing		
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Chapter 4: Women's participation in dairy production and farming technology adoption decisions in West Java, Indonesia

Abstract

It is widely recognised that the adoption of agricultural technologies is likely to improve agricultural productivity and incomes for rural households. Recent studies have found empirical evidence that technology adoption decisions are not only made by the male household head: preferences of other household members, such as the female head of the household, can influence what technologies and practices are adopted. This recent literature mostly focuses on crop farming and fewer studies have been done on other farming activities, such as dairy farming which holds an important role in supporting rural livelihoods. This study investigates the extent of women's participation in dairy farming activities and decisions and how this participation correlates with the adoption of four dairy farming nutrition technologies: high protein concentrates, feeding legume forages, growing animal crops, and improving drinking water availability. The study uses linear probability model regressions from survey data of 563 couples of dairy farmers in West Java, Indonesia. We find that women in West Java have relatively high participation in dairy farming activities when compared to men, but their decision-making participation in these activities is low. Second, women's participation in dairy farming activities and decisions positively correlates with the adoption of feeding legume forages, growing animal crops, and improving drinking water availability. These results suggest the need for further exploration and consideration of women's participation in agricultural activities and decisions for a better understanding of agricultural technology adoption.

Keywords: women's participation, intrahousehold decision-making, smallholder farmers, dairy, improved cow nutrition

4.1 Introduction

Women play important roles in agriculture; they tend crops, rear livestock, process, and commercialise agricultural products. It is recognised that the involvement of women in development interventions and programs is key to improving agricultural productivity, household income and welfare outcomes for women and their families (Baltenweck et al., 2020; Doss, 2013; Duflo, 2012). To design better development and extension programs in agriculture, the literature in the past 20 years has increased its focus on women's roles in agriculture and the potential for women to influence agricultural decisions within the household. These decisions do not only include resource allocation, but also the practices and technologies adopted at the farm (Acosta et al., 2020; Ragasa, 2012).

It is well established that adopting agricultural technologies is likely to improve agricultural productivity and incomes for rural households. The literature on the adoption of agricultural technologies is vast (for examples of the recent literature on adoption, see Arslan et al., 2015; Khonjeet al., 2018; Manda et al., 2016; Oduol, 2011; Ward et al., 2018; for reviews of the literature on adoption see Knowler & Bradshaw, 2007; Prager & Posthumus, 2010; Ragasa, 2012).

Traditionally, this literature has focused on the unitary decision-making model and assumes that decisions taken by the male household head represent the household preferences towards different technologies and practices (see Feder et al., 1985; Doss, 2006; Ruzzante et al., 2021; Takahashi et al., 2020). Given that women also lend their labour to agricultural activities, their participation in agricultural activities and agricultural decisions can also influence what technologies and practices are adopted (Doss, 2013; Doss & Morris, 2000; Mohapatra & Simon, 2017; Rola-Rubzen et al., 2020). The literature has paid less attention to this, despite the recognition that

agricultural decisions in the household are usually made by the female and male heads of household and that these decisions are influenced by men's and women's bargaining power (Bekele & Drake, 2003; Shibata et al., 2020; Zepeda & Castillo, 1997)

Decisions to adopt agricultural technologies are not made by households in isolation. Recent studies have examined the roles of social networks in agricultural technology adoption (de Janvry et al., 2016; Maertens & Barret, 2013; Magnan et al., 2015). The possibility of learning from others has shown that women with access to information via their social networks tend to adopt technologies more than those who do not (Mekonnen et al., 2018; Wang et al., 2020; Rockenbauch & Sakdapolrak, 2017).

Some studies have examined how access to information and communication technologies links to women's agency and the adoption of agricultural technology. Increasing women's access to information increases women's confidence and self-respect, which leads to women's agency and greater opportunities to influence the household decision to adopt innovations (Balarumanian, 2010; Wambu, 2019). Increasing women's access to the internet and mobile phones provides access for women to a greater array of social and professional networks and affects women farmers' ability to take on new technologies (Rola-Rubzen et al., 2020; Peterman et al., 2010).

More recent studies have focused on the associations between women's participation in agricultural decision-making within the household and how this participation links to adoption of agricultural technologies (e.g. Doss & Morris, 2000; Loos et al., 2018; Shibata et al., 2020). However, this literature mainly focuses on crop farming, and fewer studies have been done on other farming activities, such as dairy farming (Harris-Coble et al., 2022).

In developing countries, smallholder dairy farming holds an important role in supporting rural livelihoods. It becomes one of the major components of farm income

generation, supports household nutrition and food security, and contributes to poverty reduction (Devendra, 2001; Banda et al., 2021). Smallholder dairy farming in developing countries is usually characterised by a relatively small number (two to three) milking cows, labour intensive with high reliance on family labour, low levels of farm inputs (e.g. use of lower-cost feed), and low outputs (FAO, 2010; Moran, 2012).

In the smallholder dairy farming context, women play critical roles in the production and management of livestock and in the preparation and consumption of animal-source foods (FAO 2010; Mulugeta and Amsalu 2014; Harris-Coble et al., 2022). Women are important actors in production and technology adoption (Bock & Van der Burg, 2017; Kabeer, 2005; Perrons, 2005; Baltenweck et al., 2020), especially in South East Asia, where women have traditionally been the homemakers and family rearers (Moran, 2009). In South East Asian countries cows and other livestock are generally kept near the house, resulting in more opportunities for women to become closely involved in daily livestock management such as fetching animals, feeding, milking, cleaning, marketing, or even book keeping (Moran, 2009; Yasmin & Ikemoto, 2015).

Scholarly investigations have highlighted women's participation in small dairy farming by using sex-disaggregated data on the division of labour, and how women's participation in dairy activities affects the adoption of technology in improved dairy cow nutrition (see Harris-Coble et al., 2022 for a review). However, further studies on how women's agency, specifically their participation in decision-making as an important dimension of women empowerment (Kabeer, 1999), determine the adoption of improved dairy cow nutrition are rare (Baltenweck et al., 2020; Harris-Coble et al., 2022).

Indonesia has experienced a significant increase in the demand for dairy products, but increasing dairy production becomes a major challenge (Remenyi, 1986; Putra et al., 2017; Purwantini et al., 2021). Recent studies have analysed the adoption of improved

dairy cow nutrition and how women's involvement in dairy farming activities affects this adoption have been done (Moran, 2009; Hilmiati, 2017; Putra et al., 2017; Wijers, 2019). However, to the best of our knowledge, only a few studies specifically explore how women's participation in dairy farming decision-making is linked to the adoption of improved dairy cow nutrition (except for Hilmiati et al., 2017 who identify the role of women's participation in financial decision-making in the adoption of cattle farming innovation).

We analyse whether women's participation in dairy farming activities and decision-making correlate with the adoption of improved cow nutrition in dairy practices. Our study contributes to the literature by incorporating women's participation in decision-making measures from 563 paired primary and secondary decision-makers within the households.

The rest of the paper is organised as follows: Section 2 briefly provides the theoretical consideration. Section 3 describes the context of dairy farming in Indonesia. Section 4 discusses the data and method. Section 5 provides descriptive and regression results. This is followed by the discussion and conclusion in Section 6.

4.2 Theoretical consideration

Agricultural technology adoption has been widely discussed in the literature. The conceptual underpinnings used in this study focus on the models that incorporate intrahousehold decision-making dynamics in technology adoption models.

Farmers decide whether to adopt an agricultural technology depending on whether the benefits of the new technology outweigh the ones of the technology they are currently using (Griliches, 1957; Feder et al., 1985; Foster & Rosenzweig, 2010). These decisions are made considering physical and human resource constraints, agro-ecological

conditions, farmers preferences for technology attributes and household home consumption, affecting farmer's adoption decisions (de Janvry & Sadoulet, 2006).

Most adoption models assume the unitary household model of decision-making, where household members are assumed to make decisions to maximise the household utility, and that household members have the same preferences (Doss, 2006). This assumption led to consider that the decisions made by the male head of the household, often consider the farm manager, reflected the preferences of all the household members (Moser, 1993). This assumption tends to ignore that individuals within a household have different preferences for technology attributes, it also ignores intrahousehold decision-making dynamics and household members' bargaining power likely to influence agricultural technology adoption decisions (Doss, 2006).

Following Browning and Chiappori (1998), Laszlo et al. (2020) use a collective model of household decision-making. This model considers the household as the unit of production and assumes that individuals within a household, in this case, the wife and her spouse (husband), decide on allocating resources to maximise their individual utility functions. In this study, we assume that the good over which individuals have preferences is a dairy-farming technology. The consideration of individual utilities in collective models explaining agricultural technology adoption decisions is warranted because men and women may have different preferences, roles, priorities, goals, and different bargaining power (Fisher & Carr, 2015; Haider et al., 2018; Shibata et al., 2020). Hence, these differences may influence adoption decisions at the household level (Doss, 2006; Shibata et al., 2020).

In their model, Laszlo et al. (2020) formulate that the total utility of the household is equal to a weighted sum of the woman's utility $U_w(.)$and her spouse's $U_m(.)$. The weights assigned to each member in the household decision-making problem

corresponds to their bargaining power δ such that the household will maximize the objective function:

$$U(.) = \delta U_w(.) + (1-\delta) U_m(.) \quad (4.1)$$

subject to a budget and other constraints, where U indicates utility, δ and 1-δ are the bargaining weights that indicate the ability of wife and her spouse to influence decision-making within the household.

In Laszlo et al. (2020) model women's relative bargaining weights/bargaining power (δ) is not constant and it depends on the individual's access to and control over resources (e.g. the share of income generated by her labour relative to that of her spouse), the social and cultural norms (including laws, religion, and generalised attitudes towards women, gender, and empowerment), and a psychosocial measure such as an individual's ability to assert her own preferences or agency (e.g. self-confidence and self-esteem), such that:

$$\delta(y, g, s) = \left(\frac{y_f}{y_w + g y_m}\right)^{e^{(1-s)}} \quad (4.2)$$

Where y is the share of income generated by the female compared to the male, y_w is woman's income, y_m is her spouse's income, g is social and cultural attitudes towards gender equality (g=1 is interpreted as a social and cultural propensity for gender equality as well as individual beliefs about gender equality; g>1is interpreted as there is a social and cultural propensity favouring men over women), and s represents a psychosocial measure increasing with low self-confidence or self-esteem (where s=1 corresponds to gender equality in self-esteem and self-confidence), and s >1 is corresponding to women having more self-esteem and self-confidence than men. δ is bound by 0 and 1 for any value of g >0 and s >0.

Based on Equation 4.1 and Equation 4.2, the household decision-making problem to adopt new technology is:

$$U(.) = \delta(y, g, s)\, U_w(.) + (1-\delta(y, g, s))\, U_m(.) \quad (4.3)$$

subject to budget and other constraints such as women's ability to possess assets, individuals' time endowment, access to credit, access to extension services, etc. Women's relative bargaining power $\delta(y, g, s)$ is defined as in Equation 4.2.

Therefore, households where women have a higher share of income, where women have higher self-esteem and in contexts where the social and cultural propensity for gender equality are higher, women are expected to have more influence in dairy technology adoption decisions.

4.3 Dairy farming in Indonesia

This section presents a brief overview of dairy farming in Indonesia, including the typical farm characteristics and the importance of cooperatives for dairy farmers. This section also discusses women's participation in dairy activities and decisions in general.

4.3.1 Overview

Dairy farming in Indonesia is dominated by smallholder dairy farmers that managed 90% to 95% of the national milking cows population (Sudarmanto et al., 2005; Nurtini & Anggaini, 2014). A dairy farming household usually has fewer than five milking cows on average, is located in rural-highlands areas and peri-urban relatively close to major urban centres, and is managed as a family business (Nugraha, 2010; Wijers, 2019). Most of the cows are Friesian Holstein breed and are mostly continuously housed and confined in a stable in the yard of the farmer's house (Nugraha, 2010). Dairy farmers usually source forages (mainly grass) from natural fodder, cut from wasteland areas, roadsides, rice bunds, hedges, communal grazing land, and food crop residues (Marjuki et al., 2000). Although the production is mostly done traditionally, farmers usually sell the milk commercially (Nurtini & Anggaini, 2014).

In developing countries, cooperatives usually play an important part in dairy farming (Moran, 2009). In Indonesia, the majority of smallholder dairy farmers are members of a local/village cooperative known as *Koperasi Unit Desa* (KUD) (Jahroh et al. 2020; Nugraha, 2010). It is common for the dairy farmers to receive training, technical assistance, get inputs (for free, subsidised, or buy at market price) from KUD, and also most of the dairy farmers sell their milk to KUD (Batubara, 2018; Jahroh et al., 2020; Nugraha, 2010; Sembada et al., 2019; Wijers, 2019). The KUD provides a wide range of support to its members and has important parts in providing various services related to dairy farming, including providing inputs (e.g. animal feed, concentrates, and medicines), advice and services on production (e.g. artificial insemination) and animal health, and also act as local milk collection centers and marketer that link farmers with milk processor companies (Morey, 2011). The Indonesian Government also usually provides loans/credits to farmers through KUD (Wijers, 2019).

4.3.2 Women's participation in dairy farming

Small dairy farms in Indonesia mostly depend on family labour for all dairy cattle-rearing activities (Mastuti & Hidayat, 2009). Women usually take care of dairy cows and are involved in milk production daily (Sulistyawati et al., 2013; Wijers, 2019). Milking the animals, cutting and carrying grass for animal feed, feeding the animals, providing water for the cows, and taking care of the animal's health are dominantly done by women (Satiti et al., 2022). Besides rearing dairy cows, women are also involved in the dairy business, such as keeping records of costs and sales, and marketing milk and dairy products, especially in the context of West Java, the latter is considered a women's job (Hilmiati et al., 2017; Purwantini et al., 2021). Activities that require strength, such as bathing the animals and cleaning the stables, are rarely done by women (Nugraha, 2010; Satiti et al., 2022). Despite the relatively large amount of time spent in dairy farming,

their contributions are often not formally acknowledged or rewarded (Purwantini et al., 2021; Wijers, 2019).

Despite the heavy involvement of women in dairy farming, dairy farming is usually considered a men's activity (Nadhira & Sumarti, 2017; Hilmiati et al., 2017). This is reflected in the KUD membership, whereas only men (as the head of the household) can be listed as a KUD member (representing the whole family member), the male household head attends meetings and benefits from dairy farming extension programs and extension agents farm visits (Jahroh et al., 2020; Nugraha, 2010).

4.4 Data and methods

This section describes the data that is used for the analysis. It also defines the method for measuring participation in dairy farming activities and decisions and estimating the association between the dairy technology adoption and women's participation variables.

4.4.1 Data

This study uses primary data collected from 600 couples (1200 respondents) in dairy households in four dairy-producing districts (Bandung, Garut, Cianjur, and Bogor) in West Java Province. After data cleaning, data from 563 couples (1126 respondents) is used for the analysis. This data comes from the IndoDairy project on improving milk supply, competitiveness and livelihoods of smallholder dairy chains in Indonesia.

The survey applied a purposive and proportional random sampling procedure. First, West Java was purposively chosen as the study area due to its strategic importance to the dairy industry in Indonesia (Sembada et al., 2019). It was the third milk production area accounting for 21.7% of the total national dairy cow population in 2019 (Indonesia Statistical Beureu, 2020), and it was also a major dairy processing and consumption area (Ministry of Industry Indonesia, 2017; Murtini &Um, 2018).

Since most dairy farmers are members of KUD, the next step was choosing the KUD. Five KUDs within four districts were chosen purposively due to their high concentration of farmers. Field coordinators work together with each KUD and identified KUD active members (involved in milk deliveries) to make a population list. Then the number of respondents from each district was determined relatively proportional to the total dairy farm population in the region. However, since the proportion of farmers in Cianjur and Bogor was relatively small, 80 farmers in each district were selected to ensure data variation. Specifically in the Bogor district (with two KUDs), from the total of 80 respondents, only 15 farmers from KPS Bogor were selected because most of the members were large dairy farmers (more than 30 cows) and most of the owners/managers reside outside the study areas. Lastly, the respondents were randomly selected from each KUD (see Table 4.1 for the proportion of respondents by each KUD).

Tabel 4. 1 The proportion of respondents by each KUD, West Java Indonesia, 2017.

District	KUD	Farmers population	Initial proportion	Final proportion	Respondents
Bandung	KPBS Pangalengan	2860	62.13	50.00	300
Garut	KPGS Cikajang	1268	27.55	23.33	140
Cianjur	KPG Cianjur Utara	170	3.69	13.33	80
Bogor	KUD Giri Tani	108	2.35	10.83	65
Bogor	KPS Bogor	197	4.26	2.5	15
Total		4603	100.00	100.00	600

Source: IndoDairy summary report KUD visits (Ritchie et al. 2016)

The data were collected from August to September 2017. The data set includes information about household members, household and farm characteristics, access to credit and information, organisation membership, farm and non-farm physical assets ownership, and the adoption of technology related to improved animal nutrition. These questions were asked to the dairy farm manager at each household. The survey instrument further includes a gender-specific module about dairy farming activities and decision-making with questions separately directed to the primary and secondary decision-makers

within the household[13]. The survey was conducted in Bahasa, the local language of Indonesia by local enumerators not from the study site.

4.4.2 Methods

Measuring participation in dairy farming activities and dairy farming decisions

The decision-making module contains questions similar to the ones used in the decision-making module of the Abbreviated Women Empowerment in Agriculture (A-WEAI) Index by Malapit et al. (2017). We modified the A-WEAI questions to make them specific to dairy farming. The first question, "Do you yourself participate in "dairy farming activity" in the past 12 months?" The response to this question is 1 for yes and 0, otherwise. If the respondent indicated that they participated in the activity, then they were asked[14]: "In the past 12 months, when decisions are made regarding "dairy farming activity", who is it that normally makes the decision?" The responses to these questions correspond to 1: self, 2: spouse, 3: other household members, and 4: other non-household members. In this study, we are particularly interested in women's participation in dairy farming decisions. Thus, in measuring women's participation in this study we estimate a variable that indicates whether women participate in dairy farming decisions individually (self) and/or jointly (self and spouse).

Additionally, the questionnaire includes questions on the input in decisions and the extent to make personal decisions about the activities if he/she wanted to, similar to those included in the first module of the A-WEAI. In capturing the influence in decisions, the

[13] The primary and secondary member are usually the husband and wife; however, they can also be another member as long as there is one male and one female aged 18 years old and over (for instance, a mother could be living with her adult son or father with an adult daughter). In general, the primary decision-maker is also the head of the household but this may not always be the case (i.e. elderly parent living with adult son/daughter and the adult son/daughter may be the primary or secondary respondent). It may also be the case that there is only a primary female respondent and there is no adult male present in the household. In cases whereby the primary male adult is absent from the house due to migration (has gone for work), and has been or is expected to be away for more than 3 months out of the next/previous 6 months, the primary female adult is considered the primary decision maker.

[14] If the respondent did not participate in the activity it is assumed that they did not participate in the decision-making process for that activity.

respondents who participated in the decision then were asked: “How much input did you have in making decisions regarding “dairy farming activity”? The responses to these questions correspond to 1: input in a few decisions, 2: input into some decisions, and 3: input into most or all decisions. Further, they were also asked: “To what extent do you feel you can make your own personal decisions regarding “dairy farming activity” if you wanted to?” There are four answer options to this question, 1: not at all, 2: small extent, 3: medium extent, and 4: to a high extent.

These questions were asked individually and separately to the primary and secondary decision-maker in the household, for a total of four dairy farming activities: dairy in general, kind and quantity of forages, kind and quantity of concentrates, and herd health. These activities are found in other settings as vital areas where women’s participation in dairy farming decisions plays important roles (Dev et al., 2011; Harris-Coble et al., 2022; Singh, 1992; Upadhyay & Desai, 2011), specifically as it may affect animal health and milk production (Schroeder, 2015).

Association between the adoption of dairy technologies and women’s participation in dairy farming activities and decisions

To examine the association between women's participation in dairy farming activities and decisions and adoption of agricultural technologies, we estimate the adoption decision as follows:

$$y_i = \alpha + \beta w_i + \gamma x_i + \varepsilon_i \quad (4.3)$$

where y_i takes the value of 1 if technology was adopted by the household and 0 otherwise, w_i is a vector of variables including women's participation in dairy farming activities and decisions, x_i is a vector of variables containing individual, household, dairy farm, and KUD characteristics, α, β, γ are parameters to be estimated, and ε_i is the error term.

The adoption decision is estimated using probit, and the results are compared to logit and the linear probability model (LPM). Given that the dependent variable is binary, the probability of adoption is estimated using binary response models. The advantages and disadvantages of these binary response models have been discussed in Horrace & Oaxaca (2006). Probit and logit make different assumptions about the distribution of the error term. In this study, probit and logit are presented to compare the marginal effects resulting from these estimation methods. The results are compared with the LPM estimation, as an additional robustness test. The LPM is estimated with robust standard errors to account for heteroscedasticity. Equation (4.3) is estimated individually for each technology.

Improved dairy cow nutrition technologies

To increase milk production and to enhance animal health, a balanced dairy cow diet is needed and the major factors to consider are related dry matter (e.g. concentrates), fiber (e.g. legume forages and feed crops), and water (Dept. of Agriculture and Fisheries, 2022; Landefeld & Bettinger, 2003; Moran, 2009; Schroeder, 2015). Due to the above rationale, this study considered these four dairy cow nutrition technologies:

1) High protein concentrates: are low-fiber, high-energy feeds (compared to forages) to support milk production and milk protein concentration. It has higher protein content and is usually used as a feed supplement to compensate for any other deficiencies not provided by the forage (Pierre & Weiss, 2015).
2) Feeding legume forages (e.g. Leucaena): Leucaena is a deep-rooted perennial leguminous tree with high protein and is easily digested by dairy cows. It provides fiber in the animal diet, supports rumen health, and has nutritive value for milk production (Dalzell, 2006)

3) Growing animal feed crops: Producing cultivated high-quality grasses and legumes for the animals (e.g. Napier grass). This practice provides nutritious intake and ensures animal feed availability, which is important for milk production (Marjuki et al., 2000).
4) Improving drinking water availability 24/7: Providing unrestricted access for the cow to drinking water at all times (24 hours a day, seven days a week). Water access and quality are important to animal health and productivity as the limitation of water intake reduces animal performance quicker and more dramatically than any other nutrient (Landefeld & Bettinger, 2003).

To estimate adoption we asked dairy farm managers whether they were currently using each of these technologies at their dairy farm to measure current levels of adoption.

Other factors affecting the adoption of improved dairy cow nutrition technologies

The first set of other explanatory variables captures the observed individual characteristics commonly hypothesised to correlate with agricultural technology adoption. These include men's and women's years of schooling and age to account for individual assets that may determine the bargaining power between the decision-makers (Shibata et al. 2020).

Capturing the household characteristics, we include the total number of productive age members within the family as a proxy to labour availability (e.g. Doss & Morris, 2000), lag of household non-asset index and land size as a proxy for wealth (e.g. Purwantini et al., 2021), and the household access to credit and off-farm income in the past years as a proxy to credit/financial access (e.g. Okello et al., 2021).

We also include a set of explanatory variables that captures the dairy farm characteristics including the lag of total lactating cows (to account for the dairy farm size,

as in Kabebe et al., 2017), the household's total years in the dairy business as a proxy for the dairy farming experience (El-Osta & Morehart, 2000), received information in various activities related to animals nutrition in the past year to account for access to technical dairy farming information (Maleko et al., 2018), and the proportion of land that is owned and managed that is used for growing grass as a proxy to reliable access to animal food supply (Marjuki et al., 2000). For the adoption of improving drinking water availability, we specifically include whether the household using spring water as the main source. Based on the field observation, in the context of West Java, having access to spring water means having a more reliable clean water source.

Lastly, since KUD holds important roles in dairy farming in West Java, we also include KUD characteristics: the time travel needed from the KUD to the household and the size of the KUD. The descriptive statistics and definitions for all the variables are presented in Table 4.2.

4.5 Results

This section shows the findings of this study. It includes the dairy farming household characteristics, the range and the extent of women's participation in dairy farming and dairy decisions, the adoption of dairy farming technologies, and the regression results.

4.5.1 Dairy farming household characteristics

The sample characteristics are presented in Table 4.2. On average, the male head of the household was 47 years old and had 6.45 years of schooling. Meanwhile, the female head of the household was 41 years old on average, and 6.64 years of schooling. The average size of the household was four members with three members of productive age (15 to 64 years of age). About 40% of the household at least had one family member that generates off-farm income, and more than half (58%) of the households had access to credit. About 36% of the household had access to spring water (clean and relatively

reliable water source) for non-cooking and non-drinking water. On average, dairy farming households owned and managed 0.5 hectares of land, slightly higher than the average land holding of crop farmers in Indonesia[15]

Specifically for dairy farm characteristics, on average, the household has been in dairy farming for 19 years and owned three dairy cows. The household received information on dairy farming: about 38% of the household received information on concentrates, 30% received information on forages and grasses, and 67% received information on herd health. For the household who owned the land, on average 41% of the land was used for growing grass for animal feeding. Lastly, farmers had to travel for 34 minutes to reach their KUD.

Tabel 4. 2 Descriptive statistics of dairy farming household characteristics in 2017, West Java, Indonesia.

Variable	Mean	SD	Min	Max
Individual characteristics:				
Men's years of schooling (years)	6.45	3.12	0	18
Women's years of schooling (years)	6.64	2.84	0	18
Men's age (yo)	46.74	11.33	21	84
Women's age (yo)	41.13	10.21	18	70
Household characteristics:				
Total number of productive age (15-64 yo) members in the household (person)	2.78	1.08	0	8
Household non-land asset index for assets 12 months ago[16]	0.79	0.55	0	4.66
Plot size that is owned and managed in the last 12 months (hectare)	0.50	1.99	0	35
In the past 12 months, the household had access to credit (1=yes, 0= otherwise)	0.58	0.49	0	1
The household has off-farm income in 2014 (1=yes, 0= otherwise)	0.40	0.49	0	1
Spring water is the main source for the household's non-drinking and non-cooking activities (1=yes; 0=otherwise)	0.36	0.48	0	1
Dairy farm characteristics:				
Total lactating cow owned 12 months ago (unit)	2.87	3.33	0	34
The household's total years in the dairy business (years)	18.93	10.15	1	50
Received information related to dairy practices in the last 12 months (1=yes, 0= otherwise)				
Concentrates	0.38	0.49	0	1
Forages and grasses	0.30	0.46	0	1
Cow's health	0.67	0.47	0	1
The proportion of land that is owned and managed that is used for growing grass (%)	0.41	0.44	0	1

[15] The average land holding per crop (especially paddy) farmer household is 0.46 hectare (Statistics Indonesia, 2018).

[16] The index is calculated following a widely used approach to estimate asset indices similar to Smits & Steendjik (2015) for the International Wealth Index calculation (see Appendix 9 Table A9-1 for details).

Tabel 4. 3 (Continue) Descriptive statistics of dairy farming household characteristics in 2017, West Java, Indonesia.

Variable	Mean	SD	Min	Max
KUD characteristics:				
Time travel from KUD to the household's house (minutes)	33.61	25.35	2	120
The total number of active members (persons)	1761	1164	108	2860

4.5.2 Women's participation in dairy farming and dairy decisions

This section compares men's and women's responses to their participation in dairy farming activities and decisions, starting with the reports on their own participation. Then this section compares men's and women's responses about women's participation in dairy farming decisions. And finally, for those women who participated in dairy farming decisions, this section presents their level of input in dairy farming activities decisions and extent women can make decisions about dairy farming activities by themselves.

The percentage of men's and women's participation in dairy farming activities and related decisions is presented in Figure 4.1. It shows that more than 90% of men reported their participation in dairy farming activities and whether they participate (individually and/or jointly) in the related decisions. These proportions are significantly higher than those reported by women[17].

Moreover, only three-quarters of women participating in dairy activities claim that they also participate (individually and/or jointly) in the decision-making (see Figure 4.1). For example, for type and quality forages and concentrates, about 61% and 67% of those who participate in the activity, participate in the decisions. For herd's health, 78% of women who participate in this activity, also participate in the decisions. This finding resonates with the existing literature on women participation in agricultural decisions, despite women's involvement in various agricultural activities, women still have lower

[17] Using t-test analysis, the proportion of men's participation in dairy farming activities is statistically significant (at $p < 0.01$) higher than the women's participation for the four dairy farming activities studied in this paper. See Table A9-2 in Appendix 9 for the details.

decision-making power, compared to men, especially in the context of developing countries (Ashby et al., 2009; Pattnaik & Lahiri-Dutt 2020).

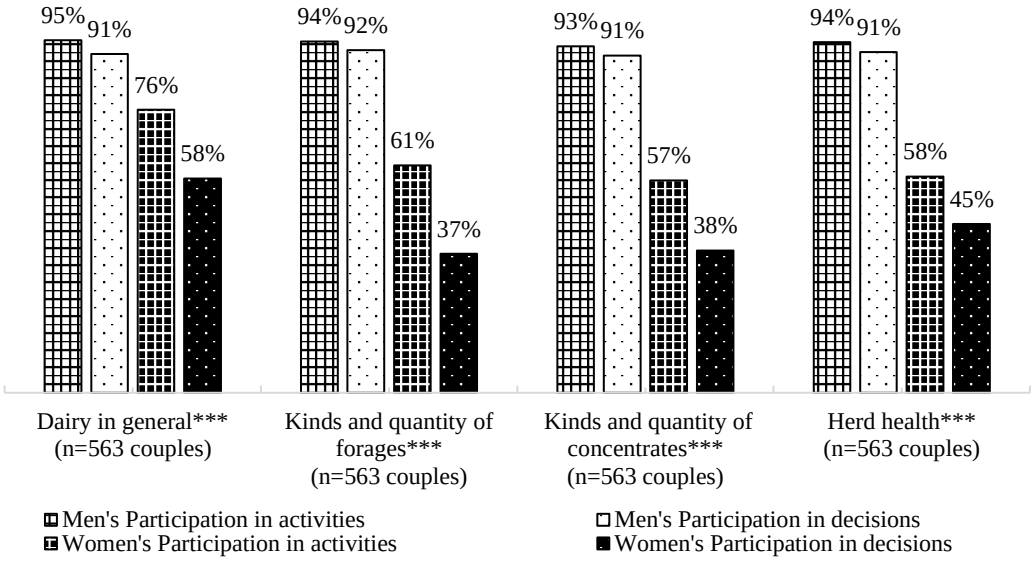
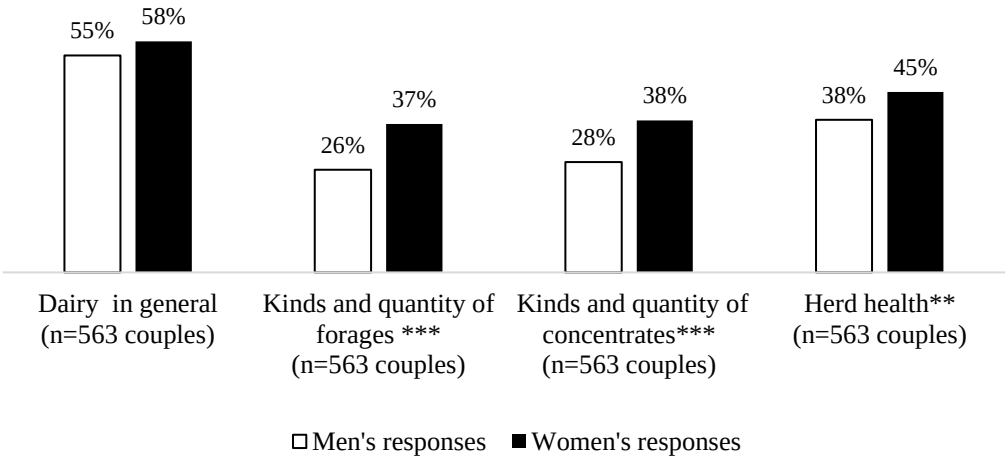


Figure 4. 1 Men's and women's participation in dairy farming activities and decisions, West Java-Indonesia, 2017.

The comparison between men's and women's responses to women's participation in dairy farming decision-making is shown in Figure 4.2. A smaller proportion of men, compared to women, responded that women participate in dairy farming decisions. For example, 55% of men responded that women participate in decisions related to dairy farming in general, whereas 58% of women claim their participation in these decisions. The differences in the proportions are higher, and statistically significant, for the other three decisions considered, namely kinds and quantity of forages, kinds and quantity of concentrates, and herd health (see Appendix 9 Table A9-2 for the details). This finding indicates the under-recognition of women's participation in dairy farming decisions: men tend to report lower women's participation in decision-making when compared to women's reports (Alkire et al., 2012; Qanti et al., 2021).



Using T-test, the differences between men's and women's responses are statistically significant at *p < 0.1; ** p< 0.05; *** p< 0.01

Figure 4. 2 Men's and women's responses on whether women individually and/or jointly participate in the dairy farming decision-making, West Java-Indonesia, 2017.

Women's responses to their input in dairy farming decisions and to what extent they can make personal decisions (only for women who responded that they participate in the dairy farming decisions) are presented in Figure 4.3. At least 64% of women who participate in dairy farming decision-making have input in some or few dairy farming decisions. Specifically, in the herd health decisions, women have relatively high participation in which 74% of women who participate in the decisions, have input at least in some decisions and 58% of women who participate in the decisions have medium and high extent in making personal decisions if they want to.

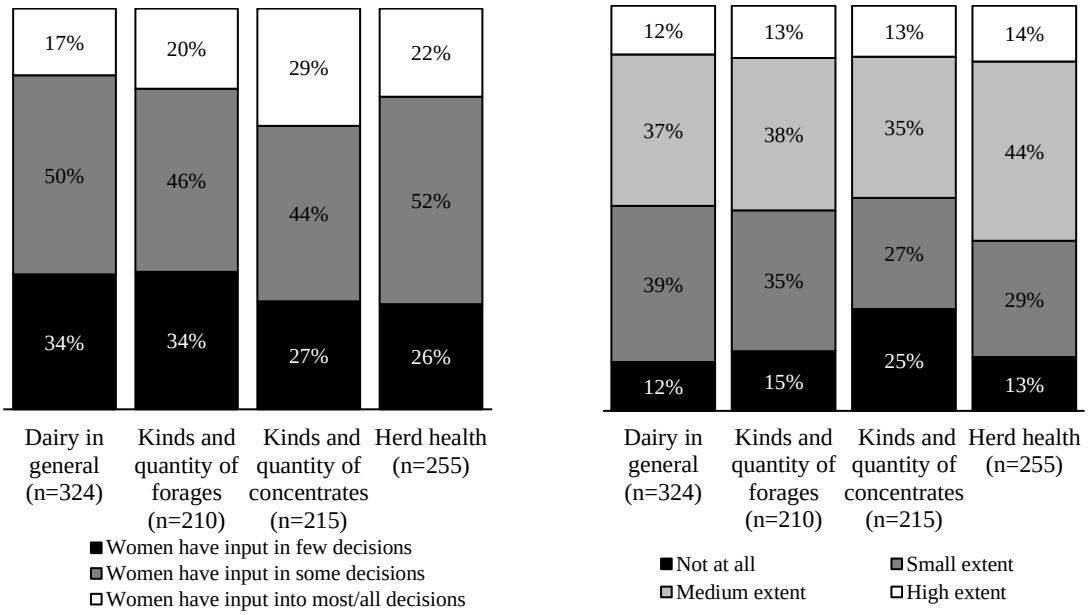


Figure 4. 3 Women's input and the extent of women making personal decisions in dairy farming decisions, for women who responded that they participate in dairy farming decision-making, West Java-Indonesia, 2017.

4.5.3 Adoption of dairy farming technologies

Around 8% of farmers adopted high protein concentrates for their dairy cows, 30% of farmers adopted feeding high protein legume forages, 57% of them grew animal feed crops, and 36% of farmers improved drinking water availability. The individual, dairy farm and household characteristics of the adopters and the non-adopters for each of the dairy farming technologies considered in this study are presented in Table 4.3.

Tabel 4. 4 Household characteristics based on non-adopter and adopter of dairy farming technologies, West Java Indonesia, 2017.

Variables	High protein concentrates			Feeding legume forages			Growing animal feed crops			Improving drinking water availability		
	Non-adopter n=517	Adopter n=46		Non-adopter n=394	Adopter n=169		Non-adopter n=244	Adopter n=319		Non-adopter n=360	Adopter n=203	
Individual characteristics:												
Men's years of schooling (years)	6.26	8.65	***	6.31	6.79		6.46	6.45		6.14	7.01	**
Women's years of schooling (years)	6.49	8.39	***	6.67	6.58		6.71	6.59		6.39	7.09	**
Men's age (yo)	47.17	41.85	***	46.27	47.83		45.20	47.92	**	46.51	47.14	
Women's age (yo)	41.55	36.46	***	40.91	41.64		40.02	41.98	*	41.09	41.21	
Household characteristics:												
Total number of productive age (15-64 yo) members in the household (person)	2.79	2.74		2.76	2.83		2.68	2.86		2.75	2.84	
Household non-land asset index for assets 12 months ago	0.77	1.08	***	0.78	0.83		0.73	0.84	*	0.74	0.89	**
Plot size that is owned and managed in the last 12 months (hectare)	0.51	0.42		0.33	0.90	**	0.29	0.66	*	0.55	0.42	
In the past 12 months, the household had access to credit (1=yes, 0= otherwise)	0.57	0.61		0.57	0.60		0.55	0.59		0.57	0.59	
The household has off-farm income in 2014 (1=yes, 0= otherwise)	0.40	0.39		0.37	0.47	*	0.36	0.43		0.38	0.43	
Spring water is the main source for the household's non-drinking and non-cooking activities (1=yes; 0=otherwise)	0.36	0.33		0.34	0.39		0.38	0.34		0.36	0.36	
Dairy farm characteristics:												
Total lactating cow owned 12 months ago (unit)	2.78	3.89	*	2.81	3.02		2.70	3.01		2.54	3.46	**
The household's total years in the dairy business (years)	18.96	18.56		19.28	18.11		19.33	18.61		18.63	19.45	
Received information related to dairy practices in the last 12 months (1=yes, 0= otherwise)												
Forages and grasses	0.37	0.50		0.33	0.50	***	0.36	0.40		0.41	0.32	*
Cow's health	0.29	0.33		0.24	0.42	***	0.28	0.31		0.32	0.26	
Concentrates	0.67	0.74		0.66	0.70		0.71	0.64		0.69	0.64	
The proportion of land that is owned and managed that is used for growing grass (%)	0.40	0.51		0.38	0.46		0.37	0.44		0.35	0.51	***
KUD characteristics:												
Time travel from KUD to the household's house (minutes)	33.62	33.59		33.69	33.43		35.03	32.53		35.32	30.59	*
The total number of active members (persons)	1735.63	2048.87		1997.59	1210.17	***	2365.29	1299.17	***	1787.63	1714.39	

* p<0.05, ** p<0.01, *** p<0.001, from paired t-test results.

4.5.4 Regression results

This section focuses on the discussion of the correlation between women's participation in dairy farming activities and decisions, and the adoption of dairy farming technologies.

The estimation results for the adoption of feeding legume forages, growing animals feed crops, increasing drinking water availability, and high protein concentrates are presented in Table 4.4 and Table 4.5. For each technology, we present two different specifications: Specification 1 includes only women's participation in the activity, and Specification 2 includes only women's participation in the decision-making. Variable women's participation in the activity and women's participation in the decision-making are run separately (in Specification 1 and 2) for each adoption equation because these two variables are highly correlated[18].

The probit, logit, and LPM estimation results are consistent across the four technology adoption estimations. The estimates for the parameters of interest are significant, and the signs are in the same direction. Table 4.4 and Table 4.5 consistently show that women's participation in dairy animal feeding and health positively correlates with the adoption of feeding legume forages, growing animal food crops, and improving animal drinking water availability.

The probit results for Specification 1 show that a household in which women participate in the activities of animal feeding and health is 8% more likely to adopt feeding legume forages, 9% more likely to adopt growing animal crops, and 12% more likely to adopt improving drinking water availability (Table 4.4). These results are supported by the literature suggesting that women play a key role in tasks such as

[18] For example, for participation in the activity and participation in the decision related to herd health, Pearson's correlation result shows 0.77 with a p-value of 0.0000.

collecting and offering feed and providing water to the animals in smallholder dairy farming in Indonesia (Moran, 2009; Nugraha, 2010; Hilmiati et al., 2017; Wijers, 2019) and in other developing countries (Harris-Coble et al., 2022). The signs and magnitudes of the estimates are consistent across estimation methods.

Table 4.4 Probit, Logit, and LPM results on the adoption of dairy farming technology, using only women's participation in the activity variables *(Specification 1)*, in West Java-Indonesia, 2017.

VARIABLES	Feeding legume forages			Growing animal crops			Improving drinking availability			High protein concentrates		
	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM
Women participate in activity: type and quality of forages (1=yes, 0= otherwise)	0.08*	0.08*	0.08**	0.09**	0.09**	0.10**						
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)						
Women participate in activity: herd's health (1=yes, 0= otherwise)							0.12***	0.12***	0.12***			
							(0.04)	(0.04)	(0.04)			
Women participate in activity: type and quality of concentrates (1=yes, 0= otherwise)										-0.02	-0.02	-0.02
										(0.02)	(0.02)	(0.02)
Men's years of schooling (years)	0.01	0.01	0.01	-0.00	-0.00	-0.01	0.01	0.01	0.01	0.01*	0.01*	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Women's years of schooling (years)	-0.01	-0.01	-0.01	0.02*	0.02*	0.02*	0.02*	0.02*	0.02*	0.01	0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Men's age (yo)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Women's age (yo)	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Total number of productive age (15-64 yo) members in the household (person)	-0.00	-0.00	-0.01	-0.01	-0.01	-0.00	0.01	0.01	0.01	-0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Household non-land asset index for assets 12 months ago	-0.07	-0.07	-0.06	0.00	0.00	-0.01	0.02	0.02	0.02	0.05*	0.05*	0.07*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.03)	(0.03)	(0.04)
Plot size that is owned and managed in the last 12 months (hectare)	0.04	0.04	0.02***	0.02	0.02	0.01	-0.02	-0.02	-0.01**	-0.01	-0.01	-0.00
	(0.03)	(0.03)	(0.00)	(0.03)	(0.03)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
In the past 12 months, the household had access to credit (1=yes, 0= otherwise)	0.00	0.00	0.03	0.00	0.00	0.06	-0.00	-0.00	0.00	0.00	0.00	0.01
	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.02)
The household has off-farm income in 2016 (1=yes, 0= otherwise)	0.04	0.04	0.04	0.02	0.02	-0.02	0.01	0.01	0.01	0.01	0.01	-0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Spring water is the main source (1=yes; 0=otherwise)							0.01	0.01	0.01			
							(0.04)	(0.04)	(0.04)			
Total lactating cow owned 12 months ago (unit)	0.00	0.00	0.00	0.00	0.00	0.00	0.01*	0.01*	0.01**	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
The household's total years in the dairy business (years)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

[1] Marginal effect

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.4 (Continue) Probit, Logit, and LPM results on the adoption of dairy farming technology, using only women's participation in the activity variables *(Specification 1)*, in West Java-Indonesia, 2017.

VARIABLES	Feeding legume forages			Growing animal crops			Improving drinking availability			High protein concentrates		
	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM
Received information related to forages and grasses in the last 12 months (1=yes, 0= otherwise)	0.14*** (0.04)	0.14*** (0.04)	0.15*** (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)						
Received information related to cow's health in the last 12 months (1=yes, 0= otherwise)							-0.08* (0.04)	-0.08* (0.04)	-0.08* (0.04)			
Received information related to concentrates in the last 12 months (1=yes, 0= otherwise)										0.02 (0.02)	0.02 (0.02)	0.03 (0.02)
The proportion of land that is owned and managed that is used for growing grass (%)	0.03 (0.04)	0.03 (0.04)	0.03 (0.04)	0.03 (0.04)	0.03 (0.04)	0.03 (0.04)	0.13*** (0.04)	0.13*** (0.04)	0.14*** (0.05)	0.04 (0.02)	0.04 (0.02)	0.04 (0.03)
Time travel from house to nearest KUD/coop (minutes)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
KUD size (total active member)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00* (0.00)	0.00* (0.00)	0.00* (0.00)
Constant			0.34** (0.15)			0.59*** (0.15)			-0.07 (0.16)			-0.03 (0.09)
Observations	563	563	563	563	563	563	563	563	563	563	563	563
R-squared			0.15			0.23			0.09			0.08

[1] Marginal effect

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The probit results for Specification 2 (Table 4.5) show that households where women participate in the type and quantity of forages decisions, are more likely to adopt feeding legume forages by 9%. When women participate in animal health decisions, the results indicate that the household is 12% more likely to adopt improving drinking water availability. Similar results in terms of the direction and the magnitude of the estimates are also observed the logit and LPM results.

The correlation between women's participation in these decisions and adoption of dairy technologies may be explained by women's role in decisions regarding investments, as suggested by previous studies on women's role in agricultural and household investment decisions in West Java (Sayogyo et al., 1979; Moji, 1980; Backues, 1992; Hilmiati et al., 2017). For example, to adopt feeding legume forages (i.e. to feed the cows with Leucaena) dairy farmers will need to plant Leucana which is considered a long-term investment (Dalzell, 2006) [19].

In the adoption of high protein concentrates, none of the women's participation variables, in the activity or participation in type and quantity of concentrates decisions are statistically significant.

The results in Table 4.4 and Table 4.5 also consistently show that, on average, the adoption of dairy farming technology (i.e. improved animal nutrition) mostly correlates with ownership and access to physical and non-physical assets. Land size owned and managed by the household (as a proxy to land availability and wealth), men's education, and whether the household received forages and grass extension are statistically significantly correlated with the adoption of feeding legume forages.

[19] Leucaena is a perennial tree that takes about 12 months to start producing and can continue producing for up to 40 years (Dalzell, 2006). Based on IndoDairy field coordinator information, in the survey area, Leucaena is not commercially sold in input stores or KUD.

Table 4.5 Probit, Logit, and LPM results on the adoption of dairy farming technology, using only women's participation in the decision-making variables *(Specification* 2*)*, in West Java-Indonesia, 2017.

VARIABLES	Feeding legume forages			Growing animal crops			Improving drinking availability			High protein concentrates		
	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM
Women's participation in decision-making: type and quality of forages (1=yes, 0= otherwise)	0.09**	0.09**	0.10**	0.04	0.05	0.05	0.12***	0.12***	0.12***	-0.02	-0.02	-0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Women's participation in decision-making: herd's health (1=yes, 0= otherwise)												
Women's participation in decision-making: type and quality of concentrates (1=yes, 0= otherwise)												
Men's years of schooling (years)	0.01*	0.02*	0.02*	-0.00	-0.00	-0.00	0.01	0.01	0.01	0.01*	0.01*	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Women's years of schooling (years)	-0.01	-0.01	-0.01	0.02*	0.02	0.02*	0.02*	0.02*	0.02*	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Men's age (yo)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Women's age (yo)	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Total number of productive age (15-64 yo) members in the household (person)	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.01	0.01	0.01	-0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Household non-land asset index for assets 12 months ago	-0.06	-0.07	-0.06	0.00	0.00	-0.01	0.02	0.02	0.02	0.05*	0.05*	0.07*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.03)	(0.03)	(0.04)
Plot size that is owned and managed in the last 12 months (hectare)	0.04	0.04	0.02***	0.02	0.02	0.01	-0.02	-0.02	-0.01**	-0.01	-0.01	-0.00
	(0.03)	(0.03)	(0.00)	(0.03)	(0.03)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
In the past 12 months, the household had access to credit (1=yes, 0= otherwise)	0.00	0.00	0.03	0.00	0.00	0.06*	-0.00	-0.00	0.00	0.00	0.00	0.01
	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.02)
The household has off-farm income in 2016 (1=yes, 0= otherwise)	0.03	0.04	0.04	0.06	0.03	-0.03	0.01	0.01	0.00	0.02	0.01	-0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Spring water is the main source (1=yes; 0=otherwise)							0.01	0.01	0.01			
							(0.04)	(0.04)	(0.04)			
Total lactating cow owned 12 months ago (unit)	0.00	0.00	0.00	0.00	0.00	0.00	0.01*	0.01*	0.01**	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
The household's total years in the dairy business (years)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

[1] Marginal effect

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.5 (Continue) Probit, Logit, and LPM results on the adoption of dairy farming technology, using only women's participation in the decision-making variables *(Specification* 2*)*, in West Java-Indonesia, 2017.

VARIABLES	Feeding legume forages			Growing animal crops			Improving drinking availability			High protein concentrates		
	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM	Probit[1]	Logit[1]	LPM
Received information related to forages and grasses in the last 12 months (1=yes, 0= otherwise)	0.13*** (0.04)	0.14*** (0.04)	0.15*** (0.04)	0.00 (0.04)	0.01 (0.04)	0.01 (0.04)						
Received information related to cow's health in the last 12 months (1=yes, 0= otherwise)							-0.08* (0.04)	-0.08* (0.04)	-0.08* (0.04)			
Received information related to concentrates in the last 12 months (1=yes, 0= otherwise)										0.02 (0.02)	0.02 (0.02)	0.03 (0.02)
The proportion of land that is owned and managed that is used for growing grass (%)	0.03 (0.04)	0.03 (0.04)	0.04 (0.04)	0.04 (0.04)	0.04 (0.04)	0.04 (0.04)	0.14*** (0.04)	0.14*** (0.04)	0.14*** (0.05)	0.04 (0.02)	0.04 (0.02)	0.04 (0.03)
Time travel from house to nearest KUD/coop (minutes)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
KUD size (total active member)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	- 0.00*** (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00* (0.00)	0.00* (0.00)
Constant			0.32** (0.15)			0.58*** (0.15)			-0.08 (0.16)			-0.03 (0.09)
Observations	563	563	563	563	563	563	563	563	563	563	563	563
R-squared			0.15			0.22			0.09			0.08

[1] Marginal effect

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Household access to credit and women's education significantly correlate with the adoption of growing animal crops. Household non-land asset index and men's education are positively and significantly correlated with the adoption of high protein concentrates. Concentrates are a relatively expensive technology when compared to the other three dairy nutrition technologies considered in our analysis.

Slightly different results are shown in the adoption of improving water availability, where land size and whether the household received/was exposed to information regarding animal health is negatively correlated with the adoption. This result is probably because the investment to provide drinking water (e.g Automatic Water Supply System that is mainly introduced by the extension programs (Widodo et al., 2019)) is too costly, and the alternative practice (e.g. the water manually added) is less costly because it uses the available resources such as family labour[20].

The above results suggest that the adoption of dairy technology is correlated with resource availability and resource allocation. Also, women's involvement in decision-making in dairy farming deserves further exploration. In West Java Indonesia, and similar to other regions in the developing world, women are not only involved in farm activities but also have relatively high involvement in household's strategic decisions such as in agricultural and non-agricultural investment (see Sayogyo et al., 1979).

Finally, we tested the correlation between input in decisions and the extent to which women can decide by themselves and adoption of dairy technologies. The results did not provide additional information. The proportion of women who responded that they provide input in some and most decisions, and of women who decide by themselves to a

[20] Households which do not adopt the practice have relatively more productive family members compared to the households which adopt the practice.

high or medium extent, are not statistically significantly different to the proportion of women participating in dairy farming decisions.

4.6 Summary and conclusions

We examined women's participation in four areas of dairy farming activities and decisions that are considered vital in improving animal nutrition and milk production. The four areas include dairy farming in general, kinds and quantity of forages, kinds, and quantity of concentrates, and herd health. Furthermore, using linear probability model and binary response model regressions from survey data of 563 couples (1126 individuals) in smallholder dairy farming in West Java-Indonesia, we also analyse the correlation between women's participation in dairy farming activities and decisions correlate with the adoption of four dairy farming technologies related to improved dairy cow nutrition (including the adoption of high protein concentrates, feeding legume forages, growing animal feed crops, and improving drinking water availability).

We found that women in West Java have relatively high participation in dairy farming activities, but their decision-making participation regarding these activities is relatively low. This finding is consistent with other studies on women's decision-making participation in agriculture (e.g. Acosta et al., 2020). However, 66% of women who participate in dairy farming decisions provide input in some and most decisions, and about half of women who participate in dairy farming decisions can decide by themselves to a high or medium extent. Consistent with the existing literature, we also find that men tend to report lower women's participation in dairy farming decision-making compared to women's participation reports.

Our results also suggest that women's participation in dairy farming activities positively correlates with the adoption of feeding legume forages, growing animal crops, and improving drinking availability. Meanwhile, women's participation in dairy farming

decision-making positively correlates with the adoption of feeding legume forages and improving drinking water availability for dairy cows.

Given that intrahousehold decision-making dynamics and husband's and wife's bargaining power are likely to influence agricultural technology adoption, our findings suggest the need to consider women's participation in dairy farming activities and decisions in technology adoption studies. Furthermore, the analysis presented in this paper suggests the need for further studies exploring the causal link between women's participation in dairy farming activities and decisions and agricultural technology adoption. Ultimately our results point to the necessity to highlight women's inclusion in dairy farming and other agricultural extension programs for improving smallholder farming performance.

Chapter 5: Conclusion

This concluding chapter provides a summary of the main findings reported in each analytical chapter (Chapters 2-4). Following this, it details the contributions of this research and the implications of the study's results. The chapter concludes with study limitations and suggestions for future research in the line of intrahousehold decision-making and women's empowerment study.

5.1. Summary of main findings

Chapter 2 focuses on Research Question 1 which analysed how men and women perceive women's participation in agricultural decision-making and explored the association between social norms and men's and women's perceptions of women's participation in decision-making in agriculture. The chapter addressed the following research questions: How do men and women perceive women's participation in household decision-making and how women's participation is associated with social norms?

In addressing the first Research Question, this study follows intrahousehold allocation framework poses by Laszlo et al. (2020). The total utility of the household is equal to the weighted sum of the utility of each member's utility in such $U_{household}(.) = \alpha U_{man}(.) + (1-\alpha)U_{woman}(.)$; where U indicates utility, α and $(1-\alpha)$ are the weights that indicate the ability of man and woman to influence decision-making (bargaining power) within the household. Women bargaining power (such as her ability to influence or control decisions within the household) relies positively on her relative income (y) but negatively on social and cultural norms hostile to gender equality (w) and negatively on her lack of self-confidence and self-esteem (s), and thus the household total utility can be formulated as $U_{household}(.) = \alpha(y, w, s)\, U_{man}(.) + (1-\alpha(y, w, s))U_{woman}(.)$.

The women's participation index (WPI) was constructed to measure men's and women's perceptions regarding women's participation in 21 agricultural decisions. The results reveal that, overall, both men and women perceived women's participation in agricultural decisions is relatively low (2.5 – 3.5 out of 10 scales) despite more than half of the respondents indicating that men and women participated in the decision-making jointly. Although men and women have different perceptions about the extent of women's participation in agricultural decision-making, they are likely to agree that women have the most participation in credit requests for investment, as well as livestock/land purchases and sales. They also tend to have similar views that women have the least participation in the decisions related to when and how to tend crops, safety, and practices in spraying chemical inputs and attending agricultural training. Using OLS regressions to survey data from 439 couples, it was found that the variation in women's participation in decision-making is mostly explained by the variables capturing the role of social norms, in which agriculture is men's domain and that men are the ones with knowledge.

Chapter 3 focuses on Research Question 2 which examined the extent and the source of spousal differences in response to questions regarding men's and women's participation in intrahousehold decision-making. The chapter addressed the following research questions: To what extent do men and women differ in answers to individuals' decision-making participation and what are the possible sources of the differences in response?

In examining the differences in response to spousal decision-making participation in agricultural and non-agricultural decisions, the study utilised an alternative question that focuses on the process of decision-making: how often do you think your household thinks about the decision, rather than the identity of the decision-maker (who makes decisions most of the time). Using the same data used in Chapter 2, for 39 households' decisions

in six domains (agricultural production, agricultural and household investment, household expenditure, income-generating activities, savings and credits, and training), the study showed that the spousal differences in response are statistically significant in 75% of the decisions, where the level of discrepancies varies based on the domains and types of decisions. Paired t-tests, multivariate tests on means, and literature exploration were used to analyse whether the spousal differences in response were due to random measurement error, asymmetric measurement error (due to different interpretations of the question), or asymmetric information (spouses hide information from each other). The study concluded that the discrepancies were not likely caused solely by random and/or asymmetric measurement errors or asymmetric information in terms of hiding information, but more likely due to social norms and cultural gender-based involvement.

To have a comprehensive picture of women's participation in decision-making in the context of rural smallholder farm households, **Chapter 4** focuses on Research Question 3 which assessed the correlation of women's participation in decision-making and activities with agricultural adoption at the household level in the case of smallholder dairy farming. The chapter addressed the following research questions: Does women's participation in decision-making correlate with agricultural technology adoption?

Using data from 563 dairy farming households, women's participation in four areas of dairy farming activities and decisions related to increasing animal health and productivity (i.e. dairy farming in general, kinds and quantity of forages, kinds, and quantity of concentrates, and herd health) were identified. It was found that women in West Java have relatively high participation rates in dairy farming activities, but their decision-making participation regarding these activities is still considered low. However, it was also found that for those women who participated in dairy farming decision-making, 66% of them provide input in some and most decisions, and about 50% of them

can decide by themselves to a high or medium extent. Linear probability model and binary response model regressions from survey data of 563 couples (1126 individuals) were used to examine the correlation between women's participation in dairy farming decisions and activities with the adoption of high protein concentrates, feeding legume forages, growing animal feed crops, and improving drinking water availability. The results showed that women's participation in dairy farming decision-making positively correlates with the adoption of feeding legume forages and improving drinking water availability for dairy cows, while women's participation in dairy farming activities positively correlates with the adoption of feeding legume forages, growing animal crops, and improving drinking availability.

5.2. Key contributions and implications

This thesis makes novel contributions to the agricultural intrahousehold decision-making literature. While each analytical chapter details contributions to the literature, the following section elaborates on some lessons learned and the implications of the study.

5.2.1 Roles of social norms and the context in determining women's participation in agricultural decision-making

This study emphasises the critical role of social norms in determining the extent of women's participation in agricultural decision-making in the context of rural smallholder farm households. This study found that social norms measures regarding men as household heads and primary decision-makers, that agriculture is men's domain, and that men are the ones with knowledge about agriculture influence men's and women's perceptions of the role of women in agriculture (**Chapter 2**). Social norms can also influence responses to intrahousehold decision-making and bias responses resulting in misinterpretation of data (**Chapter 3).** Consistent with the existing literature regarding the importance of social norms (e.g., Jayachandran, 2020; Laszlo, 2020; Mabsout & Van

Staveren, 2010; Maiorano et al., 2021), this study suggests the need to consider the local context in the design and analysis of intrahousehold decision-making dynamics, to incorporate questions that elicit existing social norms about gender in surveys, and to conduct qualitative research to inform survey questionnaire's design and the analysis of results.

The findings of this study also suggest that the Indonesian government interventions require consideration of social norms regarding the role of women in society and in the household. Women's role in intrahousehold decision-making is not only affected by the woman's idiosyncratic characteristics relative to her spouse (internally sourced, such as the woman's education and skills) but also may be affected by exogenous factors such as social norms and cultural traditions over which the individual woman has absolutely no control and thus interventions are needed (Mohapatra & Simon's, 2017).

The consideration of the local context and social norms about gender will also be needed to help policy-makers and multilateral organisations (such as the United Nations, FAO, and IFAD) in designing better policies and programs to empower women. Careful consideration of the local context and social norms about gender throughout an intervention/project cycle (from the design to the impact assessment phase) may create a pathway in reducing the constraints for women's participation in agrifood systems and women empowerment in general, which are critical in achieving the sustainable development goals of zero hunger (SDG 2) and gender equality (SDG 5) (FAO, 2023; Rola-Rubzen et al., 2020).

5.2.2 The design of decision-making surveys

Measuring participation in intrahousehold decision-making can be challenging. In the existing literature, it is commonly found that asking who makes the decision for an agricultural activity is usually used as a proxy for decision-making participation in

agriculture and the answers to the question typically include the following options: myself, my spouse, or jointly/both (such as in the Women's Empowerment in Agriculture Index by Alkire et al., 2012). However, as discussed in Chapter 3, this method has been criticised due to the possibility that the responses to this question may be driven by measurement error, information asymmetry, social desirability bias, or social norms about gender roles and gender stereotypes, thus failing to measure women's empowerment robustly (Van Campenhout et al., 2022; Mabsout & Van Staveren, 2010; Peterman et al., 2021; UNECE, 2021).

Chapter 3 shows that researchers need to consider the possible sources of spousal disagreement in survey questions regarding decision-making and asset ownership. Testing for random, systematic and asymmetric measurement error, voluntary of involuntary information asymmetry within the household, and social desirability bias, before correlating discrepancies in spouses' responses with women empowerment on household welfare outcomes is highly desirable.

This research utilised alternative methods for measuring participation in intrahousehold decision-making. In **Chapter 3**, "How often do you think your household thinks about the decision, overall, in the past year?" was used in measuring participation in intrahousehold decisions. This question is more focused on the decision-making process (in the spirit of Liaqat et al., 2021) rather than the identity of the decision-maker. The result suggests a slightly less gender-related interpretation of the "how often" question than the "who decides" question. In **Chapter 2 and 3**, a 0–10 Likert scale is applied rather than binary response options. These more flexible ways of measuring decision-making will likely improve the understanding of joint decisions and the observed differences in perceptions about men's and women's involvement in intrahousehold decision-making processes. These methods can be used by researchers,

government organisations, and NGOs as an alternative for the design of agricultural intrahousehold decision-making surveys.

5.2.3 Role of women's participation in intrahousehold decision-making in the adoption of agricultural technology

Chapter 4 finds that women's participation in dairy farming decision-making and activities positively correlates with the adoption of feeding legume forages and improving drinking water availability for dairy cows, which supports existing literature findings (consistent with Aryal et al., 2020; Giller et al., 2009; Mohaptra & Simon, 2017; Quisumbing et al., 1996; Welbank, 2011). Given that intrahousehold decision-making is likely to influence agricultural technology adoption, these findings speak to the need to consider women's participation in dairy farming activities and decisions in technology adoption studies. These findings also point to the necessity to highlight women's inclusion in dairy farming and other agricultural extension programs because it may potentially increase food production (through the adoption of technology) and generate significant gains in reducing poverty (SDG 1), likely to improve the lives of dairy farming households and help achieve the sustainable development goals of zero hunger (SDG 2) and gender equality (SDG 5) (Alex, 2013; Kristjanson et al. 2017*;* Rola-Rubzen et al., 2020; Thirtle & Piesse, 2007).

5.3. Limitations and future research

Being exploratory in nature, this study is not without limitations. Firstly, given the non-experimental data, the results and conclusions derived from the regression-based analysis in Chapter 2 and 4 are mainly based on associations rather than causation. This study, therefore, serves as the first step to provide valuable insight into women's participation in intrahousehold decision-making in the context of rural smallholder farm households. The external validity of findings demands further investigations in

experimental or quasi-experimental environments that can better facilitate the identification of causal relationships.

Secondly, even with the extensive data set employed in this study, and the given evidence in the literature that women's empowerment yields improved welfare outcomes at a household level, we still cannot determine whether the current condition is reflecting women's preferences in decision-making participation. As mentioned by Akter et al. (2017) and Spangler & Christie (2020), despite the potential benefit, increasing women's participation in decision-making can, in certain cases, also become an additional burden to women; and thus, pointing to the need for more rigorous future research studies. Moreover, as our findings highlight the importance of social norms and cultural values, which can vary depending on the context, the external validity of our findings cannot be naively concluded. Variations in the results are expected in future similar studies as it depends on the locations/context, as social norms will affect the outcomes obtained. However, the findings presented in this thesis can be used as a starting point for future exploration of this issue, and the results are better treated as suggestive rather than definitive.

5.4. Concluding remarks

As an empirical work, this thesis has contributed further clarity to the understanding and analysis of women's participation in intrahousehold decision-making in the context of rural smallholder farm households. As one of the important indicators in achieving women's empowerment, the study of women's participation in decision-making develops rapidly and will likely continue to do so. It is hoped that the thoughts explored, the knowledge produced, and the alternative methods presented in this thesis will be able to inspire further research to identify and develop solutions to the many challenges in

attaining The United Nations Sustainable Development Goals (SDGs) Goal, especially Goal number 5 “To achieve gender equality and empower all women and girls”.

Appendices

Appendix 1. Low-risk human ethics approval for IndoGreen project

THE UNIVERSITY of ADELAIDE

RESEARCH SERVICES
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
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CRICOS Provider Number 00123M

Our reference 32745

01 June 2020

Professor Randy Stringer
Centre for Global Food and Resources

Dear Professor Stringer

ETHICS APPROVAL No: H-2018-063
PROJECT TITLE: Smallholders' sustainable adaptation in the upland of Indonesia

Thank you for the amended ethics application provided on the 30th of April requesting an amendment to add Dr Xu to the investigator team. The amendment has been approved.

The ethics amendment for the above project has been reviewed by the Secretariat, Human Research Ethics Committee and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research 2007 (Updated 2018)* involving no more than low risk for research participants.

You are authorised to commence your research on: 09/04/2018
The ethics expiry date for this project is: 30/04/2022

NAMED INVESTIGATORS:

Chief Investigator:	Professor Randy Stringer
Student - Postgraduate Doctorate by Research (PhD):	Mr Sacha Amaruzaman
Associate Investigator:	Associate Professor Douglas Bardsley
Student - Postgraduate Doctorate by Research (PhD):	Mrs Sara Ratna Qanti
Associate Investigator:	Dr Alexandra Peralta
Associate Investigator:	Dr Ying Xu

CONDITIONS OF APPROVAL: . 14/05/2020: Time extension of 12 months provided by HREC for impact of Covid19

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled Annual Report on Project Status is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/research-services/oreci/human/reporting/. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the information sheet and the signed consent form to retain. It is also a condition of approval that you immediately report anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol or project investigators; and
- the project is discontinued before the expected date of completion.

Yours sincerely,

Ms Yvette Kim Clarissa Wijnandts
Secretary

The University of Adelaide

Appendix 2. Low-risk human ethics approval for IndoDairy project

THE UNIVERSITY of ADELAIDE

18 April 2017

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CRICOS Provider Number 00123M

Professor W Umberger
Centre for Global Food and Resources

Dear Professor Umberger

ETHICS APPROVAL No: **H-2014-188**

PROJECT TITLE: **Improving milk supply, competitiveness and livelihoods in smallholder dairy chains in Indonesia**

Thank you for the Annual Report on Project Status dated 10.3.17, updated ethics application and supporting documents dated 10.3.17. and detailed response dated 13.4.17 to the matters raised following the review. The extension of ethics approval for an additional three years including changes to the investigators has been approved by the Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of Professions).

The ethics expiry date for this project is: **30 September 2020**

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Project Status Report* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/ethics/human/guidelines/reporting. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Yours sincerely

DR JOHN TIBBY
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

DR ANNA OLIJNK
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

Appendix 3. IndoGreen household questionnaire

The questionnaire presented in this section only consist of modules that are used for this study.

INDOGREEN PROJECT

FARM HOUSEHOLD SURVEY

BANDUNG SITE

QUESTIONNAIRE

HOUSEHOLD IDENTITY

This section is to captured the general information of the household

Household ID	Date	District	Sub District Bandung	Sub District West Bandung	Village in Bandung	Village in West Bandung
		1 Bandung 2 West Bandung	1 Arjasari 2 Cicalengka 3 Cikancung 4 Ciwidey 5 Ibun 6 Kertasari 7 Pacet 8 Pangalengan 9 Soreang	1 Cililin 2 Cipongkor 3 Cisarua 4 Gunung Halu 5 Sindangkerta	1 Baros 2 Mekarjaya 3 Dampit 4 Tanjung Wangi 5 Mandalasari 6 Mekarlaksana 7 Lebakmuncang 8 Dukuh 9 Neglasari 10 Cihawuk 11 Cikembang 12 Cikitu 13 Pulosari 14 Sukanegara	1 Mukapayung 2 Nanggerang 3 Citalem 4 Sarinangen 5 Pasirhalang 6 Sirnajaya 7 Wargasaluyu 8 Mekarwangi
hhid	*date*	*district*	*subdistrict_bandung*	*subdistrict_west_bandung*	*village_bandung*	*village_west_bandung*

Name of the Head of Household	Name of the Respondent	Address	Phone number	Enumerator	GPS	Are you willing to continue with the interview?
				1 Pitri 2 Dewi 3 Danny 4 Masitoh 5 Anna 6 Cirama 7 Warjiyo 8 Latief 9 Fuad 10 Andri 11 Muhsonef 12 Fajri		0 No 1 Yes
name	*respondent*	*address*	*address*	*enumerator_bandung*	*gps*	*declaration*

HOUSEHOLD MEMBER INFORMATION

Read to the respondent: First we will ask for general information about you and the family members

NO	Name	Relationships with the head of the household	Is [name] a male or female?	How old is [name]? [age at last birthday, use 0 for < 1 yr]	ONLY ASKED TO THE HEAD OF HOUSEHOLD					
					How long have you stayed in this village? (Year)	Are you originally from this village?	If Other, state	Have you ever lived in other city/district for work or school more than 1	Where?	If Other, state
		1 Head 2 Spouse 3 Son/daughter 4 Son/daughter in law 5 Grandchild 6 Parents/ Parents in Law 7 Other related 8 Other unrelated	0 Male 1 Female			1 Yes, originally from this village 2 From outside the village but from the same district 3 From big cities in West Java 66 Others		0 No 1 Yes	1 Bandung 2 Other city/district in Java 3 Other city/district outside Java 4 Outside the Country 66 Others	
	hhm_name	*hhm_relation*	*hhm_gender*	*hhm_age*	*hhm_period*	*hhm_origin*	*hhm_origin_s*	*hhm_othercity*	*hhm_where*	*hhm_where__s*
1										
2										
3										
4										
5										
6										
7										
8										

HOUSEHOLD MEMBER WHO IS 15 YEARS OLD OR OLDER																				
How many years of schooling has [name] completed?	What is the marital status of [name]?		What is the **main** activity of [name]?		Where is the main location of the activity		Where is the main location of activities outside the village?		How do you work?		What is the **second main** activity of [name]?		Where is the main location of the activity		Where is the main location of activities outside the village?	
	1	Single	1	Farming	1	Only within the village	1	outside the village in one sub-district	1	Go home every day	1	Farming	1	Only within the village	1	outside the village in one sub-district
	2	Married	2	Agricultural trading business	2	Only outside the village	2	outside the sub-district in one district	2	Stay overnight	2	Agricultural trading business	2	Only outside the village	2	outside the sub-district in one district
	3	Separated	3	Non agricultural business	3	Within and outside the village	3	outside the district in one province			3	Non agricultural business	3	Within and outside the village	3	outside the district in one province
	4	Divorce	4	Public officer (teacher, govt.staff, etc.)			4	outside the province			4	Public officer (teacher, govt.staff, etc.)			4	outside the province
	5	Widow	5	Private sector							5	Private sector				
			6	Farm labor							6	Farm labor				
			7	Non agriculture labor							7	Non agriculture labor				
			8	Housework							8	Housework				
			9	Student							9	Student				
			10	None							10	None				
			11	Non-Agricultural trading business							11	Non-Agricultural trading business				
			66	Other							66	Other				
hhm_yearschool	*hhm_marital*		*hhm_main*		*hhm_main_loc*		*hhm_main_out*		*hhm_main_work*		*hhm_second*		*hhm_second_loc*		*hhm_second_out*	

HOUSE AND FARM ASSETS

Read to the respondent: In this section we would like to ask detail information regarding your house, household and farm assets

What is the approximate area of your house in square meters (incl. homegarden)	In what unit area?	[If house owned] What is the approximate value of your house without farmland? **(in million IDR)**	[If house rented] What is the annual rent that you pay for your house? (IDR)	IDR Unit	What is the main source of drinking water for your household?	What is the main type of toilet used by your household?	What is the main type of lighting used by your household?	What type of fuel is used by your household for cooking?
	1 Hectare 2 Bau *(7000 - 7400 meter square / 0.7 - 0.74 ha)* 3 Bata *(14 meter square / 0.0014 ha)* 4 Tumbak *(14 meter square / 0.0014 ha)* 5 Kubik *(272 meter square / 0.0272 ha)* 6 Meter Square (M2) 7 Patok *(400 meter square / 0.04 ha)*			1 Thousand 2 Million	1 Indoor tap 2 Outdoor private tap 3 Outdoor shared tap 4 Covered well 5 Collected rainwater 6 River, lake, pond, spring 7 Spring 8 Bottled water 66 Others 999 Not applicable/special	1 Flush toilet 2 Latrine with pipe 3 Pit latrine 4 Latrine over canal/pond 5 Public toilet 6 Other or none 7 Latrine without pipe 999 Not applicable/special	1 Electric lights 2 Oil lamps 3 Candles 66 Others 999 None	1 Electricity 2 LPG 3 Biogas 4 Kerosene 5 Wood/Charcoal 66 Others 999 Not applicable/special
ass_housearea	*ass_houseunitarea*	*ass_housevalue*	*ass_houserent*	*ass_houserent_unit*	*ass_drinking*	*ass_toilet*	*ass_lighting*	*ass_fuel*

ASSETS	How many [.....] do members of your household currently own?	How many [.....] did members of your household have 5 years ago?	What form of ownership of the asset?
Mobile phone/tablet			
internet			
motorcycle			
car			
computer			
tossa			
truck			
water pump for agriculture			
generator			
tractor/hand tractor			
tractor four wheels			
rice mill			
rice tresher			
corn sheller			
sprayer			
apo			
storage house			
coffee huller			
cattle/buffalo			
goats/sheep			
poultry			

CURRENT PLOT INVENTORY AND INFORMATION

Read to the respondent: For all the plots that you currently owned and/or managed, we would like to like to ask detail information for each plot

NO	Plot number	GENERAL															
		What is the land use of this plot?		Plot area location?		Plot size	Unit Area		How do you usually go to the plot from your house?		State	How many minutes does it usually take to go to the plot in this way?	How far from your house to the plot in meter?				
		1	Rice fields	1	Private land in the village area		1	Hectare	1	On foot							
		2	Horticulture	2	Private land outside of the village area		2	Bau *(7000 - 7400 meter square / 0.7 - 0.74 ha)*	2	Motorcycle							
		3	Estate	3	Forest land within the village area		3	Bata *(14 meter square / 0.0014 ha)*	3	Modified motorcycle							
		4	Bush	4	Forest land outside of the village area		4	Tumbak *(14 meter square / 0.0014 ha)*	66	Other							
		5	Pond				5	Kubik *(272 meter square / 0.0272 ha)*									
		6	Livestock				6	Meter Square (M2)									
		7	Forest				7	Patok *(400 meter square / 0.04 ha)*									
	plot_no	*plot_use*		*plot_location*		*plot_size*	*plot_areaunit*		*plot_transport*		*plot_transport_s*	*plot_minute*	*plot_distance*				
1																	
2																	
3																	

STATUS																			
What is the current status of land tenure?		Who did you get the land from?		Where does the owner live?		Who is currently working on the land?		How was this plot acquired?		What year did you get the land?	What is the proof of ownership of land owned?		Who is the owner stated in the document?	
1	Owned and farmed	1	Other farmer	1	Within the village	1	Local farmer	1	Inherited		1	None	1	Husband
2	Owned and rent it out	2	Village	2	In sub-district city/capital	2	Migrant from Java Island	2	Gift		2	Letter from the village	2	Wife
3	Owned & pawned out	3	Government	3	In district city/capital	3	Migrant from outside Java Island	3	Purchased		3	Transaction deed	66	Other
4	Owned & sharecropped out	4	Private sector	4	In province city/capital	66	Other	4	Open/ Cleared from the forest		4	Certificate		
5	Owned and lent out	5	Government owned Company (Perhutani)	5	other village			5	Open/ Cleared from degraded land					
6	Owned and not planted	6	Other non farmer individual					6	Allocated by the government					
7	Pawned from owner	66	Other											
8	Rented from owner													
9	Sharecropped from owner													
10	Borrowed from owner													
11	Not owned and not farmed anymore													
12	Tempohan from owner													
13	Owned and being tempoh													
14	Borrowed from government													
plot_tenure		*plot_got*		*plot_ownerlive*		*plot_work*		*plot_acquired*		*plot_year*	*plot_proof*		*plot_document*	

AMOUNT AND SOURCES OF INCOMES

Read to the respondent: In the following section we will ask about your household sources of income in "THE LAST 12 MONTHS"

SOURCE OF INCOME	In the past 12 months, have there been members of your household who received income from the activities of **other agricultural commodity farms in the backyard**?		Who is the main source of income from the activity (allocation of time or most money)		How many months in the last 12 months have your household members received income from this activity?	From each month the income received, how much is the gross income from this activity? IDR/ Month	IDR Unit		From each month the income received, how much is the total cost spend for this activity? IDR/ Month	IDR Unit		In the past 5 years, has this activity become more or less important to the household income sources?	
	0 1	No Yes	1 2 3 66	Husband Wife Both (Husband and Wife) Other member			1 2	Thousand Million		1 2	Thousand Million	1 2 3	More important The same Less important
Other agricultural products from the backyard and non backyard													
Sales of livestock and livestock products													
Fishery													
Agricultural commodity trading													
Other trade													
Coffee milling business													
Rice milling business													
Food processing business													
Other business													
Wages in the agricultural sector													
Wages in the non agricultural sector													
Salary in the professional sector													
Pension													
Remittance													
Government and non-government assistance													
Sales of forest products													
Other source													

SAVINGS AND ACCESS TO CREDIT

Read to the respondent: In the following section we will ask about current savings and credit / loan hold by your Household

Do you and/or your family members have savings?		Where you and your family members save the savings? (ANSWER CAN BE MORE THAN ONE)		What is the main purpose of the saving? (ANSWER CAN BE MORE THAN ONE)		[Ask IF the respondent is NOT COMPLIANCE] how much total household savings do you currently have?		Have you or any family member taken any loan in the last 12 months from the following institution? (ANSWER CAN BE MORE THAN ONE)	
0	No	1	Bank	1	Agriculture business	1	< 5 million IDR	1	Bank
1	Yes	2	Cooperative	2	Non agriculture business	2	5 - 15 million IDR	2	Cooperative
		3	Non bank institution	3	Education	3	15 - 25 million IDR	3	Micro finance
		4	Self saving	4	Consumption	4	25 - 50 million IDR	4	Loan sharks
				66	Other	5	> 50 million IDR	5	Middleman
						6	Respondent objected to answer	6	Pawnshop
								7	Friend/Relative
								8	Do not take any loan in the last 12 months
								9	Input Store
								66	Other
fin_savings		*fin_savings_where*		*fin_savings_purp*		*fin_savings_amout*		*fin_loan*	

Institution	What is the main purpose of taking loan from the institution?		What is the form of the loan from the institution? (ANSWER CAN BE MORE THAN ONE)		Who made the decision to borrow from this institution?		[Ask IF the respondent is NOT COMPLIANCE] how much is the total loan from the institution at this time?	
	1	Purchase land	1	Cash	1	Decided by yourself	1	< 25 million IDR
	2	Agriculture business	2	Goods	2	Decided by the spouse	2	25 - 50 million IDR
	3	Non agriculture business	3	Don't know (other family member's loan)	3	Decided together	3	50 - 100 million IDR
	4	Purchase vehicle			4	Don't know (other family member's loan)	4	100 to 250 million IDR
	5	Daily consumption					5	>250 million IDR
	6	Education					6	Respondent objected to answer
	7	Health						
	66	Other						
Bank								
Cooperative								
Micro finance								
Input store								
Loan sharks								
Middleman								
Pawnshop								
Friend/Relative								
Other								

ORGANISATION	Are there groups below existed in the village / community around you?		Are you a member of ** [.....]**		Have you ever joined the group?		What is the reason for stopping the membership?		Are you / family members active in the group?		What is your position / membership in the group?		What training is gained from the participation of you / family members in the group?		What support obtained from the participation of you / family members in the group?		Where are the seeds planted?	
	0	No	0	No	0	No	1	No benefits	0	No	1	Head	1	Cultivation technique	1	Seeds	1	Private land
	1	Yes	1	Yes	1	Yes	2	No assistance	1	Yes	2	Officer	2	Practice of Soil Water Conservation	2	Fertilizer	2	Public land non-forest
							3	Moved to other location			3	Regular member	3	Harvesting and post-harvest techniques	3	Farm equipment	3	Forest
							4	No time					4	Nursery plot	4	Water/Irrigation	4	Not yet planted
							5	Other					5	Entrepreneurship	5	Farming credit	66	Other
													6	None	6	Commodity marketing		
													66	Other	7	Planting costs		
															8	Maintenance costs		
															9	None		
															66	Other		
Farm group																		
Forest farm group																		
Cooperative																		
Women group																		
Religion group																		
Water user group																		
Trading/Business organisation																		
Youth organisation																		
Clean water group																		
Waste management group																		
Woman farm group																		
None of the above existed																		

DECISION MAKING PROCESS WITHIN HOUSEHOLD

Read to the respondent: Now we will ask how you are involved in activities and decision making for various aspects on a household scale

Group		Activities	How much do you think about this decision overall (1= I don't really think about it at all, 10= I think about this decision very often). Mark the level that you think about this decision. Please use the whole scale (only rank the most important item '10')	Who makes decisions in the following aspects? 0= my spouse decides alone, 10= I make this decision entirely by myself). Mark your level of decision making	None of us, [option] determined for us		If Other, state	Why do you think this decision is made this way?		If Other, state
					1	Other household members		1	Whoever has better knowledge about activity	
					2	Other non household members		2	Whoever paid (allocated the resources) for the activity	
					66	Other		3	This is how decisions are made at the village/in my family make;	
								66	Other	
Agricultural Production	1	What crops to grow								
	2	What variety to select								
	3	When and how to do land preparation and planting								
	4	When and how to apply agro-chemicals (e.g. fertiliser, pesticides, fungicide, growth hormones)								
	5	When and how to tend the crops (e.g weeding, watering, prunning, non synthetic fertilizer)								
	6	When and how to harvest the crops								
	7	Planting amenity or natural plants for biodiversity in the farm or home garden								
Agricultural /household investment	8	Buying farm equipment/machinery (tractor, harvester)								
	9	Buying yield increasing farm input (seed, fertiliser, pesticide, hormones, etc)								
	10	Building and maintenance of soil and water conservation structures (e.g build terrace, safe waterways)								
	11	Implementation of soil/water conservation practices (e.g. agroforestry, cover crop, mulching)								
	12	Agricultural land purchasing and selling								
	13	Livestock purchasing and selling								
	14	Purchasing land/house or other large investments								

DECISION MAKING PROCESS WITHIN HOUSEHOLD

Read to the respondent: Now we will ask how you are involved in activities and decision making for various aspects on a household scale

Group		Activities	How much do you think about this decision overall (1= I don't really think about it at all, 10= I think about this decision very often). Mark the level that you think about this decision. Please use the whole scale (only rank the most important item '10')	Who makes decisions in the following aspects? 0= my spouse decides alone, 10= I make this decision entirely by myself). Mark your level of decision making	None of us, [option] determined for us		If Other, state	Why do you think this decision is made this way?		If Other, state
					1	Other household members		1	Whoever has better knowledge about activity	
					2	Other non household members		2	Whoever paid (allocated the resources) for the activity	
					66	Other		3	This is how decisions are made at the villagein my family make;	
								66	Other	
Household Expenditure	15	How much to spend on housing repairs/improvements								
	16	Durable goods expenditures (e.g. refrigerator, television, furniture)								
	17	Small durables expenditures (e.g. cell phone, smartphone)								
	18	School fees and other related school expenditures								
	19	How much to spend on food								
	20	Means of transportation purchase (motorcycle, car, truck, etc)								
	21	Leisure and enjoyment expenditures (cigarettes, going out for fun)								
	22	Health related expenditures								
	23	Expenditure on clothes (e.g. new dresses)								
	24	Parties and ceremonies (wedding, religious)								
Income Generating Activities	25	Whether to take work seasonal work away from the home (e.g. in another region for a short time)								
	26	Whether to take long-term work away from home (e.g. in another region/country for a long time)								
	27	Non-farm economic activities (small business, buy and sell, self-employment)								
	28	Wage salary employment (work paid in cash or in kind, includes and non ag work)								
	29	Processing (drying, fermenting, packing, etc)								
	30	Whom to sell								
	31	Marketing arrangement (where and when)								
	32	Negotiating with buyer/trader (price negotiation)								

DECISION MAKING PROCESS WITHIN HOUSEHOLD

Read to the respondent: Now we will ask how you are involved in activities and decision making for various aspects on a household scale

Group		Activities	How much do you think about this decision overall (1= I don't really think about it at all, 10= I think about this decision very often). Mark the level that you think about this decision. Please use the whole scale (only rank the most important item '10')	Who makes decisions in the following aspects? 0= my spouse decides alone, 10= I make this decision entirely by myself). Mark your level of decision making	None of us, [option] determined for us		If Other, state	Why do you think this decision is made this way?		If Other, state
					1	Other household members		1	Whoever has better knowledge about activity	
					2	Other non household members		2	Whoever paid (allocated the resources) for the activity	
					66	Other		3	This is how decisions are made at the villagein my family make;	
								66	Other	
Saving and Credit	33	How much to save								
	34	Request credit for agricultural investment								
	35	Request credit for non-agricultural investments								
	36	Lending to friends or family								
	37	Use of savings/credit								
Training	38	Attending agriculture training or extension activities (field school, pest management, new varieties, etc)								
	39	Attending non-agricultural training or extension activities								

Appendix 4. IndoDairy household questionnaire

The questionnaire presented in this section only consist of modules that are used for this study.

Indonesian Center for Agricultural Socio Economic and Policy Studies
Indonesian Agency for Agricultural Research and Development, Ministry of Agriculture

Indonesian Dairy Farm Household Survey 2017

THE UNIVERSITY of ADELAIDE

Objective: The main purpose of this survey is to improve our understanding about some of the key characteristics about dairy farmers in West Java particularly to address farm performance, technology adoption, and decision making.

Use of data: The data collected as part of this survey are for research purposes ONLY. Household-level data will not be shared with non-research organizations.

Only summary results will be included in published report.

Household ID number				
Village code		Enumerator code		Household code

		Code in A2
Name of head of household		
Name of the respondent*		
Address of the house (NOT FARM)		
Name of farmer groups		
Name of KUD		
Phone		
Sub-district		
District		
Province		
GPS Coordinate		

Introduction

Hello, my name is _____. We are carrying out a survey of dairy farmers in West Java. The survey is intended to understand the status of technology adoption and decision making in dairy farming business. Your household is one of the households that have been selected to participate. Remember, there are not right or wrong answers; ideally the answers should be as accurate as possible. The results are confidential and will only be used for research purposes. We would like about 2-3 hours of your time to interview you about your dairy business.

*The respondent should be the person that makes most of the decisions regarding the dairy farm, it may or may not be the head of the household

A. HOUSEHOLD CHARACTERISTICS*										
	Name	What is the relationship between [name] and the head of household? Please use the CODES below to reply CODES: 1 Head of household 2 Spouse/partner 3 Son/daughter 4 Son/daughter in law 5 Grandchild 6 Parent or in-law 7 Other related 8 Other unrelated	**Gender** Is [name] a male or female? CODES: 1=Male 2=Female	**Age** How old is [name]? (age at last birthday) use 0 for members < 1 yr	**Ask these questions only for members 6 years or older (A4>6)** What is the highest level of education completed (e.g. Year 8 = 8) **Total number of years**	Which of this tertiary education has been completed by [...] ? 1 = No 2 = Undergraduate 3 = Post graduate 4 = Vocational training **Choose one option**	**Ask these questions only for members 10 years and older** What is the marital status of [name]? 1 Single 2 Married or de-facto 3. Divorced or separated 4 Widowed	*What are the **main activities in the last 12 months** of [name]? If there is no secondary activity, write 0 for A8 1. Dairy farming 2. Farmer or fishermen 3. Self-employed/employer 4. Wage/salary employee 5. Unpaid family/community worker 6. Student 7. Unemployed 8. Retired 9. Disabled 10. Other	
								Main	Secondary
	A1	**A2**	**A3**	**A4**	**A5a**	**A5b**	**A6**	**A7**	**A8**
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

*NOTES: 1.The household is defined as a group of people who live and eat together most of the time under the same roof.

*NOTES: 2.Each member must live with others at least 6 months of the year unless a new member (baby, or new in-law living for at least a month in the HH)

*NOTES: 3.The head of the household is defined as the member (male or female) who makes most of the economic decisions.

*NOTES: **Questions A7 and A8**, 'main activities' are defined according to the time it takes, rather than the money it generates.

Page 2

B.HOUSING

What is the approximate area of your house in square metres? Do not include the farm land. If don't know, please write DK — **B1**

[If house owned] What is the approximate value of your house without farmland? [IDR] *if not owned write 0; don't know write (DK)* — **B2a**

[If house rented] What is the monthly rent that you pay for your house (without farmland)? [IDR] *if neither owned nor rented please write 0* — **B2b**

[If house] is neither own nor rented, what is the status? Select codes — **B2c**

Codes for **B2c**

1= borrowed from family 2= borrowed from non-family 3=other

What is the main source of water for your household for drinking? — **B3a**

1 Bottled water	5 Outdoor shared tap	9 Collected rainwater
2 Refill water	6 Covered well	10 River, lake, or pond
3 Indoor tap	7 Uncovered well	11 Other
4 Outdoor private tap	8 Spring	

What is the main source of water for your household for cooking? — **B3b**

1 Bottled water	5 Outdoor shared tap	9 Collected rainwater
2 Refill water	6 Covered well	10 River, lake, or pond
3 Indoor tap	7 Uncovered well	11 Other
4 Outdoor private tap	8 Spring	

What is the main source of water for your household for non-drinking and non-cooking activities? — **B4**

1 Indoor tap	5 Uncovered well	9 other
2 Outdoor private tap	6 Spring	
3 Outdoor shared tap	7 Collected rainwater	
4 Covered well	8 River, lake, or pond	

What is the main type of toilet used by your household? — **B5**

1 Flush toilet	4 Latrine over water
2 Latrine with pipe	5 Public toilet (all types)
3 Pit latrine	6 Other or none

What is the main type of lighting used by your household? — **B6**

1 Electric lights	4 Candles
2 Generator	5 Solar
3 Oil lamps	6 Other or none

What type of fuel is used by your household for cooking? — **B7**

1 Electricity	3. Biogas	5 Wood/charcoal
2 LPG	4. Kerosene	6. Other

Do you have public garbage collection? (1=Yes; 0=No) — **B8**

C1. ASSETS AND GENERAL FARMING TOOLS

A. Household items	How many of each does your household **CURRENTLY OWN**? If none, please write 0 — Number		How many […] did your household own **12 months ago**? If none please write 0 if can't recall please write DK — Number		When did you buy the most recent […] e.g. 2016 If cannot recall please write DK		If you were to sell […] TODAY how much money would you get? [IDR] if more than one […] use an average	
a refrigerator		C1a		C1b		C1c		
a mobile phone?		C2a		C2b		C2c		
a television		C3a		C3b		C3c		
a parabola		C4a		C4b		C4c		
internet access?		C5a		C5b		C5c		
a washing machine?		C6a		C6b		C6c		
Transportation								
Bentor		C7a		C7b		C7c		C8d
a motorbike?		C8a		C8b		C8c		C8d
Three-wheeled motorcycle		C9a		C9b		C9c		C9d
Tricycle (becak)		C10a		C10b		C10c		C10d
a car?		C11a		C11b		C11c		C11d
a truck?		C12a		C12b		C12c		C12d
Others								
biogas?		C13a		C13b		C13c		
Genset		C14a		C14b		C14c		
manure/dung processing tool		C15a		C15b		C15c		

C2. ASSETS (LAND AND LIVESTOCK)

***The following table refers to land CURRENTLY managed or owned by the respondent, other than the house**

Plot ID used in the last 12 months	Plot use (please use the codes below)	Size of the plot, please use the codes below for the units		Tenure system (use codes)	If C21=1,2; who owns the plot? (use codes)
		Area	Unit		
C16	**C17**	**C18**	**C19**	**C20**	**C21**
1					
2					
3					
5					
6					

Plot use codes C17	Codes for C19	Codes for C20	Codes for C21
1=crops	1 Hectare	1= owned	1=head of household
2=dairy cattle	2 Bau	2= rented	2=spouse
3=grow grass	3 Bata/Tumbak	3= share cropped	3=joint (household head and spouse)
4= livestock non-dairy	4 Are	4= pawned	4=father head of household
5 : horticulture	5 M2	5=borrowed	5=mother head of household
6 = idle	6 Patok	6=communal/public land	6=in-laws
7 others		7=other	7=other relatives
			8=other

How many of this ruminansia livestock [...] do you own?

Livestock Ownership	How many of […] does your household **CURRENTLY MANAGE**?	How many of […] does your household **CURRENTLY OWN**?	How many of […] did your household **12 months ago?**
C22	**C23**	**C24**	**C25**
Dairy cattle			
Beef cattle			
Buffalo			
Goat/lamb			

The following table records the herd structure of managed and owned DAIRY CATTLE

Herd category		How many of […] does your household **CURRENTLY MANAGE**?	How many of […] does your household **CURRENTLY OWN**?	How many of […] did your household **OWN I 12 months ago?**	If you were to sell ONE of the animals for each category, how much money would you get for it?
C26		**C27**	**C28**	**C29**	**C30**
		Number	**Number**	**Number**	**[IDR]**
1	Milking cows [lactation]				
2	Dry cows				
3	Pregnant heifers				
4	Heifers				
5	Calves				
6	Culling cow				
7	Bulls (dairy)				

Note: if don't know or can't remember please write DK

Have you sold stock (dairy) in the last 12 months? 1=Yes; 0=No C31

If C31=1, how many stocks have you sold? [number] C32

If C31=1, what is your reasons sold your stocks? use codes for C33 C33

Codes for C33	
1 = for family party (e.g. wedding)	5 = for purchasing vehicle
2 = for children's education fee	6 = stocks are not productive anymore
3 = for renovating house	7 = others
4 = for medical fee	

*NOTE FOR 'C.ASSETS': If the respondent does not own or manage any land at all, please write a line vertically across all columns. It may be the case that the barn/cage is attached to the house and there is no land available for any other activity within the property.

D1. EXPERIENCE AND CAPITAL

Would you say the dairy business is for your household … Please use the codes below [ ] D1

Codes for **D1**
1=the main business activity
2= a secondary business
3= a third or fourth..

How many **years** in total have you been working in dairy business? [ ] D2

For the last 12 months what has been the **main** source of capital for your dairy cow business? Please use the codes below [ ] D3

Codes for D3
1=private (own/savings)
2=cash loan
3=partnership
4=government aid
5=heritage
6=cooperative input credit
7 = state owned bank (e.g. BPR)
8=other

If D3=2; what was the source of the loan? Please use the codes below
If D3=other than 2, skip to Q D6 [ ] D4

Credit sources codes for **D4**	
1=private commercial bank;	8=NGO
2= cooperative	9=employer
3=farmer's group	10=landlord/cow owners
4=government agency/bank	11=leasing
5=input supplier/SAPRODI	12=arisan
6=family member	13=pawn shop
7=money lender	14= buyer
	15= other

If D3=2; what is the interest rate of the loan? [ ] D5
Please use DK if you don't know or can't remember *[% per month]*

How much was the loan? (in IDR)		D5a
How long was the payment period? (in months)		D5b
How much was the monthly payment? (in IDR)		D5c
What was the interest rate of the loan? (in % per month)		D5d

D2 ACCESS TO CREDIT

Do you know of a place or person where you can go to borrow money? (1 = Yes, 0 = No) [ ] D6
If D6=0; Skip to Question E1

D7 From the following list of sources can you borrow money? Select from the following codes 1=Yes; 0=No; DK=Don't Know

1=private commercial bank;		9=employer	
2= cooperative		10=landlord/cows owner	
3=farmer's group		11=leasing	
4=government agency/bank		12=arisan	
5=input supplier/SAPRODI		13=pawn shop	
6=family member			
7=money lender			
8=NGO			

Have you ever borrowed money? [ ] D8
1 = yes, 0 = no

In the **past 12 months** have you tried to borrow money **except from** family/friend/neighbour? (1=Yes; 0=No) [ ] D9
IF F9=1, What was the purpose you borrow money? [ ] D10

Codes for D10	
1 = for dairy business	5 = for medical fee
2 = for family party (e.g. wed	6 = for purchasing vehicle
3 = for children's education f	7 = other
4 = for renovating house	

If D9=1; which source/s did you approach to lend you the money [ ] D11a
Select up to three sources from the codes in the D7 list above [ ] D11b [ ] D11c

If D9=1; Were you successful on the efforts of securing a loan? (1=Yes; 0=No) [ ] D12

If D12=0; Skip to Question D17
If D12=1; which source/s agreed to lend you the money [ ] D13a
Select up to three sources from the codes in the D7 list above [ ] D13b [ ] D13c

Was the amount of money borrowed that time enough for its main purpose? (1=Yes; 0=No) [ ] D14

What was the interest rate per month? (%/month) DK=don't know [ ] D15 [%/month]

What was the payback time? (months) [ ] D16 [months]

Do you currently hold a loan/credit? 1=Yes; 0=No [ ] D17

E1. FAMILY AND HIRE LABOUR

What is the main source of labour in your dairy business? **E1**

Codes for E1		
1=just myself	3=hired labour	5=collective action
2=my family and I	4= hired labor and I	0=other

Have you hired anyone to work in your dairy business in the last 12 months? (1=Yes;0=No) **E2**

If E2=1; How many people are you currently hiring? (number of people) **E3**

If E2=0; Skip to question E4

If you were to hire someone today to work at the dairy farm what would be the daily rate? (In IDR including meals) DK=Don't Know **E4**

What are the most common methods of payment when you hire someone to work in dairy farming? Select from the following codes: **E5**

Codes for E5		
1=only cash	3=cash and milk	0=other
2=cash and meals	4=cash, meals and milk	

In your local area, how easy is to find people to hire to work at your dairy farm? **E6**

Codes for E6		
1= easy	2=somewhat easy	3= difficult

Please complete the following details as per the labour allocation in hours per day**.** Think of the activities, how long does it take **every day** and how many hired workers (in case hired labour). If there is family and hired labour, please write both, don't know please write DK.

Daily Activities		Family labour (total working hours/day)			Hire Labour	
					Daily hours and # hired workers	
		Male	Female	*Children	Hours/day	# hired workers
E7		E8	E9	E10	E11	E12
1	Cut-and-carry grass					
2	Feeding					
3	Providing water					
4	Milking					
5	Washing barn/cage					
6	Washing cows					
7	Cleaning equipment					
8	Milk handling (filtering, packing)					
9	Milk delivery					

E3. EQUIPMENT USED OF DAIRY FARM PURPOSES			
E30		Do you own this equipment [...]? 1 = Yes, 0= No, If 0, skip to next question	How long have you been using [...] for? 1 = last 12 months ; 2 = last three years ; 3 = more than three years
		E31	E32
	Around animal house		
1	hand tractor		
2	cow barn		
3	warehouse		
4	a water pump		
5	spraying pump		
6	recording facilities		
7	floor insulation (rubber) for cage		
	Tools		
8	chaff cutter		
9	aluminium milking cans		
10	stainless steel milking buckets		
11	plastic buckets		
12	milking machinery		
13	drum Can		
14	litre measurement tool		
15	milk filter		
16	teat dipper		
17	scale		
18	brush		
19	broom		
20	mattock		
21	metal fork tool		
22	hose		
23	plastic boots		
	Milk processing		
24	milk processing tool (pasteurization, yoghurt, UHT)		

H. DISTANCE TO PLACES

What is the distance in minutes using the transport method that is most utilised to go from your dwelling to the nearest […] *If don't know, please write DK.*

Please indicate the approximate distance in kilometres IF KNOWN; if don't know please write=DK

	Location	Means	[Minutes]	[kilometres]
	H1	**H2**	**H3**	**H4**
1	…non-asphalted road			
2	…asphalt road			
3	…traditional market			
4	…urban centre			
5	…milk collection point			
6	…KUD/Dairy co-operatives			
7	…extension office			
8	…dairy inputs and supplies			
9	…milk processing centre?			
10	…potential raw milk buyer?			
11	…free grass to cut and carry?			
12	…neighbour dairy farmer?			
13	…dairy farmer leader?			
14	…big dairy farm >15 milking cows?			
15	… your agricultural plots? (If any)			
16	… Research centre for agricultural development (Balitbangtan)			
17	… Local livestock services offices (dinas peternakan)			
18	… House of Inseminator			
19	… Livestock clinic/veterinary doctor			
20	… Veterinary technician			
21	… Middlemen/buyer			

Codes H2

1. walking	3. Bicycle	5. owned car	7. minibus	9. other
2. horse	4. motorcycle	6. bus	8. truck	

I1. ADOPTION OF TECHNOLOGY AND MANAGEMENT PRACTICES

How do you manage your cows? (use code for I1) ____ I1

Codes for I1

1 = not offered shade 3=offered shade all day 5 = other _____

2= offered shade for part of the d 4=continously housed

How do you restrain your cows? (use code for I2) ____ I2

Codes for I2

1 = continously tied 2 = tied for part of day 3 = not tied

What method of heat detection do you use? (use codes for I3) ____ I3

Codes for I3

1 = visual 2= bull/teaser 3 = none

What method do you use for the induction of oestrus? (use codes for I4) ____ I4

Codes for I4

1 = One shot of prostaglandin
2 = Two shots of prostaglandin
3 = None
4 = Other _____

How often do the following reproductive problems [....] occur on your farm?	**I5** Use codes for I5	**Use codes for I5** 1 = never 2 = ocassionally 3 = often
Anoestrus animals		
Uterine infection		
Prolapse		
Dystocia		
Repeat breeder		
Mastitis		

I2. ADOPTION OF TECHNOLOGY AND MANAGEMENT PRACTICES

	New technologies, management practices and business models	Are you familiar with or have you heard of […]?	Have you ever used/done […]?	Have you used/done […] since 2014	Answer these questions ONLY if I7b=1									If I7b=0 ; I8=0 and I10=0	
					What year did you used/do [...] for the first time?	Are you still using/doing [...]?	Who introduced [...] for the first time to you or your farm?	What type of assistance or help have you received to adopt […]? IF I12=17 skip to I15	Is the person or organisation that introduced you to […] the same that provided support in I12?	If I13=0, Who provided this support?	What are the main two reasons you decided to adopt [...]?		If I10=0, What year did you stop doing […]?	What are the 2 main reasons you have not used/adopted or stopped using [...]?	
		1= Yes; 0= No>> skip to the next row	1= Yes; 0= No>> skip to question I17	1= Yes; 0= No	[e.g. 2013]	1=Yes; 0=No	**See codes below for I11 & I14**	See codes below for I12	0=No; 1=Yes>> skip to quesiton I15	**See codes below for I11 & I14**	**See codes below for I15**		[e.g. 2013]	**See codes below for I17**	
	I6	**I7a**	I7b	**I8**	**I9**	**I10**	**I11**	**I12**	**I13**	**I14**	**I15a**	**I15b**	**I16**	**I17a**	**I17b**
1	Artificial Insemination (AI)														
2	Mastitis test														
3	High protein concentrates (16% or higher)														
4	Feed legume forages (e.g. Leucaena)														
5	Use of high quality grasses														
6	Grow animal feed crops														
7	Use of fertiliser to grow grass														
8	Rubber/Plastic floor for the barn/cage														

Codes for I11 & I14	**Codes for I12**	**Codes for I15 'Reasons for adoption'**	**Codes for I17 'Reasons for not adopting'**
1 Dairy farmer	1 Training/Seminar/Workshop	1 To reduce costs of production	1 Lack of information about the new
2 Non-dairy farmer neighbour	2 Information (flyer, books, advice)	2 To reduce risks	2 Costs of adoption or implementation
3 Technical officer from KUD/KPS	3 Semen for AI	3 To increase milk yields	3 Too complicated to adopt
4 Milk Trader	4 Seeds	4 To earn higher profits	4 Excessive labour requirements
5 Government extension officer DINAS	5 Raw feeding materials	5 Increase quality of milk	5 I am satisfied with the current practice
6 BPTP	6 Mixers and feeding equipment	6 To reduce labour use	6 Milk yields lower than expected
7 Veterinary doctor	7 Filters	7 Saw neighbours adopting with good results	7 Benefits too far in the future
8 Village leader	8 Vaccines	8 To increase yield grass	8 Limited availability of inputs
9 University	9 Fertilisers	9 To improve health and wellbeing of the animals	9 Other farmers recommend stopping
10 Media (Newspaper, TV, radio)	10 Vitamins	10 To prepare better feed (hay, silage) for the dry season	10 Extension agent recommends stopping
11 Internet	11 Medicines	11 A new technology that becomes available	11 Other government officials recommend stopping
12 Inputs seller	12 Access to credit	12 To have access to new buyers	12 Lack of financial support or credit
13 NGO	13 Milk quality testing	13 To take advantage of promotions by chemical vendors	13 Lack of government support
14 Farmer's group	14 Mastitis tests	14 To benefit from assistance programs	14 Complaints from neighbours
15 Family member	15 Other inputs	15 Learned and implement after training	15 Price paid for the milk is too low
16 Self-observation	16 Equipment	16 Recommended by other farmers	16 Too much Risk involved
17 Other	17 Nothing	17 Recommended by extension agent	17 The existing practice is better
	18 Other	18 Recommended by a trader	18 Unsuitable for the local area conditions
		19 Recommended by other government officials	19 Other
		20 More practical	
		21 to be enviromentally friendly	
		22 to improve the breed	
		23 other	

I3. ADOPTION OF TECHNOLOGY AND MANAGEMENT PRACTICES

	New technologies, management practices and business models	Are you familiar with or have you heard of […]?	Have you ever used/done […]?	Have you used/done […] since 2014	Answer these questions ONLY if I7b=1									If I7b=0 ; I8=0 and I10=0	
					What year did you used/do […] for the first time?	Are you still using/doing […]?	Who introduced […] for the first time to you or your farm?	What type of assistance or help have you received to adopt […]? IF I12=17 skip to I15	Is the person or organisation that introduced you to […] the same that provided support in I12?	If I13=0, Who provided this support?	What are the main two reasons you decided to adopt […]?		If I10=0, What year did you stop doing […]?	What are the 2 main reasons you have not used/adopted or stopped using […]?	
		1= Yes; 0= No>> skip to the next row	1= Yes; 0= No>> skip to question I17	1= Yes; 0= No	[e.g. 2013]	1=Yes; 0=No	See codes below for I11 & I14	See codes below for I12	0=No; 1=Yes>> skip to quesiton I15	See codes below for I11 & I14	See codes below for I15		[e.g. 2013]	See codes below for I17	
	I6	**I7a**	I7b	**I8**	**I9**	**I10**	**I11**	**I12**	**I13**	**I14**	**I15a**	**I15b**	**I16**	**I17a**	**I17b**
9	Teat dipping after milking														
10	Improving drinking water availability 24/7														
11	Conserving forages for the dry seasons (hay, silage)														
12	Record keeping														
13	Using detergents for milking equipment														
14	Improved milking hygiene to reduce TPC														
15	Automatic milking machines														

Codes for I11 & I14	Codes for I12	Codes for I15 'Reasons for adoption'	Codes for I17 'Reasons for not adopting'
1 Dairy farmer	1 Training/Seminar/Workshop	1 To reduce costs of production	1 Lack of information about the new technology
2 Non-dairy farmer neighbour	2 Information (flyer, books, advice)	2 To reduce risks	2 Costs of adoption or implementation are too high
3 Technical officer from KUD/KPS	3 Semen for AI	3 To increase milk yields	3 Too complicated to adopt
4 Milk Trader	4 Seeds	4 To earn higher profits	4 Excessive labour requirements
5 Government extension officer DINAS	5 Raw feeding materials	5 Increase quality of milk	5 I am satisfied with the current practice
6 BPTP	6 Mixers and feeding equipment	6 To reduce labour use	6 Milk yields lower than expected
7 Veterinary doctor	7 Filters	7 Saw neighbours adopting with good results	7 Benefits too far in the future
8 Village leader	8 Vaccines	8 To increase yield grass	8 Limited availability of inputs
9 University	9 Fertilisers	9 To improve health and wellbeing of the animals	9 Other farmers recommend stopping
10 Media (Newspaper, TV, radio)	10 Vitamins	10 To prepare better feed (hay, silage) for the dry season	10 Extension agent recommends stopping
11 Internet	11 Medicines	11 A new technology that becomes available	11 Other government officials recommend stopping
12 Inputs seller	12 Access to credit	12 To have access to new buyers	12 Lack of financial support or credit
13 NGO	13 Milk quality testing	13 To take advantage of promotions by chemical vendors	13 Lack of government support
14 Farmer's group	14 Mastitis tests	14 To benefit from assistance programs	14 Complaints from neighbours
15 Family member	15 Other inputs	15 Learned and implement after training	15 Price paid for the milk is too low
16 Self-observation	16 Equipment	16 Recommended by other farmers	16 Too much Risk involved
17 Other	17 Nothing	17 Recommended by extension agent	17 The existing practice is better
	18 Other	18 Recommended by a trader	18 Unsuitable for the local area conditions
		19 Recommended by other government officials	19 Other
		20 More practical	
		21 to be enviromentally friendly	
		22 to improve the breed	
		23 other	

I4. ADOPTION OF TECHNOLOGY AND MANAGEMENT PRACTICES

	New technologies, management practices and business models	Are you familiar with or have you heard of […]?	Have you ever used/done […]?	Have you used/done […] since 2014	Answer these questions ONLY if I7b=1								If I7b=0 ; I8=0 and I10=0	
					What year did you used/do […] for the first time?	Are you still using/doing […]?	Who introduced […] for the first time to you or your farm?	What type of assistance or help have you received to adopt […]? IF I12=17 skip to I15	Is the person or organisation that introduced you to […] the same that provided support in I12?	If I13=0, Who provided this support?	What are the main two reasons you decided to adopt […]?		If I10=0, What year did you stop doing […]?	What are the 2 main reasons you have not used/adopted or stopped using […]?	
		1= Yes; 0= No>> skip to the next row	1= Yes; 0= No>> skip to question I17	1= Yes; 0= No	[e.g. 2013]	1=Yes; 0=No	See codes below for I11 & I14	See codes below for I12	0=No; 1=Yes>> skip to quesiton I15	See codes below for I11 & I14	See codes below for I15		[e.g. 2013]	See codes below for I17	
	I6	**I7a**	I7b	**I8**	**I9**	**I10**	**I11**	**I12**	**I13**	**I14**	**I15a**	**I15b**	**I16**	**I17a**	**I17b**
16	Nutrient feed blocks														
17	Cooling milk in water tanks														
18	Stainless steel milking equipment														
19	Biogas units														
20	Milk pasteurisation														
21	Milk processing (make yogurt)														

Codes for I11 & I14	Codes for I12	Codes for I15 'Reasons for adoption'	Codes for I17 'Reasons for not adopting'
1 Dairy farmer	1 Training/Seminar/Workshop	1 To reduce costs of production	1 Lack of information about the new technology
2 Non-dairy farmer neighbour	2 Information (flyer, books, advice)	2 To reduce risks	2 Costs of adoption or implementation are too high
3 Technical officer from KUD/KPS	3 Semen for AI	3 To increase milk yields	3 Too complicated to adopt
4 Milk Trader	4 Seeds	4 To earn higher profits	4 Excessive labour requirements
5 Government extension officer DINA	5 Raw feeding materials	5 Increase quality of milk	5 I am satisfied with the current practice
6 BPTP	6 Mixers and feeding equipment	6 To reduce labour use	6 Milk yields lower than expected
7 Veterinary doctor	7 Filters	7 Saw neighbours adopting with good results	7 Benefits too far in the future
8 Village leader	8 Vaccines	8 To increase yield grass	8 Limited availability of inputs
9 University	9 Fertilisers	9 To improve health and wellbeing of the animals	9 Other farmers recommend stopping
10 Media (Newspaper, TV, radio)	10 Vitamins	10 To prepare better feed (hay, silage) for the dry season	10 Extension agent recommends stopping
11 Internet	11 Medicines	11 A new technology that becomes available	11 Other government officials recommend stopping
12 Inputs seller	12 Access to credit	12 To have access to new buyers	12 Lack of financial support or credit
13 NGO	13 Milk quality testing	13 To take advantage of promotions by chemical vendors	13 Lack of government support
14 Farmer's group	14 Mastitis tests	14 To benefit from assistance programs	14 Complaints from neighbours
15 Family member	15 Other inputs	15 Learned and implement after training	15 Price paid for the milk is too low
16 Self-observation	16 Equipment	16 Recommended by other farmers	16 Too much Risk involved
17 Other	17 Nothing	17 Recommended by extension agent	17 The existing practice is better
	18 Other	18 Recommended by a trader	18 Unsuitable for the local area conditions
		19 Recommended by other government officials	19 Other
		20 More practical	
		21 to be enviromentally friendly	
		22 to improve the breed	
		23 other	

I5. ADOPTION OF TECHNOLOGY AND MANAGEMENT PRACTICES

New technologies, management practices and business models		Are you familiar with or have you heard of […]?	Have you ever used/done […] since 2014	Have you used/done […] since 2014	Answer these questions ONLY if I7b=1								If I7b=0 ; I8=0 and I10=0	
					What year did you used/do [...] for the first time?	Are you still using/doing [...]?	Who introduced [...] for the first time to you or your farm?	What type of assistance or help have you received to adopt […]? IF I12=17 skip to I15	Is the person or organisation that introduced you to […] the same that provided support in I12?	If I13=0, Who provided this support?	What are the main two reasons you decided to adopt [...]?		If I10=0, What year did you stop doing […]?	What are the 2 main reasons you have not used/adopted or stopped using [...]?	
		1= Yes; 0= No>> skip to the next row	1= Yes; 0= No>> skip to question	1= Yes; 0= No	[e.g. 2013]	1=Yes; 0=No	See codes below for I11 & I14	See codes below for I12	0=No; 1=Yes>> skip to quesiton I15	See codes below for I11 & I14	See codes below for I15		[e.g. 2013]	See codes below for I17	
	I6	I7a	I7b	I8	I9	I10	I11	I12	I13	I14	I15a	I15b	I16	I17a	I17b
22	Milk quality test														
23	UHT (Ultra High Temperature)														
24	Breeding plan applied														
25	Synchronization estrus														
26	Manure processing / manure re-use														

Codes for I11 & I14	Codes for I12	Codes for I15 'Reasons for adoption'	Codes for I17 'Reasons for not adopting'
1 Dairy farmer	1 Training/Seminar/Workshop	1 To reduce costs of production	1 Lack of information about the new technology
2 Non-dairy farmer neighbour	2 Information (flyer, books, advice)	2 To reduce risks	2 Costs of adoption or implementation are too high
3 Technical officer from KUD/KPS	3 Semen for AI	3 To increase milk yields	3 Too complicated to adopt
4 Milk Trader	4 Seeds	4 To earn higher profits	4 Excessive labour requirements
5 Government extension officer DINAS	5 Raw feeding materials	5 Increase quality of milk	5 I am satisfied with the current practice
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7 Veterinary doctor	7 Filters	7 Saw neighbours adopting with good results	7 Benefits too far in the future
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10 Media (Newspaper, TV, radio)	10 Vitamins	10 To prepare better feed (hay, silage) for the dry season	10 Extension agent recommends stopping
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14 Farmer's group	14 Mastitis tests	14 To benefit from assistance programs	14 Complaints from neighbours
15 Family member	15 Other inputs	15 Learned and implement after training	15 Price paid for the milk is too low
16 Self-observation	16 Equipment	16 Recommended by other farmers	16 Too much Risk involved
17 Other	17 Nothing	17 Recommended by extension agent	17 The existing practice is better
	18 Other	18 Recommended by a trader	18 Unsuitable for the local area conditions
		19 Recommended by other government officials	19 Other
		20 More practical	
		21 to be enviromentally friendly	
		22 to improve the breed	
		23 other	

J. INFORMATION SOURCES

	Type of information	In the last 12 months, have you received information about [...] 1= Yes, 0=No. if Yes continue next question, if No skip to next row	In the last 12 months, what have been your main sources of information about [...]? (ask for up to 2 sources) If J3a or J3b=22 skip to the next row; see codes for **J3**		If sources=[1 to 15] in average, what has been the total number of visits or contact in the last 12 months? If sources [16 to 21] N/A, continue to next row		[For these 2 sources] How would you rate the quality of the information? 1=useful; 2= somewhat useful; 3 =poor	
			1st	2nd	visits in the last 12 months		1st	2nd
	J1	**J2**	**J3a**	**J3b**	**J4a**	**J4b**	**J5a**	**J5b**
1	Dairy cow nutrition							
2	Reproduction and AI							
3	Milk sales (buyers, prices)							
4	Increase milk quality							
5	Increase milk yields							
6	Forage and grasses							
7	Cow's health							
8	Applied of breeding plan/progeny testing							
9	Rearing heifer for replacement cow							
10	Provision of new credit							
11	Information on new technology							
12	New management practices							
13	Concentrates							
14	Access to new markets							
15	Government programs							
16	Knowledge sharing							
17	Value adding of milk							
18	Feed supplements							
19	Mastitis test							

Codes for J3a, J3b

1. Balitbangtan	12. Inputs seller
2. DINAS	13. farmers' field school
3. Government extension officer	14.Friend
4. University	15. NGO
5. Veterinary doctor	16.TV
6. Technical officer from the KUD	17. Radio
7. Non-dairy farmer neighbour	18. Newspaper
8.Dairy farmer	19. Internet
9. Farmer group	20. flyer & brochure
10. Trader	21. books and magazines
11. Processor	22. None

K. MEMBERSHIP

Membership groups		Have you ever been a member of [...]? (1=Yes, 0 =No)	Have you or any of the household members ever joined […] since 2014?	From the household members (including yourself) who is **currently** a member of […]?	**IF K3 other than=8;** Do you/ your household members attend the regular meetings of […]? **IF K3=8 skip to the next row**	**Has this group provided with support in any of the follow fields?** **1=Yes, utilised ; 2 = Yes, not utilised, 3 = Tidak , 4 = DK**																			**How satisfied are you / your family members with […]?**	**Do you receive dividends from […]?**
			1=Yes; 0=No, If Yes continue next question, if No skip to next row	select from the codes **above for K3**	1=Yes always; 2 = Yes, often, 3=Yes sometimes; 4=never	Dairy cow nutrition	Reproduction and AI	Milk sales (buyers, prices)	Increase milk quality	Increase milk yields	Forages and grasses	Cow's health	Applied of breeding plan/progeny testing	Rearing heifer for replacement cow	provision of credit	information on new technologies	new management practices	concentrates	access to new markets	government programs	knowledge sharing	value adding of milk	feed supplements	mastitis tests	1.Satisfied Satisfied 3.Not Satisfied	1=Yes; 0=No
K1		K2a	**K2b**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**	**K15**	**K16**	**K17**	**K18**	**K19**	**K20**	**K21**	**K22**	**K23**	**K24**	**K25**
1	KUD/Dairy Co-operatives																								
2	Farmer's group																								
3	Women association																								
4	Farmer's field school																								
5	Colony farming																								
6	Science technopark																								
7	Other (specify)																								

Codes for question K3

1=head of household	6=in-laws
2=spouse	7=other relatives
3=joint (household head and spouse)	8=nobody
4=father head of household	9=other
5=mother head of household	

N. CASH INCOME ACTIVITIES

	Income Activities	Have members of your household been involved in [activity] at ...?		If N2=YES, ask questions N4-N7 if not draw a horizontal line across							If N2=1 & N3=1
				In the last 12 months who in the household was mainly responsible for this activity?	In the last 12 months how many [units] did the household member receive income from [...]?		For each of these income activities that your household was involved in, please answer the following				
							How much gross revenue did the household member make from this activity?		How much does your household spend in BUSINESS expenses related to this activity?		Has [income source] become less important or more important as a percentage of total income since 2014?
		2017	2014	1. Head 2. Spouse of head 3. Both 4. Other	Number	**Units** 1. days 2.weeks 3. months 4. year 5. tasks 6.harvests	[IDR]	**[IDR] Units** [IDR]1. days [IDR]2.weeks [IDR]3. months [IDR]4. year [IDR]5. tasks [IDR]6.harvests	[IDR]	**[IDR] Units** [IDR]1. days [IDR]2.weeks [IDR]3. months [IDR]4. year [IDR]5. tasks [IDR]6.harvests	1. More 2. Same 3. Less
	N1	**N2**	**N3**	**N4**	**N5**	**N5u**	**N6**	**N6u**	**N7**	**N7u**	**N8**
1	Agricultural wage employment										
2	Non-agricultural wage employment										
3	Pension										
4	Remittances from family members										
5	Milk sales										
6	Milk processing business										
7	Horticultural products sales										
8	Crop farming										
9	Live dairy cattle sales										
10	Agricultural trading										
11	Aquaculture										
12	Other livestock products										
13	Non-agricultural trading										
14	Non-agricultural self employment										
15	other non-labour sources of income										
16	Expertise fee (veterinarian, insemination)										

R. ABBREVIATED-WOMEN'S EMPOWERMENT ON AGRICULTURE INDEX (A-WEAI)

At this stage, I would like to interview the (1) **primary*** and (2) **secondary* decision-makers SEPARATELY. (See notes below)**
One should be male and the other female *(Place 88888 if not applicable, meaning there is no appropriate secondary decision-maker).*

D.P. PRIMARY/SECONDARY:_____
(Refer to A1).

1. Role in Household Decision-making around Production and Income Generation [checkbox]

Now, I would like to ask you some questions about your participation in certain types of work activities and on making decisions on various aspects of household life.	Did you yourself participate in [ACTIVITY] **in the past 12 months** ?	When decisions are made regarding [ACTIVITY], who is it that normally makes the decision? [Tick all that applies] ***If response is SELF***	How much input did you have in making decisions about [ACTIVITY]?	To what extent do you feel you can make your own personal decisions regarding [ACTIVITY] if you want(ed) to? Select one.	How much input did you have in decisions on the **use of income generated from** [ACTIVITY]?
Activity description	0. no ***(go to the next activity)*** 1. yes	1. self 2. spouse 3. other HH member 4. other non-HH member	1. input in few decisions 2. input into some 3. input into most or all decisions	1. not at all 2. small extent 3. medium extent 4. to a high extent	1. input in few decisions 2. input into some 3. input into most or all decisions
	R1	R2	R3	R4	R5
A. Food crop farming: These are crops that are grown primarily for household food consumption.					
B. Cash crop farming: These are crops that are grown for sale in the market.					
C. livestock raising (cattle, buffalo, horse, etc.)					
D. Dairy Production scale (population) : selling and buying cows Kinds and quantity of forages Kinds and quantity of concentrates Herd health Milk marketing					

Provide this note at the beginning of this section
The primary and secondary member are usually the husband and wife; however, they can also be another member as long as there is **one male and one female aged 18 years old and over**
In general, the primary decision-maker is also the head of the household but this may not always be the case (i.e. elderly parent living with adult son/daughter and the adult son/daughter may be

It may also be the case that there is only a primary female respondent and there is no adult male present in the household. In cases whereby the primary male adult is absent from the house due

2. Access to Productive Capital [checkbox]

Now, I would like to ask you about your household's assets to and ownership of a number of items that could be used to generate income.	Does anyone in your household currently have any [item]?	Do you own any of the item? Choose all applicable.
Productive capital	0. no ***(go to the next item)*** 1. yes	0. no 1. yes, solely 2. yes, jointly
	R6	R7
A. Agricultural land (pieces/plots)		
B. Large livestock (cattle, buffalo, horse, etc.)		
C. Small livestock (goats, pigs, etc.)		
D. Chickens, ducks, turkeys, pigeons		
E. Fish pond or fishing equipment		
F. Farm equipment (non-mechanized; hand tools, animal-drawn plough,		
G. Farm equipment (mechanized: tractor-plough, power tiller, treadle		
H. Nonfarm business equipment		
I. House or other structures		
J. Large consumer durables (refrigerator, TV, sofa, etc.)		
K. Small consumer durables (radio, cookware, etc.)		
L. Mobile phones		
M. Other land not used for agricultural purposes (pieces/plots, residential		
N. Means of transportation (bicycle, motorcycle, car, etc.)		

R. ABBREVIATED-WOMEN'S EMPOWERMENT ON AGRICULTURE INDEX (A-WEAI) (cont.)

3. Access to Credit

Next, I would like to ask about your household's experience with borrowing money or other items in the past 12 months.	Has anyone in your household taken any loans or borrowed cash/in-kind from [SOURCE] in the past 12 months?	Form(s) of loan	Who makes the decision to borrow from [SOURCE] most of the time? [Choose all that applies]	Who makes the decision about what to do with the money/item borrowed from [SOURCE] most of the time? [Choose all that applies]
Lending source	0. no ***(go to the next*** 1. yes	1. cash 2. in-kind 3. cash and in-kind	1. self 2. spouse 3. other HH member 4. other non-HH member	1. self 2. spouse 3. other HH member 4. other non-HH member
	R8	R9	R10	R11
A Dairy cooperative				
B Formal lender (bank/financial institution)				
C Informal lender (private moneylenders and traders and friends charging				
D Friends/relatives (charging zero interest)				
E Union (Farmers'/Women's Union, People's Credit Funds)				
F Informal savings and credit groups (SCGs)				
G.NGO				

4. Group Membership

Now I am going to ask you about groups in the community. These can be either formal or informal and customary groups.	Is there a [GROUP] in your community (village/commune)?	Are you an active member of this
Group	0. no ***(go to next group)*** 1. yes 999 don't know	0. no 1. yes
	R12	R13
A Agricultural/Livestock/Fisheries producer's group (including marketing group)		
B Youth Union		
C Forest user's group		
D Credit or microfinance group, insurance group		
E Trade and business association group		
F Civic groups (improving community) or charitable group		
G Religious group		
H Women's Union		
I Other (specify)		

Appendix 5. Sampling technique for IndoGreen survey

The survey was located in upper Citarum, the biggest watershed in West Java. This upper watershed was mostly located in mountainous areas and the majority of the study site was used for agriculture and forestry. The survey applied a multistage stratified random sampling procedure and interviewed 500 couples. There were several stages in selecting the samples.

The first stage was district selection. Upper Citarum Watershed covers five districts: Bandung, West Bandung, Sumedang, Bandung City, and Cimahi City. Bandung and West Bandung were selected purposely because 65% of the Watershed lies within these two districts.

West Bandung and Bandung are predominantly Muslim, with approximately 98% of the population in each district following that faith. The predominant ethnicity in the region is Sundanese. The fertility rate in West Bandung is 2.2, and in Bandung is 2.1, which is relatively similar to the average for West Java (2.1) and Indonesia (2.2). West Bandung and Bandung had the lowest proportion (around 15%) of female-headed households compared to other rural areas in West Java (West Java Population and Civil Registration Agency (PCRA), 2019). Women in West Bandung and Bandung have important roles in the family economy as the percentage of women's contribution to total family income (about 33% on average) is above the average of women's contribution percentage in West Java (29.9%) (West Java Open Data, 2019). This setting is typical of rural Indonesia and provides a good case study to explore gender issues in Indonesia.

The second stage was subdistrict selection. Within the two districts that were selected, there are eight sub-watersheds. Two sub-watersheds are located in urban areas (Cikapundung and Cikeruh) and six sub-watersheds are located in rural areas (Citarik, Cirasea, Cisangkuy, Ciminyak, Cihaur, and Ciwidey). Since this project aims for

agricultural conservation, the sub-watersheds that are located in the urban area were not included due to the lack of farming activities related to those two areas.

Administratively, the Upper Citarum Watershed which covers urban and rural Bandung and West Bandung District lies in 27 sub-districts with 224 villages (for Bandung District) and 14 sub-districts with 140 villages (for West Bandung District). However, after the urban areas were excluded, there are only 221 villages in Bandung District and 103 villages in West Bandung Districts that were included.

The third stage was village selection. To fit the research objectives related to conservation practices in relatively steep areas, within each sub-district, villages that have less than 15-degree slope were dropped. Using a topography map, there are 142 villages in Bandung District and 76 villages in West Bandung District that fits the criteria. Within the villages that fit the criteria, 10 % were randomly selected, thus there were 22 villages chosen as the location of this research. The last stage was sample selection, in which 20 households were randomly selected from each village. The head of the household (husband) and the partner (wife) were both interviewed separately.

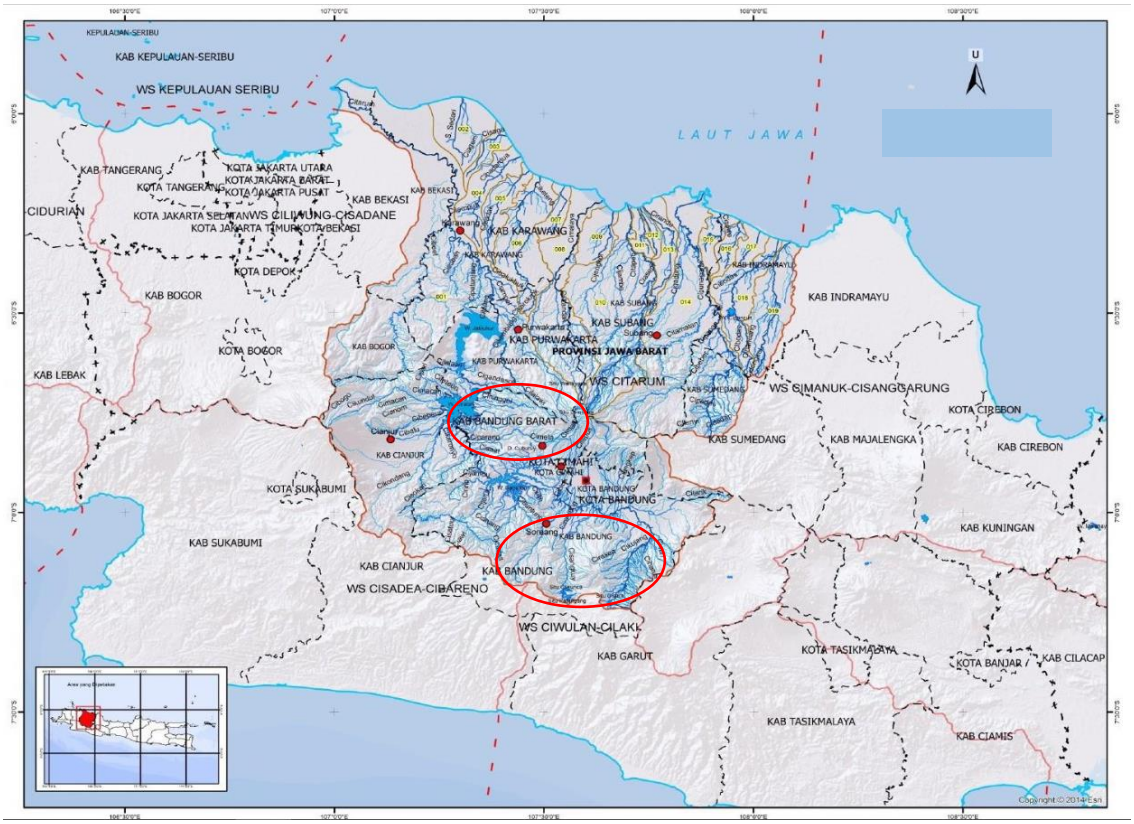

Figure A5-1 Study location sketch.

Appendix 6. Sampling technique for IndoDairy survey

The survey was located in Java due to its high concentration of dairy cattle production and dairy milk production. The survey applied purposive proportional random sampling and interviewed 600 smallholder dairy farmers. Based on the IndoDairy summary report KUD visits (Ritchie et al. 2016), there were several stages in selecting the samples.

The first stage was the selection of West Java province. This province was purposively selected because the majority of smallholder farmers in Indonesia are located in dairy-producing districts in West Java Province, with close proximity to urban areas such as Jakarta, Bandung, and Bogor where the demand for dairy products is considerably high. The majority of smallholder dairy farmers in Indonesia (especially, Java) are members of dairy cooperatives. Thus the second stage was to select the dairy cooperatives. Five dairy cooperatives in four dairy-producing districts in West Java (including Bandung, Garut, Cianjur, and Bogor) were identified and purposively selected following the criteria developed by the project such as willingness to share information and to participate in project extension programs. The number of samples from each coop was determined by following the relative proportion of the total dairy farm population within each district. Finally, the samples were randomly selected from each dairy coop.

Appendix 7. Appendices for Chapter 2: Social norms and perceptions drive women's participation in agricultural decisions in West Java, Indonesia

Table A7-1. PCA first component weights for women and men

Category of activities		Type of decision	PCA first component weights for women[1]	PCA first component weights for men[2]
Production	1	What crops to grow	0.22	0.19
	2	When and how to do land preparation and planting	0.24	0.22
	3	When and how to apply agrochemicals (fertiliser, pesticides, fungicide, growth hormones, etc.)	0.23	0.22
	4	When and how to tend the crops (e.g. weeding, watering, pruning, non-synthetic fertilizer, etc.)	0.20	0.21
	5	When and how to harvest the crops	0.24	0.24
	6	Buying farm equipment/machinery (tractor, harvester)	0.22	0.21
	7	Buying yield increasing farm input (seed, fertiliser, pesticide, hormones, etc.)	0.25	0.25
Conservation Practices	8	Building and maintenance of soil and water conservation structures (e.g. build terraces, safe waterways, etc.)	0.23	0.23
	9	Implementation of soil/water conservation practices (e.g. agroforestry, cover crop, mulching, etc)	0.23	0.21
	10	Planting amenity or natural plants for biodiversity in the farm or home garden	0.19	0.21
	11	Safety and practices in spraying of pesticides/herbicides	0.22	0.19
Processing and Marketing	12	Processing (drying, fermenting, packing, etc.)	0.23	0.22
	13	Whom to sell	0.23	0.24
	14	Marketing arrangement (where and when)	0.23	0.25
	15	Negotiating with buyer/trader (price negotiation)	0.23	0.25
	16	What variety to select	0.24	0.25
Training	17	Attending agriculture training or extension activities: soil and water conservation	0.21	0.22
	18	Attending other agriculture training or extension activities (field school, pest management, new varieties, etc.)	0.22	0.22
Credit	19	Request credit for agricultural investment	0.17	0.18
Buying and Selling Assets	20	Land purchasing and selling	0.15	0.16
	21	Livestock purchasing and selling	0.17	0.17

[1)] The first component explains 45 % of the variation in the data
[2)] The first component explains 39 % of the variation in the data

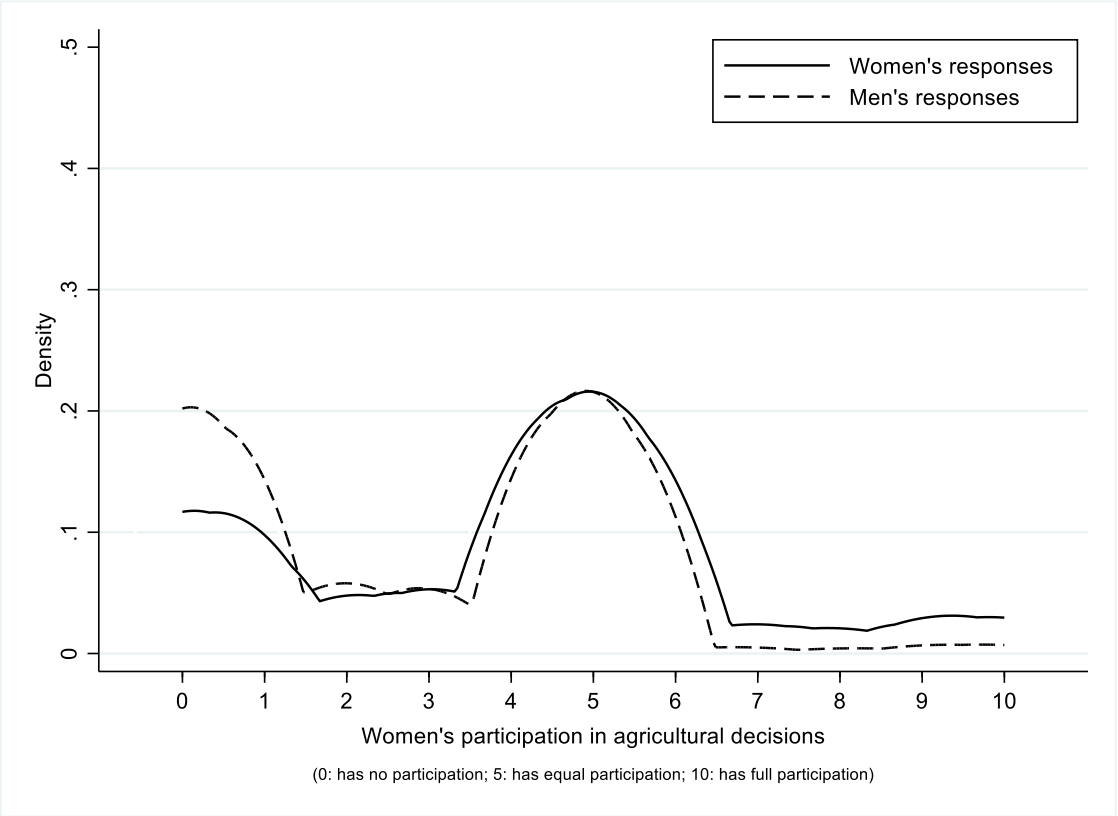

Figure A7-1. Kernel density for women's and men's perception to women's participation in deciding what crops to grow

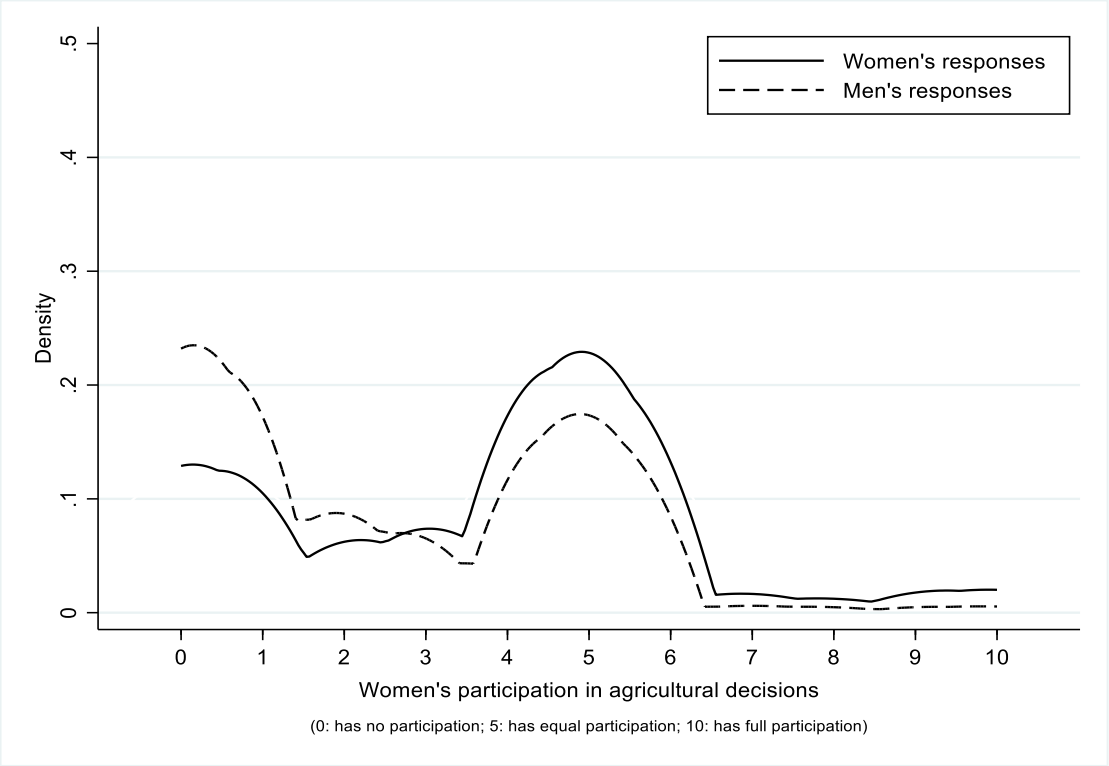

Figure A7-2. Kernel density for women's and men's perception to women's participation in deciding when and how to do land preparation and planting

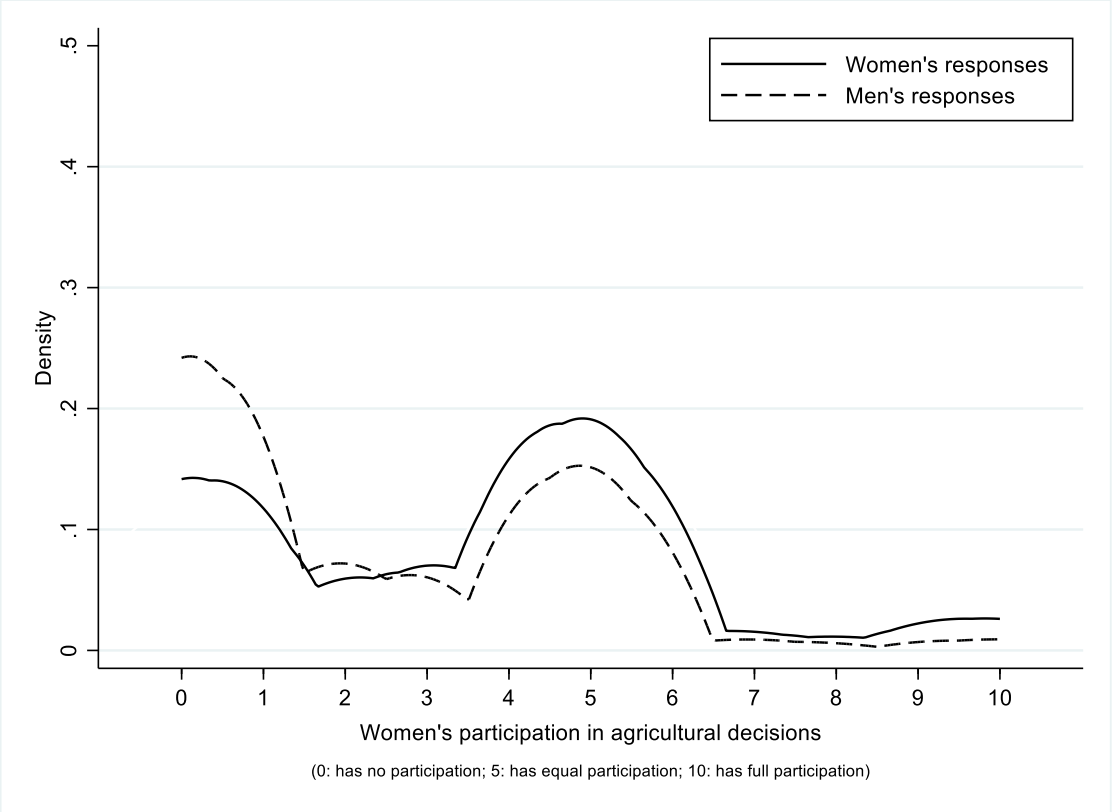

Figure A7-3. Kernel density for women's and men's perception to women's participation in deciding when and how to apply agrochemicals

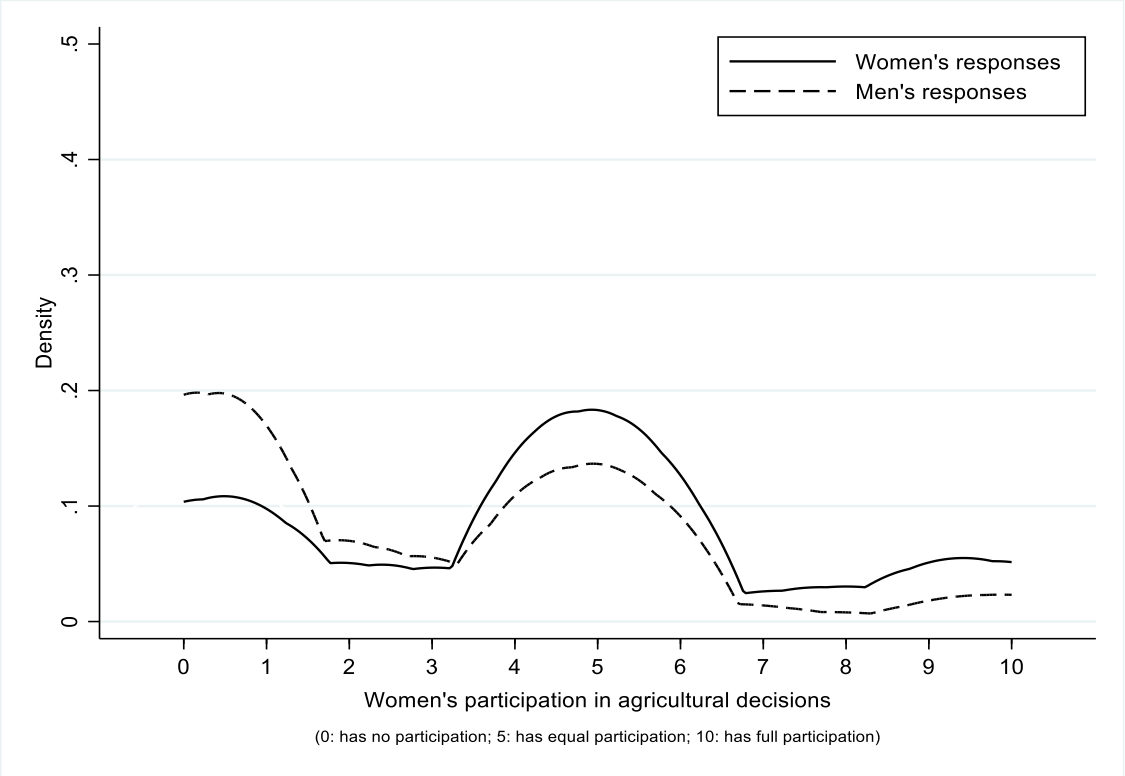

Figure A7-4. Kernel density for women's and men's perception to women's participation in deciding when and how to tend the crops

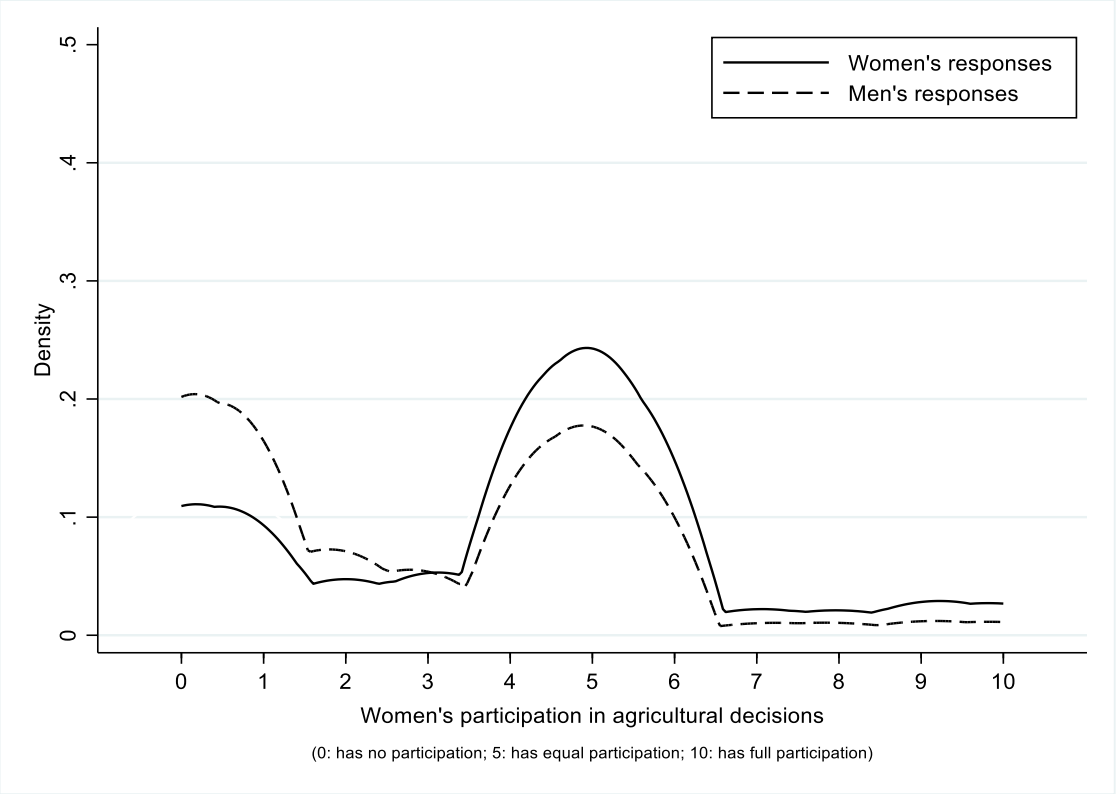

Figure A7-5. Kernel density for women's and men's perception to women's participation in deciding when and how to harvest the crops

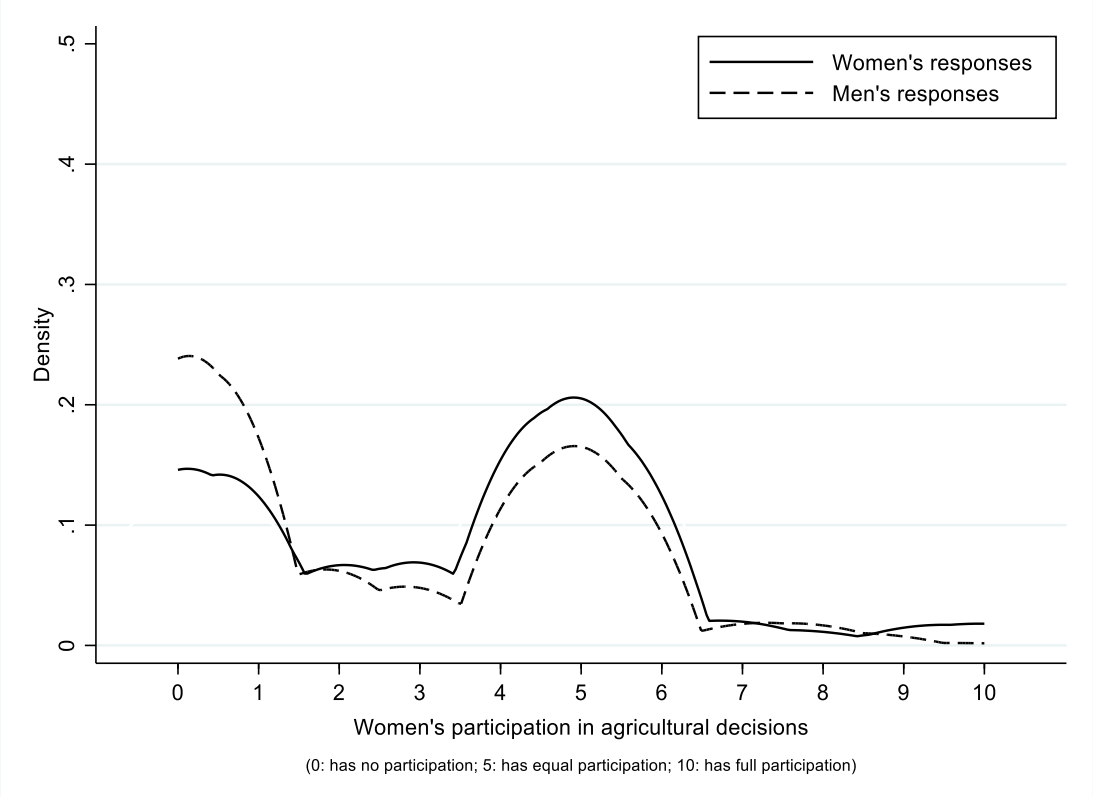

Figure A7-6. Kernel density for women's and men's perception to women's participation in deciding buying farm equipment/machinery

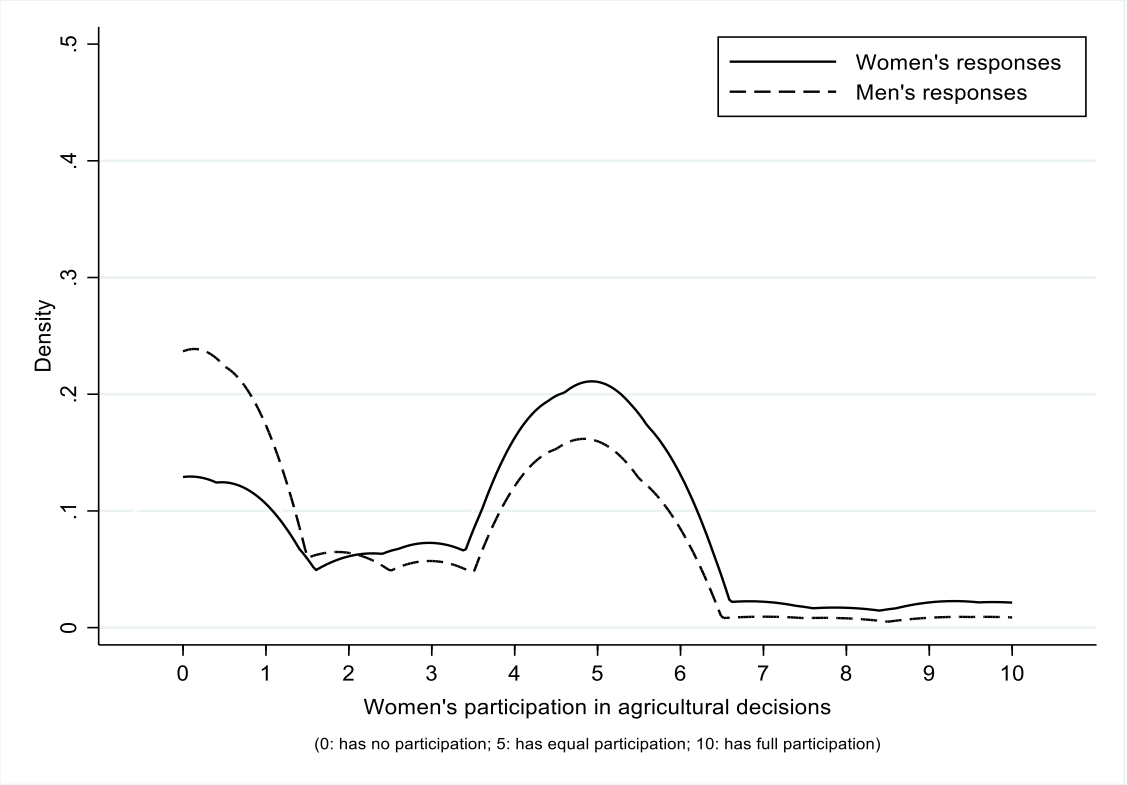

Figure A7-7. Kernel density for women's and men's perception to women's participation in deciding buying yield increasing farm input

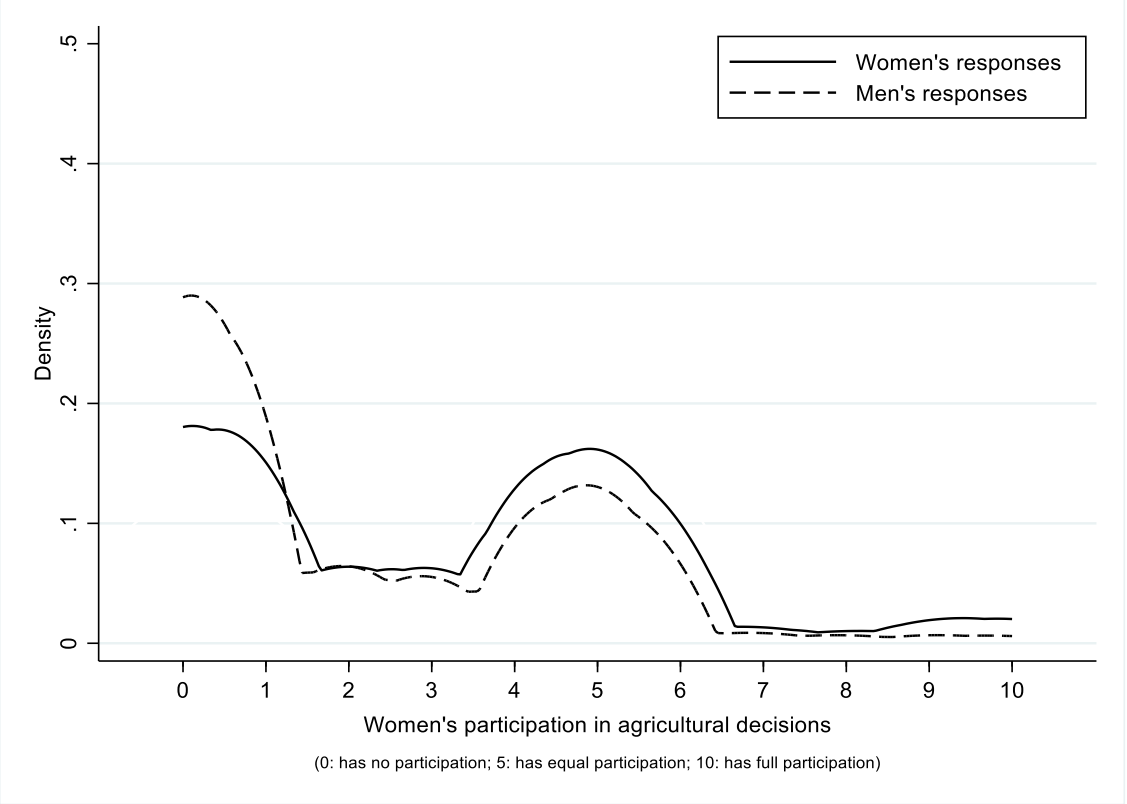

Figure A7-8. Kernel density for women's and men's perception to women's participation in deciding building and maintenance of soil and water conservation structures

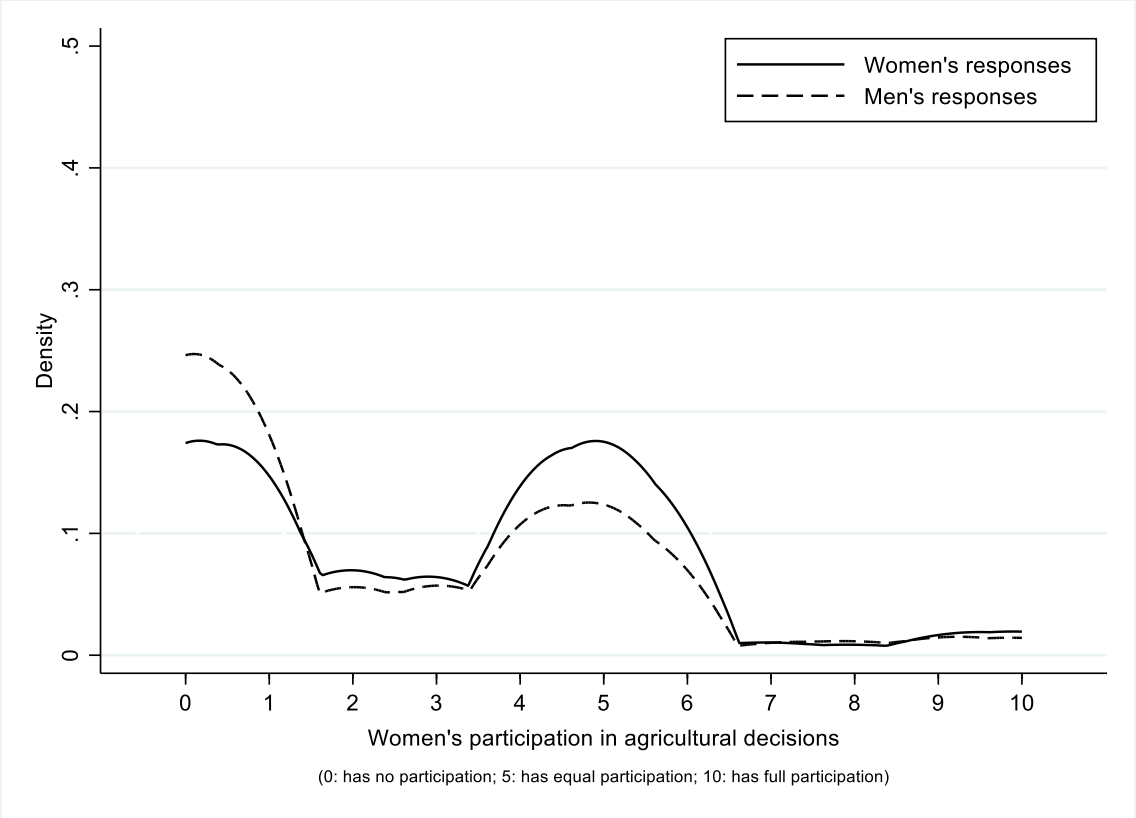

Figure A7-9. Kernel density for women's and men's perception to women's participation in deciding implementation of soil/water conservation practices

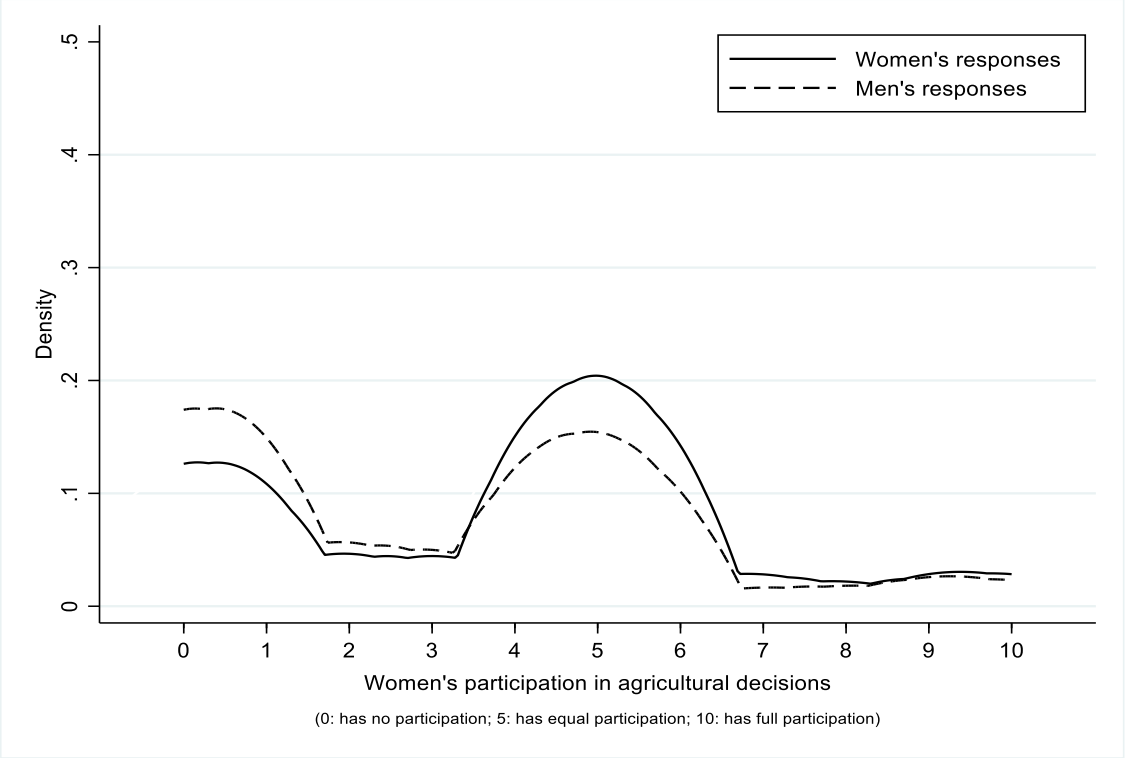

Figure A7-10. Kernel density for women's and men's perception to women's participation in deciding planting amenity or natural plants for biodiversity in the farm or home garden

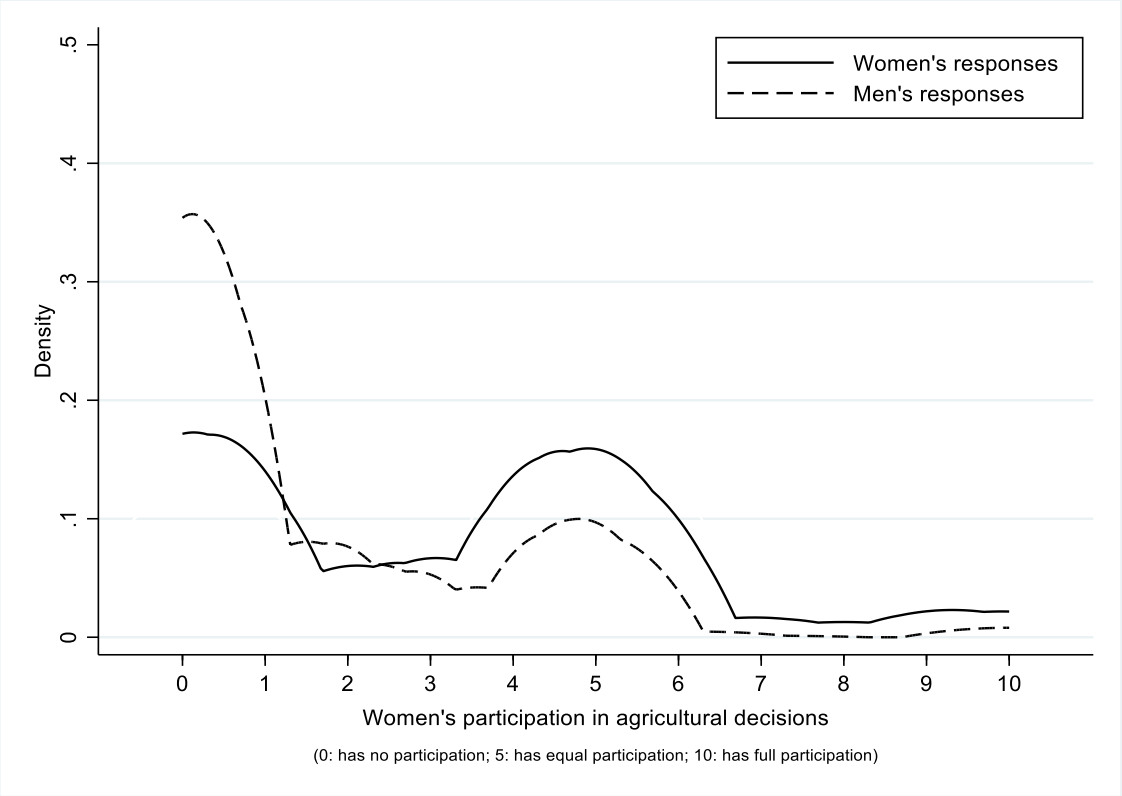

Figure A7-11. Kernel density for women's and men's perception to women's participation in deciding safety and practices in spraying of pesticides/herbicides

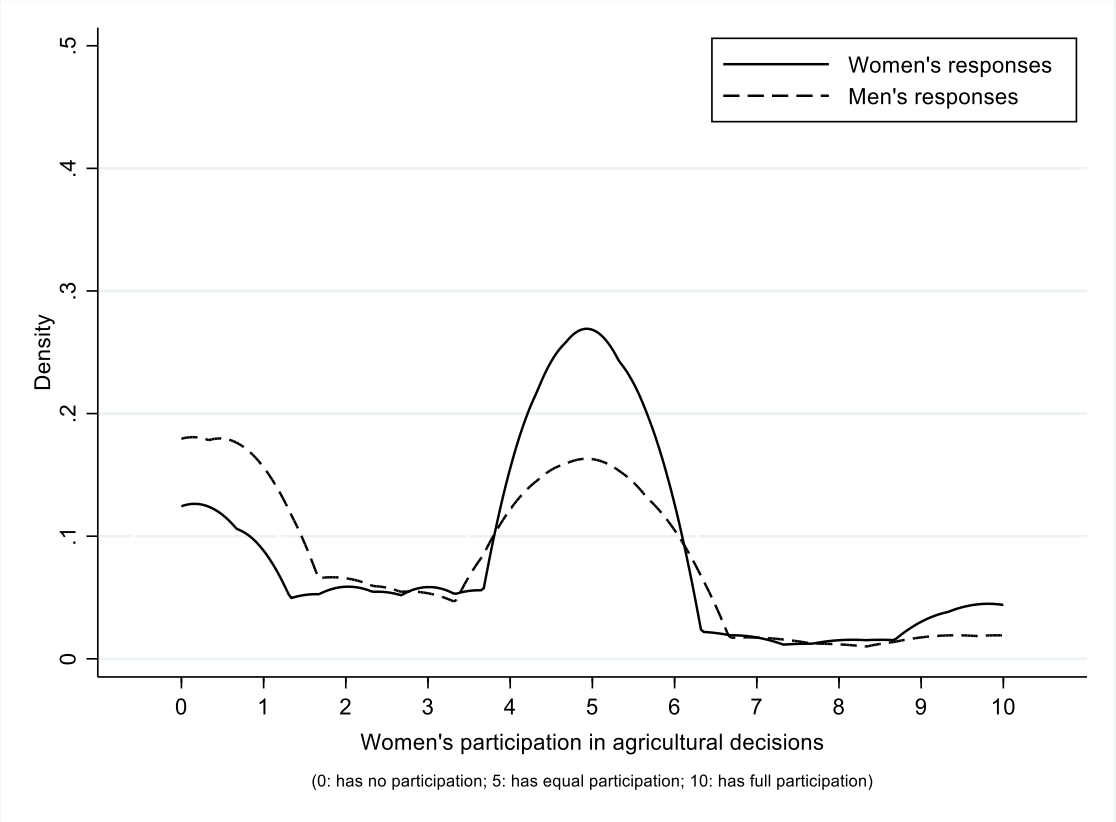

Figure A7-12. Kernel density for women's and men's perception to women's participation in deciding processing (drying, fermenting, packing, etc.)

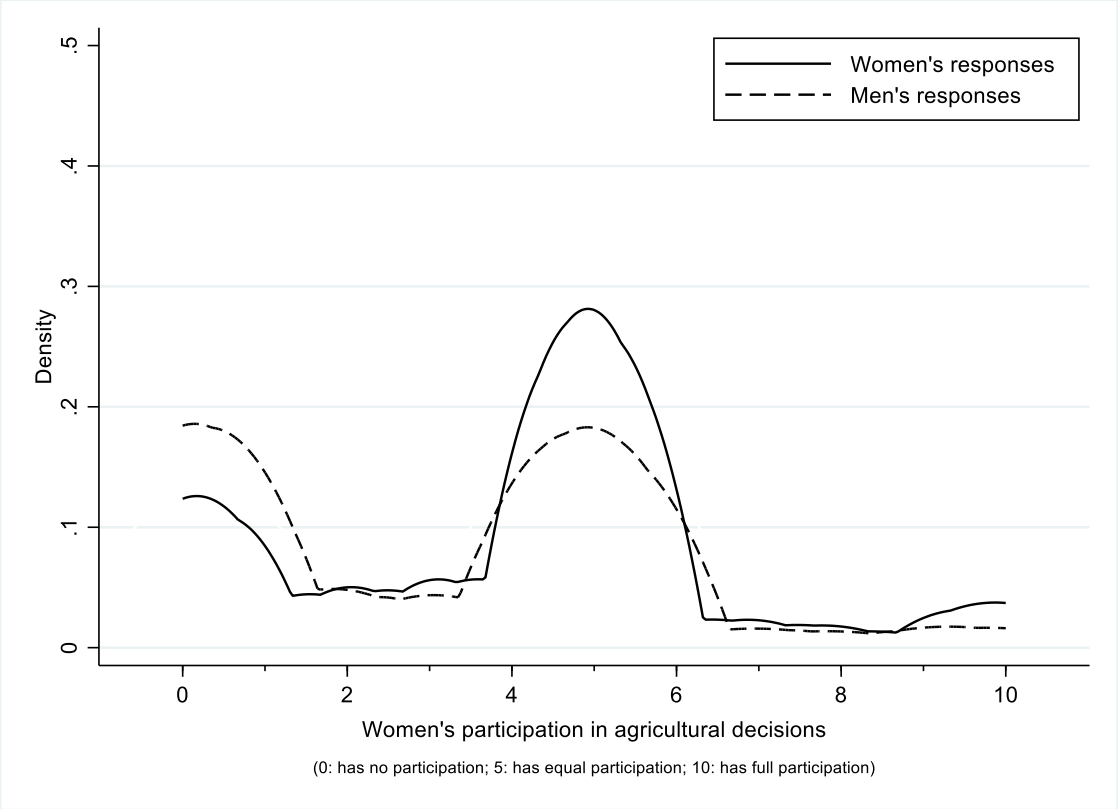

Figure A7-13. Kernel density for women's and men's perception to women's participation in deciding whom to sell

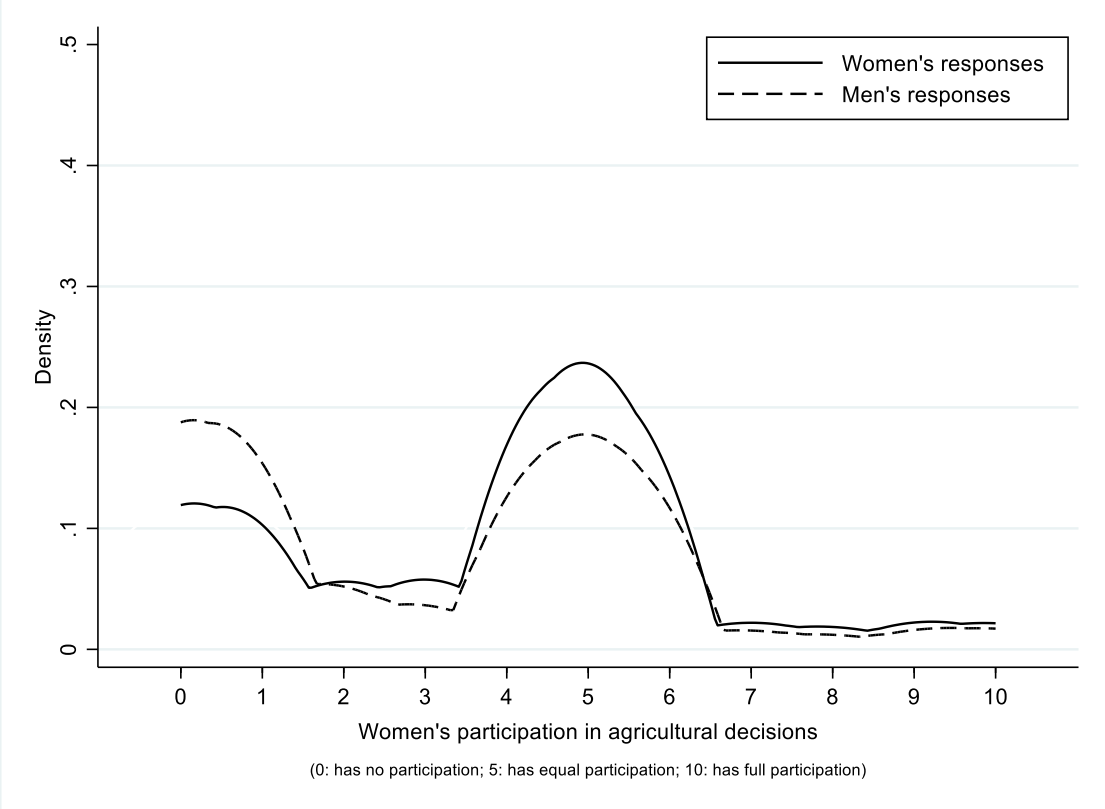

Figure A7-14. Kernel density for women's and men's perception to women's participation in deciding marketing arrangement

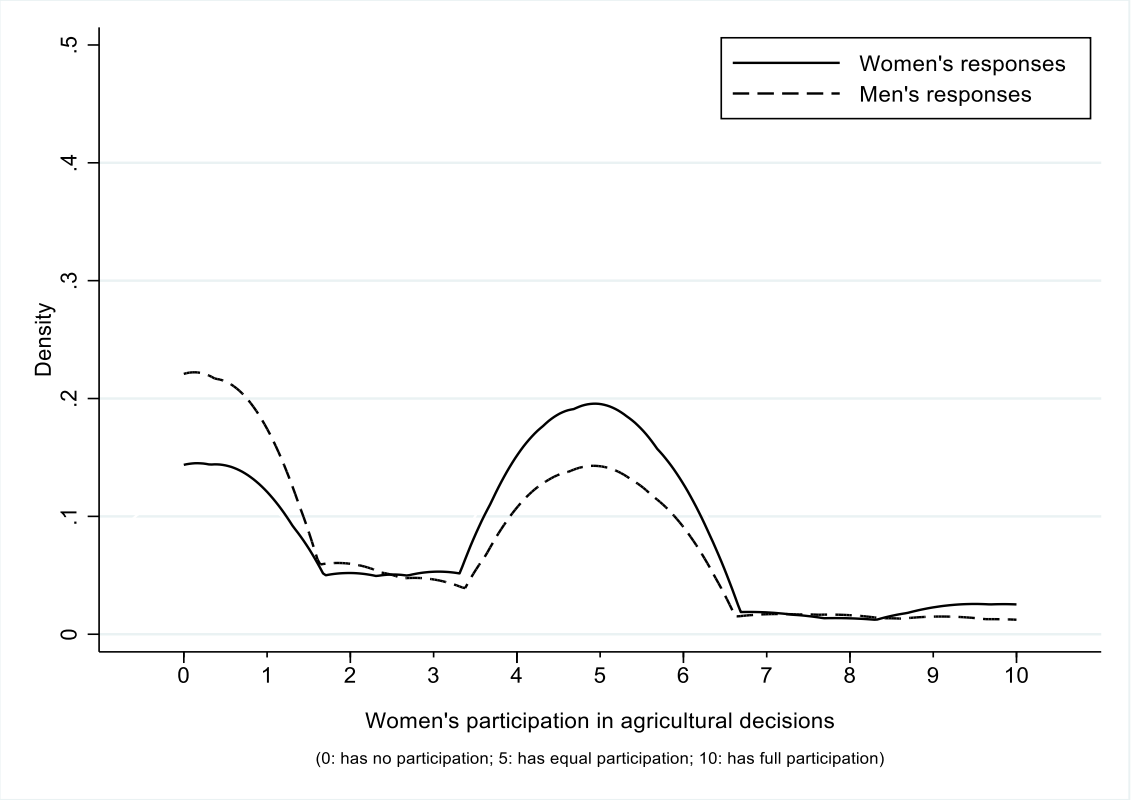

Figure A7-15. Kernel density for women's and men's perception to women's participation in deciding negotiating with buyer/trader

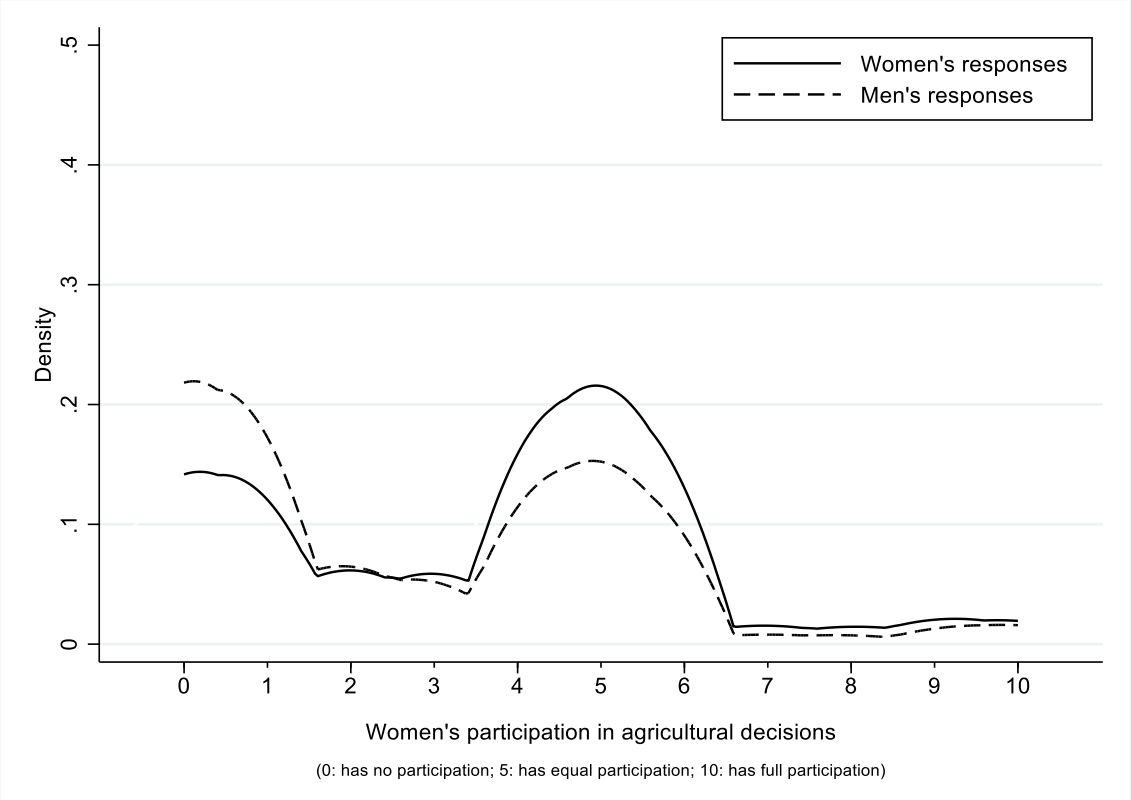

Figure A7-16. Kernel density for women's and men's perception to women's participation in deciding what variety to select

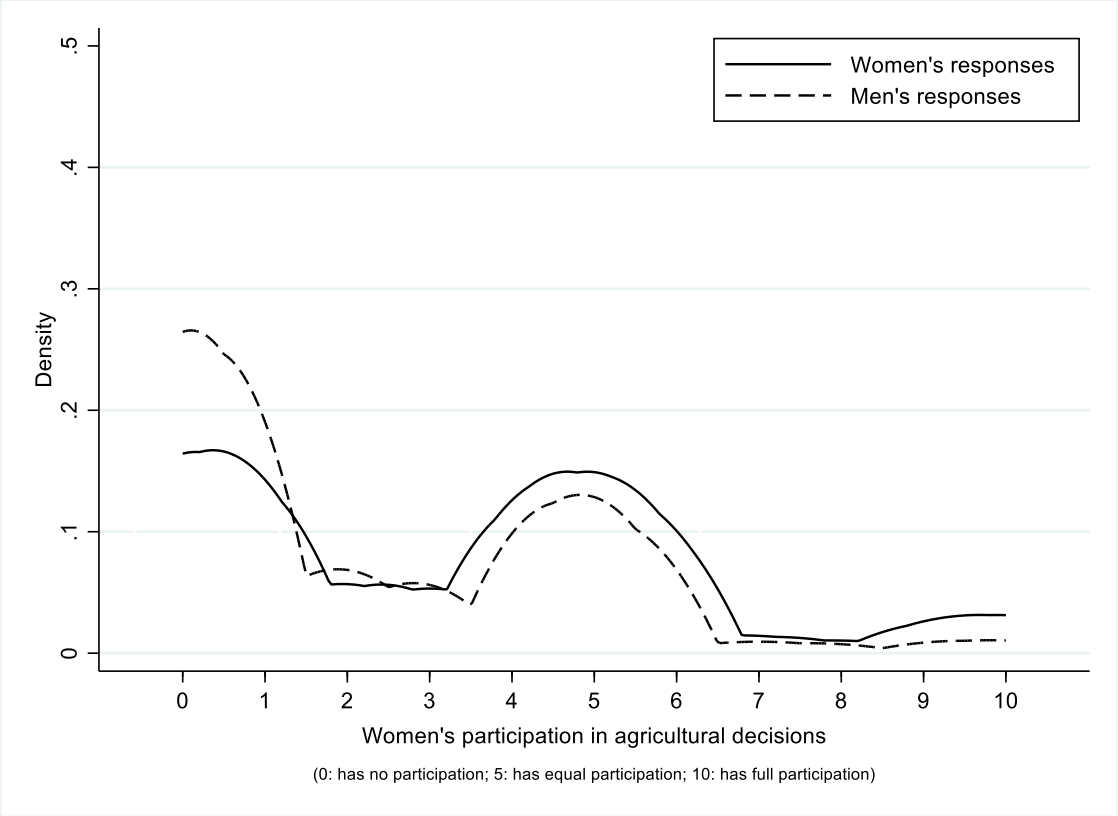

Figure A7-17. Kernel density for women's and men's perception to women's participation in deciding attending agriculture training or extension activities related to soil and water conservation

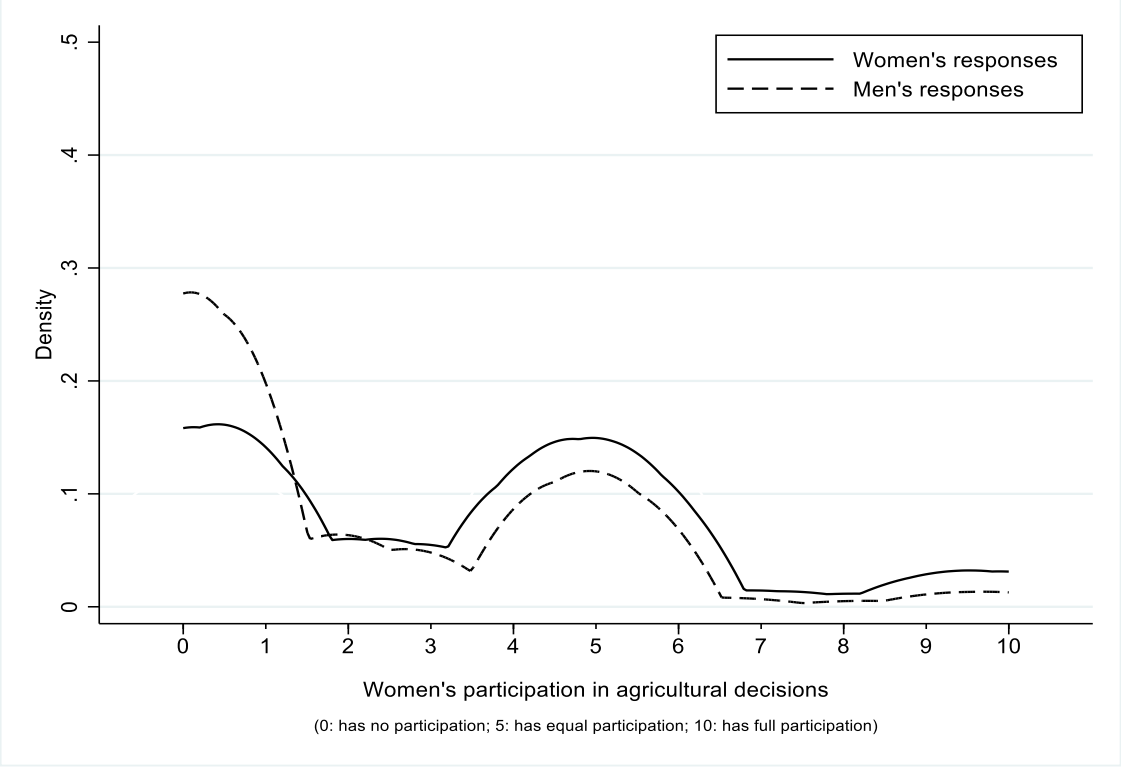

Figure A7-18. Kernel density for women's and men's perception to women's participation in deciding attending other agriculture training or extension activities

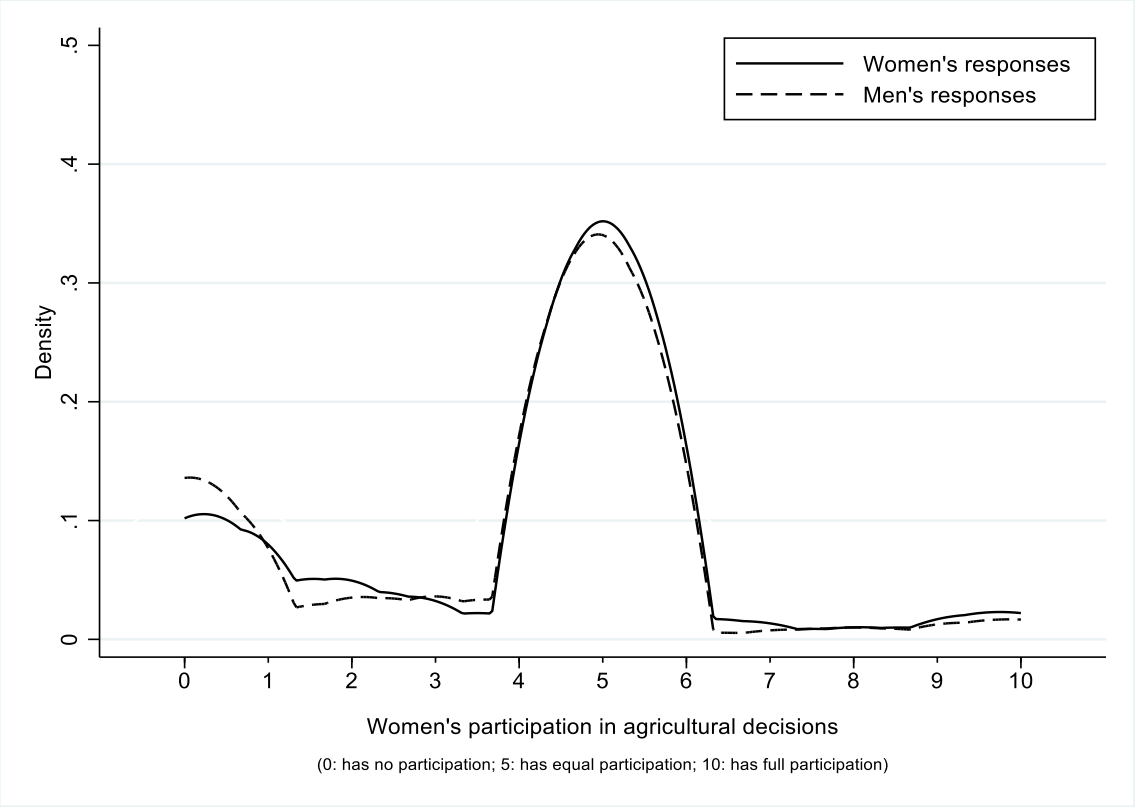

Figure A7-19. Kernel density for women's and men's perception to women's participation in deciding request credit for agricultural investment

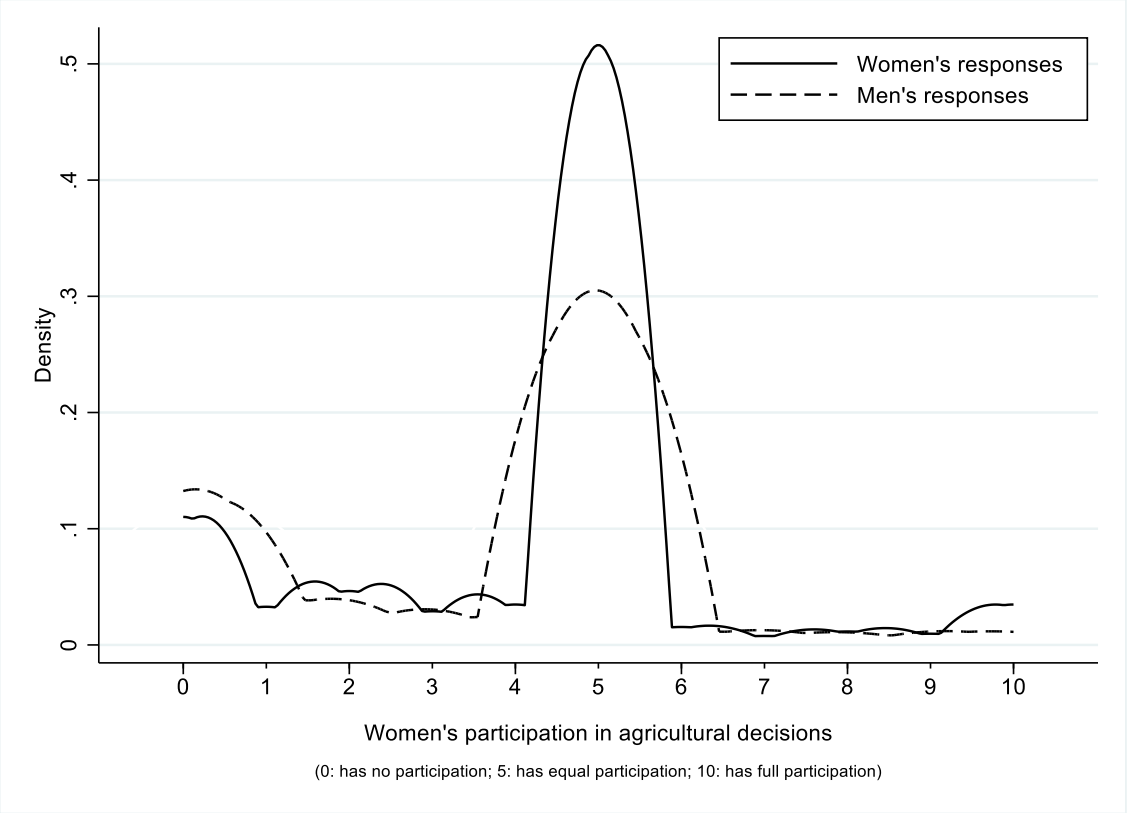

Figure A7-20. Kernel density for women's and men's perception to women's participation in deciding land purchasing and selling

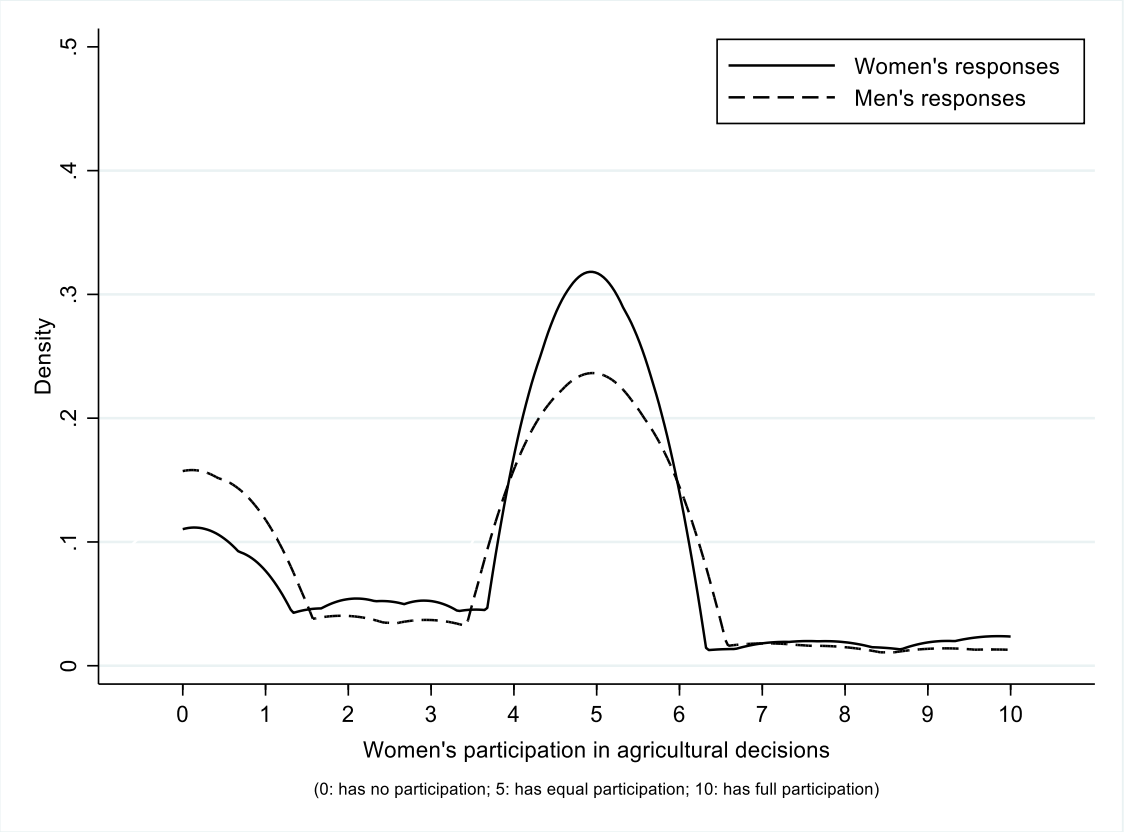

Figure A7-21. Kernel density for women's and men's perception to women's participation in deciding livestock purchasing and selling

Table A7-2. Women's participation in decisions on agricultural activities, West Java-Indonesia, 2019.

Category of activity	No	Type of decision	Women's decision-making participation perceived by women and men[1]				
			Women's perception		Men's perception		Mean difference
			Mean	Std.error	Mean	Std.error	(women's-men's)[2]
Production	1	What crops to grow	3.85	2.80	2.72	2.47	1.13***
	2	When and how to do land preparation and planting	3.53	2.59	2.34	2.37	1.19***
	3	When and how to apply agrochemicals (fertiliser, pesticides, fungicide, growth hormones, etc.)	3.39	2.78	2.26	2.50	1.13***
	4	When and how to tend the crops (e.g. weeding, watering, pruning, non-synthetic fertilizer, etc.)	4.26	3.09	2.69	2.85	1.58***
	5	When and how to harvest the crops	3.94	2.68	2.66	2.59	1.28***
	6	Buying farm equipment/machinery (tractor, harvester)	3.28	2.65	2.37	2.49	0.91***
	7	Buying yield increasing farm input (seed, fertiliser, pesticide, hormones, etc.)	3.54	2.68	2.35	2.52	1.19***
Conservation Practices	8	Building and maintenance of soil and water conservation structures (e.g. build terraces, safe waterways, etc.)	2.87	2.78	1.92	2.40	0.95***
	9	Implementation of soil/water conservation practices (e.g. agroforestry, cover crop, mulching, etc.)	2.95	2.71	2.23	2.68	0.72***
	10	Planting amenity or natural plants for biodiversity in the farm or home garden	3.75	2.85	3.01	2.9	0.75***
	11	Safety and practices in spraying of pesticides/herbicides	3.01	2.83	1.48	2.18	1.53***
Processing and Marketing	12	Processing (drying, fermenting, packing, etc.)	3.98	2.79	2.89	2.79	1.09***
	13	Whom to sell	3.98	2.71	2.95	2.76	1.04***
	14	Marketing arrangement (where and when)	3.72	2.64	2.89	2.78	0.83***
	15	Negotiating with buyer/trader (price negotiation)	3.43	2.82	2.48	2.72	0.95***
	16	What variety to select	3.41	2.67	2.48	2.68	0.93***
Training	17	Attending agriculture training or extension activities: soil and water conservation	3.14	3.01	2.06	2.51	1.08***
	18	Attending other agriculture training or extension activities (field school, pest management, new varieties, etc.)	3.18	3.02	1.95	2.55	1.23***
Credit	19	Request credit for agricultural investment	4.06	2.39	3.76	2.45	0.30***
Buying and Selling Assets	20	Land purchasing and selling	4.25	2.32	3.65	2.44	0.60***
	21	Livestock purchasing and selling	3.98	2.48	3.33	2.64	0.65***

[1] The responses correspond to a Likert scale from 0 to 10, which 0 means the spouse decides alone and the respondent has no participation at all over the decision; 5 means the respondent perceives that the spouse and the respondent participate equally in the decision, and 10 means that the respondent has full participation over the decision and the spouse has no participation at all.

[2] Pairwise t-test (mean-comparison t-test) is performed for each activity; * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table A7-3. Rationale for women participation in decisions in agricultural activities, West Java-Indonesia, 2019.

Category of Activity	No	Type of decision	Reasons					
			Knowledge			Family/village		
			Woman (n= 439)	Man (n= 439)	Diff (women-men) [1]	Woman (n= 439)	Man (n= 439)	Diff (women-men) [1]
Production	1	What crops to grow	45%	42%	3%	51%	51%	0%
	2	When and how to do land preparation and planting	41%	47%	-6% *	55%	45%	10% ***
	3	When and how to apply agrochemicals (fertiliser, pesticides, fungicide, growth hormones, etc.)	49%	53%	-4%	47%	41%	6% *
	4	When and how to tend the crops (e.g. weeding, watering, pruning, non-synthetic fertilizer, etc.)	45%	51%	-6% *	48%	41%	7% **
	5	When and how to harvest the crops	42%	47%	-5%	55%	48%	7% **
	6	Buying farm equipment/machinery (tractor, harvester)	47%	51%	-4%	51%	45%	6% *
	7	Buying yield increasing farm input (seed, fertiliser, pesticide, hormones, etc.)	45%	54%	-9% ***	51%	41%	10% ***
Conservation practices	8	Building and maintenance of soil and water conservation structures (e.g. build terraces, safe waterways, etc.)	54%	60%	-6% **	41%	34%	7% **
	9	Implementation of soil/water conservation practices (e.g. agroforestry, cover crop, mulching, etc.)	53%	61%	-8% ***	44%	34%	10% ***
	10	Planting amenity or natural plants for biodiversity in the farm or home garden	45%	51%	-6% *	52%	44%	8% **
	11	Safety and practices in spraying of pesticides/herbicides	54%	64%	-10% ***	43%	31%	12% ***
Processing and marketing	12	Processing (drying, fermenting, packing, etc.)	44%	54%	-10% ***	51%	41%	10% ***
	13	Whom to sell	44%	46%	-2%	54%	51%	3%
	14	Marketing arrangement (where and when)	45%	47%	-2%	53%	50%	3%
	15	Negotiating with buyer/trader (price negotiation)	51%	52%	-1%	47%	44%	3%
	16	What variety to select	49%	51%	-2%	49%	45%	4%
Training	17	Attending agriculture training or extension activities: soil and water conservation	53%	56%	-3%	44%	41%	3%
	18	Attending other agriculture training or extension activities (field school, pest management, new varieties, etc.)	51%	59%	-8% ***	46%	37%	9% ***
Credits	19	Request credit for agricultural investment	33%	35%	-2%	66%	64%	9%
Buying and selling assets	20	Land purchasing and selling	34%	35%	-1%	65%	65%	0%
	21	Livestock purchasing and selling	38%	41%	-3%	59%	57%	2%

[1] Pairwise t-test (mean-comparison t-test) is used; * p<.1; ** p<.05; *** p<.01

Table A7-4. The mean comparison for women's women's participation index (WPI_w) and men's women's participation index (WPI_m) in multigenerational households and in nuclear households, West Java-Indonesia, 2019.

Variable	Multigenerational households[1] n=17	Nuclear households[2] n=422	Overall N=439
WPI_w	3.11	3.56	3.54
	(1.67)	(1.86)	(1.86)
WPI_m	2.68	2.53	2.54
	(1.54)	(1.63)	(1.63)

[1]Multigenerational households means having parents/parents-in-laws living within the household.

[2] Nuclear households means the households do not have parents/parents-in-laws living within the household.

Pairwise t-test (mean-comparison t-test) is used; * p<.1; ** p<.05; *** p<.01

Standard deviations are reported in parentheses

Table A7-5. Robustness check using Seemingly Unrelated Regression (SUR) for WPI in agriculture, West Java-Indonesia 2019.

Variable	WPIw		WPIm	
	Specification 2	Specification 3	Specification 2	Specification 3
Individual's characteristics				
Knowledge	-0.12 ***		-0.10 ***	
	(0.01)		(0.01)	
Family/village		0.11 ***		0.10 ***
		(0.01)		(0.01)
Age	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Education	-0.03	-0.04	0.07 **	0.06 **
	(0.04)	(0.04)	(0.03)	(0.03)
Agricultural organization membership	0.08	0.06	0.08	0.06
(yes=1)	(0.18)	(0.18)	(0.15)	(0.16)
Off farm activity (yes=1)	-0.12	-0.15	0.05	0.07
	(0.18)	(0.18)	(0.15)	(0.15)
Difference between husband and wife				
Age	0.02	0.02	0.04 **	0.04 **
	(0.02)	(0.02)	(0.02)	(0.02)
Education	0.05	0.04	-0.02	-0.02
	(0.03)	(0.03)	(0.03)	(0.03)
Agricultural organization membership	-0.24	-0.17	-0.22	-0.14
	(0.19)	(0.19)	(0.17)	(0.17)
Household characteristics				
Women farm production participation	0.08 **	0.08 **	0.09 ***	0.09 ***
	(0.03)	(0.03)	(0.03)	(0.03)
Number of children under 5 years old	0.05	0.04	-0.13	-0.13
	(0.15)	(0.15)	(0.14)	(0.14)
Men-women ratio	0.15	0.14	-0.02	-0.04
	(0.12)	(0.13)	(0.11)	(0.11)
Parents/in-laws live within the household	-0.27	-0.17	0.20	0.16
(yes=1)	(0.40)	(0.40)	(0.35)	(0.35)
Land size (Hectare)	-0.13	-0.12	0.05	0.05
	(0.10)	(0.10)	(0.09)	(0.09)
Household assets index	0.01	0.02	-0.58 ***	-0.55 ***
(wife's information)	(0.23)	(0.23)	(0.20)	(0.20)
Social Desirability Bias:				
Woman enumerator (yes=1)	-0.10	-0.05	-0.13	-0.09
	(0.16)	(0.16)	(0.14)	(0.14)
Other variables:				
West Bandung	-0.26	-0.31	-0.02	-0.07
	(0.16)	(0.17)	(0.14)	(0.15)
Constant	4.64 ***	2.36 ***	2.92 ***	0.94 ***
	(0.56)	(0.55)	(0.49)	(0.48)
N	439	439	439	439
R^2	0.28	0.27	0.27	0.27
Chi2	172.49	164.70	177.94	175.34
Prob>F	0.00 ***	0.00 ***	0.00 ***	0.00 ***
Correlation of residuals	0.23	0.24		
Chi2	22.46	24.68		
Prob>F	0.00 ***	0.00 ***		

* p<.1; ** p<.05; *** p<.01; Standard errors are reported in parentheses.
Note: We run women and men equations simultaneously. The result for the correlation of residuals show that the errors in the two equations are slightly correlated.

Table A7-6. Robustness check using Instrument Variable Regression (IV) for WPI in agriculture, West Java-Indonesia, 2019.

Variable	WPIw		WPIm	
	Specification 2	Specification 3	Specification 2	Specification 3
Individual's characteristics				
Knowledge	-0.12 ***		-0.11 ***	
	(0.01)		(0.01)	
Family/village		0.13 ***		0.11 ***
		(0.01)		(0.01)
Age	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Education	-0.03	-0.04	0.07 *	0.06 *
	(0.04)	(0.04)	(0.04)	(0.03)
Agricultural organization membership	0.07	0.05	0.07	0.05
(yes=1)	(0.18)	(0.19)	(0.16)	(0.16)
Off farm activity (yes=1)	-0.15	-0.19	0.07	0.11
	(0.19)	(0.18)	(0.15)	(0.16)
Difference between husband and wife				
Age	0.02	0.02	0.04 **	0.04 **
	(0.02)	(0.02)	(0.02)	(0.02)
Education	0.05	0.04	-0.02	-0.02
	(0.03)	(0.03)	(0.03)	(0.03)
Agricultural organization membership	-0.25	-0.18	-0.23	-0.14
	(0.20)	(0.20)	(0.17)	(0.17)
Household characteristics				
Women farm production participation	0.08 **	0.07 **	0.08 ***	0.08 ***
	(0.03)	(0.03)	(0.03)	(0.03)
Number of children under 5 years old	0.05	0.05	-0.12	-0.13
	(0.16)	(0.16)	(0.14)	(0.14)
Men-women ratio	0.15	0.13	-0.02	-0.04
	(0.13)	(0.13)	(0.11)	(0.11)
Parents/ in laws lives within the household	-0.27	-0.15	0.20	0.15
(yes=1)	(0.41)	(0.41)	(0.36)	(0.36)
Land size (Hectare)	-0.13	-0.12	0.05	0.06
	(0.10)	(0.10)	(0.09)	(0.09)
Household asset index	0.02	0.05	-0.58 ***	-0.53 ***
(wife's information)	(0.24)	(0.24)	(0.20)	(0.21)
Social Desirability Bias:				
Woman enumerator (yes=1)	-0.10	-0.04	-0.12	-0.07
	(0.16)	(0.16)	(0.14)	(0.15)
Other variables:				
West Bandung	-0.27	-0.35	-0.03	-0.10
	(0.17)	(0.17)	(0.15)	(0.15)
Constant	4.71 ***	2.30 ***	2.99 ***	0.86 ***
	(0.59)	(0.57)	(0.50)	(0.51)
N	439	439	439	439
R^2	0.25	0.26	0.28	0.25
Prob > F	0.00 ***	0.00 ***	0.00 ***	0.00 ***

* p<.1; ** p<.05; *** p<.01; Standard errors are reported in parentheses.

Note: The average of other's villager's perception is used as a proxy for the common belief in society related to "the person who has better knowledge about the activity". This variable is used as an IV because society has an important role in shaping one's perceptions, for example, regarding gender roles (Cifci et al., 2021; Gurieva et al., 2022; Laszlo et al., 2020). However, other villager's perception is not necessarily directly affecting households' women's participation in the decision-making. The IV regression results show that the average of other's villager's perception statistically significantly correlated with the knowledge variable with p-value= 0.000. The same rationale, procedures, and results are also observed for Specification 3. We use the average of other villagers' perception (of the same gender) of family/village as the IV in Specification 3. The IV regression results show that the average of other's villager's perception of family/village statistically significantly correlated with the family/village variable with p-value= 0.000.

Appendix 8. Appendices for Chapter 3: Unfolding the spousal differences in response to intrahousehold decision-making participation questions: Evidence from West Java, Indonesia

Table A8-1. Paired T-test results for the means differences for each activity in the agricultural production domain, in West Java-Indonesia, 2019.

Type of decision	**P-value for paired t-test (H_o:mean(diff)=0)**						
	What crops to grow	What variety to select	When and how to do land preparation and planting	When and how to apply agro-chemicals	When and how to tend the crops	When and how to harvest the crops	Planting amenity or natural plants for biodiversity
What crops to grow		0.412	0.460	0.142	0.522	0.119	0.015
What variety to select			0.827	0.582	0.131	0.020	0.001
When and how to do land preparation and planting				0.347	0.169	0.023	0.003
When and how to apply agro-chemicals					0.017	0.003	0.000
When and how to tend the crops						0.389	0.063
When and how to harvest the crops							0.245
Planting amenity or natural plants for biodiversity							

Table A8-2. Paired T-test results for the means differences for each activity in the agricultural/household investment domain, in West Java-Indonesia, 2019.

Type of decision	**P-value for paired t-test (H_o:mean(diff)=0)**						
	Buying farm equipment/machinery	Buying yield increasing farm input	Building/maintenance of SWC structures	Implementation of SWC practices	Agricultural land purchasing and selling	Livestock purchasing and selling	Purchasing land/house/other large investments
Buying farm equipment/machinery		0.610	0.204	0.488	0.000	0.000	0.000
Buying yield increasing farm input			0.048	0.785	0.000	0.000	0.001
Building/maintenance of SWC[1] structures				0.025	0.000	0.000	0.000
Implementation of SWC practices					0.000	0.001	0.005
Agricultural land purchasing and selling						0.333	0.270
Livestock purchasing and selling							0.845
Purchasing land/house or other large investments							

[1] Soil and Water Conservation

Table A8-3. Paired T-test results for the means differences for each activity in the household expenditure domain, in West Java-Indonesia, 2019.

Type of decision	P-value for paired t-test (H_o:mean(diff)=0)									
	How much to spend on housing repairs improvements	Durable goods expenditures	Small durables expenditures	School fees and other school expenditures	How much to spend on food	Means of transportation purchase	Leisure/enjoyment expenditures	Health expenditures	Expenditure on clothes	Parties and ceremonies
How much to spend on housing repairs/improvements		0.000	0.000	0.025	0.000	0.705	0.027	0.032	0.000	0.074
Durable goods expenditures			0.991	0.074	0.189	0.000	0.000	0.068	0.017	0.035
Small durables expenditures				0.092	0.193	0.000	0.000	0.056	0.027	0.050
School fees and other school expenditures					0.001	0.011	0.000	0.891	0.000	0.745
How much to spend on food						0.000	0.000	0.001	0.371	0.001
Means of transportation purchase							0.038	0.015	0.000	0.028
Leisure/enjoyment expenditures								0.000	0.000	0.000
Health expenditures									0.000	0.835
Expenditure on clothes										0.000
Parties and ceremonies										

Table A8-4. Paired T-test results for the means differences for each activity in the income generating domain, in West Java-Indonesia, 2019.

Type of decision	P-value for paired t-test (H_o:mean(diff)=0)							
	Whether to take work seasonal work away from the home	Whether to take long-term work away from home	Non-farm economic activities	Wage salary employment	Processing	Whom to sell	Marketing arrangement	Negotiating with buyer/trader
Whether to take work seasonal work away from the home		0.017	0.104	0.028	0.094	0.794	0.766	0.086
Whether to take long-term work away from home			0.652	0.955	0.775	0.068	0.025	0.000
Non-farm economic activities				0.700	0.900	0.175	0.064	0.001
Wage salary employment					0.819	0.106	0.035	0.000
Processing						0.071	0.016	0.000
Whom to sell							0.393	0.009
Marketing arrangement								0.046
Negotiating with buyer/trader								

Table A8-5. Paired T-test results for the means differences for each activity in the saving and credit domain, in West Java Indonesia, 2019.

Type of decision	P-value for paired t-test (H_o:mean(diff)=0)				
	How much to save	Request credit for agricultural investment	Request credit for non-agricultural investments	Lending to friends or family	Use of savings/credit
How much to save		0.040	0.469	0.508	0.915
Request credit for agricultural investment			0.114	0.149	0.016
Request credit for non-agricultural investments				0.961	0.385
Lending to friends or family					0.394
Use of savings/credit					

Table A8-6. Paired T-test results for the means differences for each activity in the training domain, in West Java Indonesia, 2019.

Type of decision	P-value for paired t-test (H_o:mean(diff)=0)	
	Attending agriculture training or extension activities	Attending non-agricultural training or extension activities
Attending agriculture training or extension activities		0.00
Attending non-agricultural training or extension activities		

Table A8-7. Women's and men's responses to the question "how many assets the household currently owns" and the multivariate test of means, in West Java Indonesia, 2019.

Type of assets	The number of assets owned by household			
	Women's responses (n=439)	Men's responses (n=439)	Difference (women-men)	P-value
	Mean	Mean	Mean	
1	2	3	4	5
Mobile phone/tablet	1.61	1.66	-0.05	0.56
Motorcycle	1.15	1.19	-0.05	0.44
Car	0.09	0.09	0	0.84
Computer	0.11	0.11	0	0.93
Tossa	0	0.01	-0.01	0.32
Truck	0	0	0	.
Water pump	0.14	0.2	-0.06	0.10
Generator	0.01	0.01	0	0.53
Hand tractor	0.03	0.03	0	1
Four wheels tractor	0	0	0	.
Rice mill	0.03	0.01	0.02	0.35
Rice thresher	0	0	0	.
Storage	0.09	0.11	-0.02	0.51
Corn sheller	0.01	0.01	0	0.37
Sprayer	0.73	0.81	-0.08	0.14
Coffee huller	0.02	0.01	0.01	0.49
Buffalo/cattle	0.16	0.15	0.01	0.90
Goat/sheep	1.23	1.28	-0.05	0.74
Poultry	5.73	6.12	-0.39	0.87
Multivariate test of means results:				
H_o=all means are equal				
Hotelling's T2	1673.82***	1726.82***	44.32***	
Prob>F	0	0	0.001	

*** denote statistical significance at the 1% levels, from the multivariate test on means results.

Table A8-8. Women's and men's responses to the question "Who makes decisions in the following decision", in West Java Indonesia, 2019.

Domain	Type of decision	Self-decision-making authority perceived by each respondent						
		Women's responses			Men's responses			Difference
		Obs	Mean	SE	Obs	Mean	SE	Mean
Agricultural production	What crops to grow	438	3.85	0.13	439	7.28	0.12	-3.42***
	What variety to select	437	3.41	0.13	439	7.52	0.13	-4.11***
	When/how to do land preparation and planting	438	3.53	0.12	439	7.66	0.11	-4.13***
	When/how to apply agro-chemicals	437	3.39	0.13	438	7.74	0.12	-4.35***
	When/how to tend the crops	438	4.26	0.15	438	7.32	0.14	-3.05***
	When/how to harvest the crops	438	3.94	0.13	439	7.34	0.12	-3.41***
	Planting amenity or natural plants for biodiversity	438	3.75	0.14	436	6.99	0.14	-3.24***
Agricultural /household investment	Buy farm equipment/machinery	437	3.28	0.13	438	7.63	0.12	-4.34***
	Buy yield increasing farm input	439	3.54	0.13	439	7.65	0.12	-4.11***
	Build/maintain soil/water conservation structures	437	2.87	0.13	437	8.08	0.11	-5.20***
	Implement soil/water conservation practices	436	2.95	0.13	435	7.77	0.13	-4.83***
	Agricultural land purchasing or selling	439	4.25	0.11	438	6.35	0.12	-2.10***
	Livestock purchasing or selling	439	3.98	0.12	437	6.68	0.13	-2.70***
	Purchasing land/house or other large investments	439	4.27	0.11	437	6.34	0.11	-2.06***
Household expenditure	Housing repairs/improvement expenditures	439	4.39	0.11	439	6.40	0.11	-2.01***
	Durable goods expenditures	436	5.43	0.13	437	5.06	0.13	0.37**
	Small durables expenditures	422	4.90	0.13	424	5.79	0.14	-0.89***
	School fees and other school expenditures	433	4.93	0.12	437	5.82	0.13	-0.89***
	How much to spend on food	437	6.46	0.13	437	4.77	0.15	1.69***
	Vehicle purchase	431	4.31	0.11	433	6.24	0.12	-1.93***
	Leisure and enjoyment expenditures	435	3.89	0.14	436	7.03	0.14	-3.14***
	Health related expenditures	436	5.24	0.11	439	6.29	0.12	-1.05***
	Clothing expenditures	433	6.09	0.13	433	4.93	0.14	1.16***
	Parties and ceremonies	437	4.98	0.10	436	5.88	0.11	-0.90***
Income generating activities	Whether to take seasonal off-farm work	433	4.90	0.14	436	7.18	0.13	-2.28***
	Whether to take long-term off-farm work	435	4.47	0.14	435	6.93	0.13	-2.46***
	Off-farm economic activities	433	4.85	0.13	436	6.26	0.13	-1.41***
	Wage salary employment	436	4.49	0.13	435	6.80	0.13	-2.31***
	Produce processing	438	3.98	0.13	438	7.11	0.13	-3.12***
	Whom to sell	438	3.98	0.13	438	7.05	0.13	-3.07***
	Where/when to sell	436	3.72	0.13	436	7.10	0.13	-3.38***
	Negotiate price with buyer/trader	432	3.43	0.14	430	7.52	0.13	-4.09***
Saving and Credit	How much to save	438	5.46	0.12	437	5.90	0.13	-0.44**
	Request credit for agricultural investment	439	4.06	0.11	437	6.25	0.12	-2.19***
	Request credit for non-agricultural investments	439	4.13	0.12	436	5.91	0.12	-1.78***
	Lend to friends or family	439	4.54	0.12	437	5.83	0.12	-1.29***
	Use of savings/credit	438	4.93	0.11	438	6.02	0.11	-1.09***
Training	Attend agriculture training	438	3.18	0.14	435	8.05	0.12	-4.87***
	Attending non-agricultural training	436	4.15	0.16	430	7.40	0.14	-3.25***

Pairwise t-test (mean-comparison t-test) is performed for each activity; * p<0.1; ** p<0.05; *** p<0.01

Table A8-9. Multivariate test of means results for women's and men's responses to "Who makes decisions in the following decision" question, in West Java-Indonesia, 2019.

Domain	Women's responses	Men's responses	Difference
	Hotelling's T2	Hotelling's T2	Hotelling's T2
Agricultural production	53.03***	35.86***	61.5***
Agricultural/household investment	143.07***	214.73***	277.87***
Household expenditure	235.12***	212.85***	315.04***
Income generating activities	82.17***	82.11***	115.03***
Saving and credit	112.21***	17.65***	81.25***
Training	38.32***	27.17***	65.72***

H_o = all means are equal

*** denote statistical significance at the 1% level.

Table A8-10. Women's and men's responses to the question "Who makes decisions in the following decision" by enumerator gender, in West Java-Indonesia, 2019.

Domain	Type of decision	Male enumerator				Female enumerator			
		Obs	Women's[1]	Men's[2]	Diff.	Obs	Women's[1]	Men's[2]	Diff.
Agricultural production	What crops to grow	268	3.96	7.19	-3.24***	169	3.65	7.39	-3.74***
	What variety to select	269	3.41	7.65	-4.23***	167	3.36	7.33	-3.97***
	When/how to do land preparation and planting	268	3.49	7.57	-4.08***	169	3.56	7.78	-4.22***
	When/how to apply agro-chemicals	267	3.51	7.55	-4.04***	168	3.18	8.01	-4.82***
	When/how to tend the crops	268	4.18	7.36	-3.19***	168	4.36	7.26	-2.89***
	When/how to harvest the crops	268	3.99	7.40	-3.42***	169	3.85	7.21	-3.37***
	Planting amenity or natural plants for biodiversity	265	3.64	6.79	-3.14***	169	3.98	7.31	-3.34***
Agricultural /household investment	Buy farm equipment/machinery	267	3.37	7.52	-4.15***	168	3.14	7.79	-4.66***
	Buy yield increasing farm input	269	3.62	7.58	-3.96***	169	3.37	7.76	-4.39***
	Build/maintain soil/water conservation structures	268	3.05	7.76	-4.72***	166	2.50	8.60	-6.10***
	Implement soil/water conservation practices	266	2.90	7.45	-4.55***	167	3.01	8.27	-5.26***
	Agricultural land purchasing or selling	268	4.14	6.23	-2.10***	169	4.46	6.52	-2.07***
	Livestock purchasing or selling	269	4.01	6.58	-2.57***	167	3.93	6.81	-2.88***
	Purchasing land/house or other large investments	268	4.37	6.46	-2.10***	168	4.08	6.11	-2.03***
Household expenditure	Housing repairs/improvement expenditures	269	4.44	6.49	-2.05***	169	4.31	6.24	-1.93***
	Durable goods expenditures	269	5.30	5.19	0.11	165	5.65	4.80	0.85***
	Small durables expenditures	258	4.70	5.80	-1.10***	155	5.30	5.81	-0.51
	School fees and other school expenditures	268	4.87	5.92	-1.05***	163	5.02	5.72	-0.69***
	How much to spend on food	269	6.01	5.28	0.73***	167	7.17	3.92	3.25***
	Vehicle purchase	266	4.28	6.39	-2.11***	161	4.32	5.98	-1.65***
	Leisure and enjoyment expenditures	269	3.71	6.90	-3.19***	163	4.13	7.20	-3.07***
	Health related expenditures	268	5.16	6.50	-1.34***	167	5.35	5.94	-0.59**
	Clothing expenditures	268	5.95	4.99	0.97***	163	6.30	4.83	1.47***
	Parties and ceremonies	267	4.98	6.04	-1.06***	167	4.98	5.57	-0.59**
Income generating activities	Whether to take seasonal off-farm work	265	4.59	6.78	-2.19***	166	5.34	7.79	-2.45***
	Whether to take long-term off-farm work	265	4.24	6.70	-2.46***	167	4.85	7.26	-2.42***
	Off-farm economic activities	266	4.47	6.31	-1.84***	165	5.47	6.16	-0.69**
	Wage salary employment	268	4.35	6.45	-2.10***	165	4.70	7.32	-2.62***
	Produce processing	268	3.88	7.09	-3.22***	168	4.14	7.10	-2.96***
	Whom to sell	268	3.98	7.16	-3.18***	168	3.95	6.85	-2.90***
	Where/when to sell	266	3.74	7.02	-3.28***	167	3.71	7.22	-3.50***
	Negotiate price with buyer/trader	260	3.42	7.32	-3.90***	166	3.45	7.89	-4.44***

Note: 1) The mean of female respondent's responses ; 2) The mean of male respondent's responses; ***,**,* denote statistical significance at the 1% , 5% , and 10% level, from t-test results.

Table A8-10. (Continue) Women's and men's responses to the question "Who makes decisions in the following decision" by enumerator gender, in West Java-Indonesia, 2019.

Domain	Type of decision	Male enumerator				Female enumerator			
		Obs	Women's[1]	Men's[2]	Diff.	Obs	Women's[1]	Men's[2]	Diff.
Saving and Credit	How much to save	269	5.20	6.00	-0.81***	167	5.90	5.70	0.20
	Request credit for agricultural investment	268	3.95	6.18	-2.23***	168	4.25	6.33	-2.08***
	Request credit for non-agricultural investments	267	3.84	5.63	-1.78***	168	4.63	6.33	-1.70***
	Lend to friends or family	268	4.38	5.83	-1.45***	168	4.82	5.82	-1.00***
	Use of savings/credit	269	4.73	6.08	-1.35***	167	5.27	5.89	-0.62**
Training	Attend agriculture training	266	3.53	7.59	-4.06***	168	2.62	8.76	-6.14***
	Attending non-agricultural training	263	4.40	7.08	-2.67***	165	3.80	7.95	-4.15***

Note: 1) The mean of female respondent's responses ; 2) The mean of male respondent's responses; ***,**,* denote statistical significance at the 1% , 5% , and 10% level, from t-test results.

Table A8-11. Multivariate test of means results for the differences between women's and men's responses to "Who makes decisions in the following decision" question, by enumerator gender by domain, in West-Java Indonesia, 2019.

Domain	Male respondent, male enumerator	Male repondent, female enumerator	Female respondent, male enumerator	Female repondent, female enumerator
	Hotelling's T2	Hotelling's T2	Hotelling's T2	Hotelling's T2
Agricultural production	22.84***	22.91***	22.84***	22.91***
Agricultural/household investment	126.43***	133.25***	126.43***	133.25***
Household expenditure	272.23***	313.6***	272.23***	313.6***
Income generating activities	160.72***	185.54***	160.72***	185.54***
Saving and credit	138.73***	87.93***	138.73***	87.93***
Training	0.19	0	0.19	0

The mean of male respondent's responses

H_o = all means are equal

***,** denote statistical significance at the 1% and 5% level.

Appendix 9. Appendices for Chapter 4: Women's participation in dairy production and farming technology adoption decisions in West Java, Indonesia

Table A9-1. Household non-land asset index calculation (n=563)

	Type of non-land assets	Quantity owned by the household				PCA first component weights
		Mean	SD	Min	Max	
1	Refrigerator	0.39	0.56	0	4	0.3614
2	Mobile phone	1.73	1.36	0	10	0.4023
3	Television	1.17	0.54	0	4	0.3425
4	Parabola	0.24	0.43	0	2	0.0655
5	Internet access	0.65	0.97	0	7	0.3732
6	Washing machine	0.14	0.36	0	2	0.3253
7	Bentor	0.1	0.1	0	1	0.0274
8	Motorbike	0.00	0.04	0	1	0.1582
9	Three-wheeled motorcycle	1.39	1.06	0	6	0.3859
10	Trcycle	0.13	0.47	0	4	0.3344
11	Car	0.08	0.27	0	1	0.1226
12	Truck	0.02	0.13	0	1	0.1983

Table A9-2. The descriptive statistics on participation in dairy farming activities and decisions based on gender, West Java-Indonesia, 2017.

Type of activity and decision	Men (n=563)		Women (n=563)		Difference	
	Mean	Std err	Mean	Std err		
Individuals participate in the activity (1=yes; 0=otherwise)						
Dairy farming in general	95%	1%	76%	2%	-19%	***
Kinds and quantity of forages	94%	1%	61%	2%	-33%	***
Kinds and quantity of concentrates	93%	1%	57%	2%	-36%	***
Herd health	94%	1%	58%	2%	-36%	***
Individuals participate in the decision-making (1=yes; 0=otherwise)						
Dairy farming in general	91%	1%	58%	2%	-33%	***
Kinds and quantity of forages	92%	1%	37%	2%	-55%	***
Kinds and quantity of concentrates	91%	1%	38%	2%	-52%	***
Herd health	91%	1%	45%	2%	-46%	***
Individual's responses for "Women participate individually or jointly in the decision-making" (1=yes; 0=otherwise)						
Dairy farming in general	55%	2%	58%	2%	3%	
Kinds and quantity of forages	26%	2%	37%	2%	12%	***
Kinds and quantity of concentrates	28%	2%	38%	2%	10%	***
Herd health	39%	2%	45%	2%	7%	**

** p<.05; *** p<.01; using t-test analysis.

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