Land-use change, socioeconomic welfare, and gender roles in rural Indonesia

Dissertation

to obtain the doctoral degree

in the

International Ph.D. Program for Agricultural Sciences in Goettingen

(IPAG)

at the Faculty of Agricultural Sciences,

Georg-August-University Goettingen, Germany

presented by

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Date of dissertation: May 11th, 2021

Summary

Global population and income growth has driven the demand for agricultural land. This rapid conversion of land use to agriculture has affected the social and economic welfare of local communities within the landscape. Indonesia is a country that has recently undergone rapid land-use change due to increasing demand in global crop commodities. Oil palm, the largest export commodity in Indonesia, has been identified as a key driver of deforestation and biodiversity loss in this region. Oil palm has also replaced agricultural lands that were previously used to grow food crops for local subsistence, as well as other cash crops such as rubber. The agricultural sector is a main contributor to the national economy and is a major element in Indonesia's economic growth and development strategy. Despite experiencing rapid economic and social changes over the past two decades, rural poverty, malnutrition, and food insecurity continue to persist at high rates.

Understanding the social and economic consequences of land-use change is therefore imperative to address how to support the welfare and development of local communities affected within the landscape. This dissertation explores the human dimension of the recent land-use changes and particularly focuses on the impact of agricultural specialization and oil palm expansion in Indonesia. This dissertation has two research objectives. The first research objective is to analyze how agricultural specialization has affected diets in rural Indonesian households over a time. The second research objective is to examine how the oil palm expansion has affected smallholder farmers in terms of household economic welfare and intra-household gender roles.

Despite great strides in reducing hunger over the last two decades, malnutrition remains a major challenge in Indonesia. High rates of child stunting coexist with high and increasing rates of overweight and obesity despite rapid economic growth and reductions in poverty over the last two decades. Part of this economic growth has been driven by a change in agricultural production systems from traditional farming techniques that typically grow multiple crops to more intensified, specialized and commercialized farms. The objective of the first essay is to analyze how changes in the structure of agricultural production have affected diets in rural Indonesian households over time. We use three waves of a panel data from the Indonesian Family Life Survey with a balanced sample of 2785 rural households between 2000 and 2015 to observe transitions in households' food choices over time in response to the changes in production systems. We find positive relationships between production diversity and household dietary diversity as well as

between market access and household dietary diversity. However, we see that there has been an overall decline in dietary diversity in households where production diversity has also reduced. This decline in dietary diversity was mostly driven by the decreased consumption of nutritious food groups (fruits, vegetables, legumes, and fish). Although the magnitude of the association between dietary diversity and production diversity was relatively small, the association between household production and consumption of some of these important food groups was quite substantial. The overall impact of increased specialization in Indonesia during the period 2000–2015 on dietary quality appears to have been negative.

After looking at national household dietary quality implications, we zoom in on oil palm producing households. The rapid expansion of oil palm in tropical regions has substantial implications for socioeconomic development. Several studies show that smallholder farmers benefit economically from cultivating oil palm. However, most existing studies examine short-term impacts with cross-sectional data, which has two disadvantages. First, issues of endogeneity are difficult to address with cross-sectional data. Second, dynamic and risk effects cannot be analyzed. In this second essay, we address both issues by using three waves of panel data from smallholder farmers in Indonesia and pseudo fixed effects panel estimators. We show that oil palm cultivation increases household living standards, measured by annual consumption expenditure, by 13% on average. Moreover, we demonstrate that oil palm cultivation reduced households' economic risk, measured in terms of potential decreases in living standard due to income variability. The risk-reduction effect is evident despite fluctuating international palm oil prices and consequences for oil palm revenues and profits. Oil palm requires less labour than alternative crops, thus freeing family labour for other economic activities. We find that oil palm farmers are more involved in off-farm activities, which helps to smooth income and consumption. Policy support may be required to address oil palm adoption constraints that some smallholders face. In addition, fostering the non-farm economy and improving household access to lucrative off-farm jobs are important for equitable rural development.

To our knowledge, there are only few studies that address the intra-household implications of oil palm expansion in Indonesia. Male and female household members might be affected differently by the increasing adoption expanding oil palm cultivation. The last essay explores the gender-disaggregated implications of oil palm cultivation among smallholder households in Indonesia. By using panel and cross-sectional data of

700 smallholder households, we examine the disaggregated farm labor input over time, 24-hour time allocation and females' economic decision-making power. Results show that oil palm cultivation decreases on-farm family labor input, especially female labor. When looking at the male and female time allocation, results suggest that females spend less time on farms, more time on work inside the house and enjoy more leisure time as the share of farm under oil palm cultivation increases. For the male counterparts, differences in time allocation were not statistically significant, except for more leisure time among male members as the intensity of oil palm cultivation increases. Findings reveal that females are more likely to lose intra-household decision-making power in relation to farm management and farm income allocation. These findings make important contributions to addressing rural development policies aiming to expand cash crop production while also improve women's welfare.

This dissertation concludes by providing a synopsis of all three essays, discussing the limitations, possible future research areas, and broader policy conclusions from the findings presented above. For the first research objective, results point to more nuanced policies, targeting nutrition as such. For the second research objective, findings from essay two and three suggest that positive gains from commercial oil palm cultivation occurred in terms of household welfare but the gender implications are rather mixed. In this context rural non-farm sector is important to support income diversification, especially regarding the economic involvement of females that are no longer working on-farm in oil palm cultivation.

Acknowledgements

First of all, I would like thank my supervisor Prof. Dr. Matin Qaim for his thorough supervision in the past three years. Thank you for all your guidance and feedback during this incredible journey. I would also like to thank Prof. Dr. Meike Wollni and Prof. Dr. Krisztina Kis-Katos for joining my thesis committee and giving me feedback whenever needed.

My gratitude goes also to my dear colleagues Dr. Bethelhem Legesse Debela and Dr. Christoph Kubitza for their thorough advice during my PhD. I am also thankful to Dr. Amy Ickowitz for being so empowering throughout these years.

This research would not have been possible without the hard work of our field work team: Amrina, Anas, Artha, Dila, Fitriah, Irham, Joharis, Juanda, Juwita, May, Moncia, Nando, Niko, Randi, Rosmalia, Sauit, Shara, Winda and Daniela. Makasih banyak teman-teman! Thank you to all our respondents and village heads in Jambi Province for welcoming us into their homes and taking the time to participate in the survey. I would also like to extend my gratitude to our counterparts Prof. Hermanto Siregar and Prof. Zulkifli Alamsyah for supporting our research in Indonesia and our CRC colleagues in Bogor, Jambi and Göttingen supporting the whole process.

Thanks also to the whole chair family and especially my C07 teammates for all the support and exchange during this time. Thanks Micki, Dom and Jessie for borrowing your English skills.

I feel so lucky having met so many wonderful people that I can call my friends, my family by choice. Thanks for bearing with me during the ups and downs of these past few years. Special thanks goes to my ‘power partner’ Franzi for all the support, all the walks and talks during this past year.

Laslty, I want to thank my beloved family for all the love and support. I feel so blessed being part of this incredible and strong team.

This thesis is written as part of an interdisciplinary project, the Collaborative Research Center (CRC 990): Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia), financially supported by Deutsche Forschungsgemeinschaft (DFG).

Dear parents,

I will always be grateful that you did not accept what was supposed to be our fate and sought refuge in a whole new world, leaving behind everything you have known and loved.
This PhD would have never been possible without all
your courage, love and support.

مادر و پـدر دوسـت داشـــــتنی،

تشـــــکر از اینکـــــه شما اصـلا از آن راه ای‌ه دور و دراز بـــه آلمـان آمـده بودیـــد.

و تشـــــکر دیگـــر از اینکـــــه شما من را گذاشـــــتید کـــه زنـــــدگی خود ر در ا

دسـت بـــــگیرم و سرنوشـــــت رخـود قلـم ا بـــزنم .

بـدون محبـت و حمایـت شـما یـان دوکتـــــور ام امکـان پـــذیر

بـــودنـــمی.

Table of contents

Summary ..... **i**
Acknowledgements ..... **iv**
List of tables ..... **viii**
List of figures ..... **ix**
Abbreviations ..... **x**
1 General introduction……..1
1.1 Background 2
1.2 Research objectives 4
1.3 Study area and data 6
1.4 Outline of the dissertation 7
2 Dietary diversity of rural Indonesian households declines over time with agricultural production diversity even as incomes rise ……8
2.1 Introduction 9
2.2 Research hypothesis 10
2.3 Data and variables 11
2.3.1 Dietary diversity and consumption of individual food groups 12
2.3.2 Production diversity 13
2.3.3 Market access 14
2.3.4 Other control variables 14
2.4 Methods 15
2.5 Results 17
2.6 Discussion 24
2.7 Conclusion 26
2.8 Appendix 28
3 Oil palm cultivation, household welfare, and exposure to economic risk in the Indonesian small farm sector..... 32
3.1 Introduction 33
3.2 Materials and methods 34
3.2.1 Study region and household survey 34
3.2.2 Conceptual framework 36
3.2.3 Estimation effects of oil palm on household welfare 37
3.2.4 Estimation effects of oil palm on downside risk 39
3.2.5 Dealing with endogeneity 40
3.3 Results 41
3.3.1 Descriptive statistics 41
3.3.2 Effects of oil palm cultivation on consumption expenditure 44
3.3.3 Effect of oil palm cultivation on economic risk 47
3.4 Discussion and conclusion 49
3.5 Appendix 52
4 What about her? Oil palm cultivation and intra-household gender roles 61
4.1 Introduction 62
4.2 Conceptual framework 64
4.3 Data and methods 65
4.3.1 Study context: Jambi Province, Indonesia 65

4.3.2 Household survey 66
4.3.3 On-farm labor allocation 67
4.3.4 Individual time allocation 67
4.3.5 Female decision-making power 68
4.3.6 Empirical methods 68
4.4 Results 70
4.4.1 Oil palm cultivation over time 70
4.4.2 Effects on farm labor division 71
4.4.3 Effects on male and female time allocation 74
4.4.4 Effects on female decision-making power 78
4.5 Discussion and conclusion 81
4.6 Appendix 82
5 General conclusion 84
5.1 Main findings and discussion 85
5.2 Limitations and scope for future research 88
References 89
General appendix 99

List of tables

Table 1.1 Descriptive statistics 18
Table 1.2 Factors associated with household dietary diversity..... 19
Table 1.3 Probability of consumption of each food group 22
Table 2.1 Descriptive statistics for key explanatory variables 42
Table 2.2 Comparison of early oil palm adopters and non-adopters 44
Table 2.3 Effects of oil palm cultivation on consumption expenditures 45
Table 2.4 Effects of oil palm cultivation on downside economic risk..... 48
Table 2.5 Effect of oil palm cultivation on off-farm activities 48
Table 3.1 Descriptive statistics 71
Table 3.2 Household-level farm labor input in oil palm and rubber on selected activities 72
Table 3.3 Results from panel analysis of household-level farm labor input 73
Table 3.4 Comparing 24-h time allocation in different livelihood groups 75
Table 3.5 Regression results of individual level female 24-h time allocation 76
Table 3.6 OLS analysis of individual level male 24-h time allocation 77
Table 3.7 Comparing female asset ownership and decision-making in different livelihood groups 78
Table 3.8 Results from OLS regressions on share of assets and female involvement in decision-making..... 80
Table A1.1 Food groups and included items in dietary and production diversity indicators..... 28
Table A1.2 Components of dietary and production diversity measures..... 29
Table A1.3 Describing HDDS, PD and consumption of individual food groups..... 30
Table A1.4 Determinants of household dietary diversity using HDDS10 and HDDS12 31
Table A2.1 Comparison of attrition and panel households..... 52
Table A2.2 Regression-based test for attrition bias..... 53
Table A2.3 Variable descriptions 55
Table A2.4 Effect of share of farmland under oil palm on consumption expenditures.. 56
Table A2.5 Effects of oil palm cultivation on consumption expenditures by survey wave ……..57
Table A2.6 Effect of share of farmland under oil palm on downside economic..... 58
Table A2.7 Effect of oil palm cultivation on off-farm activities (full model results) 60
Table A3.1 Household member characteristics 83

List of figures

Figure 1.1. Consumption and production of each food group in 2000 and 2014/15 20

Figure 2.1. Price movement of rubber and palm oil between 2012 and 2018 43

Figure 2.2. Mean consumption expenditures among oil palm adopters and non-adopters (2012-2018)..... 43

Figure A2.1. Average labor input per hectare of rubber and oil palm 54

Figure A2.2. Share of farm and off-farm income (2012-2018) 59

Abbreviations

AE	Adult equivalent
BPS	Statistical Office Indonesia
CPO	Crude Palm Oil
CRC	Collaborative Research Center
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Statistics Division of the Food and Agriculture Organization of the United Nations
FE	Fixed-Effects
FFB	Fresh Fruit Bunches
GNR	Global Nutrition Report
HDDS	Household Dietary Diversity
IDR	Indonesian Rupiah
IFLS	Indonesian Family and Life Survey
LMIC	Low and middle income country
MCA	Multiple Correspondence Analysis
OLS	Ordinary least squares
PD	Production Diversity
RE	Random-Effects

Chapter 1

General introduction

1.1 Background

As humans we have marked our landscapes throughout history and left our footprints where we lived by clearing forests, manipulating rivers or building settlements (Thomson et al. 2004; Foley et al. 2005). Most notably the appropriation of ecosystem goods such as food, fiber or timber was a major reason for these changes (DeFries, Asner, and Houghton 2004). This is why the increasing world population and per-capita incomes are expected to further spur the demand for agricultural products to feed and equip everyone, but also land for shelter, resulting in continuing land-use changes, i.e. conversion of natural landscapes for human use but also changes in management practices of already appropriated lands (Foley et al. 2005; Drescher et al. 2016; Alexandratos and Bruinsma 2012). At the same time we face resource constraints for agricultural production. Especially arable land is becoming scarcer (Alexandratos and Bruinsma 2012) and existing land is becoming degraded, leading to decreasing yields crop land expansion in the forest-rich tropical countries (Foley et al. 2005; Gibbs et al. 2010). In the past agricultural intensification and land-saving technologies could increase yields considerably and reduce the pressure on land. Yet still, cropland expanded by 15% between 1955 and 2005 (Schmitz et al. 2014) and in the past few decades about half of the newly expanded agricultural land stem from intact forests (Gibbs et al. 2010). Agricultural expansions lead to trade-offs between satisfying immediate human needs versus long-term human well-being (Defries et al. 2010; Foley et al. 2005; Díaz et al. 2006). Tropical rainforests play a crucial role in keeping the planet healthy by regulating the climate and water supplies and supporting soil formation. Tropical forests are also among the most biodiverse habitats on earth (Millennium Ecosystem Assessment 2005). Thus the conversion of these areas into agricultural land poses a major sustainability challenge (Barnes et al. 2014).

Oil-yielding crops have been one of the major drivers of the recent land-use changes observed globally, especially soybean and oil palm (Byerlee, Falcon, and Naylor 2017; Qaim et al. 2020). Since 1970 the area under oil crops has increased more than the area under all cereals crops (Byerlee et al. 2017). Even at lower growth rates, the demand for oil crops is projected to further increase as the demand for vegetable oils for food, feed, cosmetics and biofuels will rise (Byerlee et al. 2017). Increased demand is expected to be driven by an increasing world population as well as per per-capita due to increased incomes in emerging countries, resulting in future expansions of oil seeds (Byerlee et al. 2017; Drescher et al. 2016). Oil palm has been the fastest growing oil crop due its labor

productivity and low production cost (Sheil et al. 2009). Currently two countries, Malaysia and Indonesia, produce 84% of global supply (FAOSTAT 2020). Since 2009 Indonesia has been the largest producer of oil palm. The area under oil palm in Indonesia, tripled from 4 million hectares to over 12 million hectares between 2000 and 2018 (BPS 2019). These land-use changes have far-reaching environmental and socioeconomic consequences (Allen et al. 2015; Barnes et al. 2014; Clough et al. 2016; Drescher et al. 2016). Much of the oil palm expansion took place on land that was previously used for other food and cash crops (Gatto et al. 2017; Qaim et al. 2020). But parts of it came at the cost of clearing primary forest for agricultural land and thus causing negative environmental effects (Abood et al. 2015; Austin et al. 2019).

Despite environmental concerns the agricultural sector and oil palm are also considered major elements of Indonesia's plan for economic growth and development (UNDP 2014). Currently the agricultural sector employs 28% of the total 270 million Indonesians. Thus it plays an important role in sustaining millions of livelihoods (World Bank 2021). Agricultural production systems have changed substantially over the past two decades. As farms have become more specialized and commercialized, the cultivation of cash crops, particularly oil palm, have increased (Austin et al. 2019). Although the country has experience rapid economic and social changes over the past two decades it still faces some challenges: in 2018 about 150 million people were categorized as being poor measured in terms of the "upper middle income class poverty line" of 5.50 PPP dollars per capita per day and about 10% of Indonesians as poor according to the national poverty line of 25 PPP dollars per capita per month (World Bank 2021). Indonesia has come far in reducing hunger but malnutrition remains a major challenge. Micronutrient deficiency is still a widespread problem and over-nutrition is increasingly becoming one (Hanandita and Tampubolon 2015; Global Nutrition Report 2018).

The question arises what these observed land-use changes imply in terms of social and economic consequences. This dissertation explores the human dimension of the recent land-use changes, i.e. agricultural specialization and oil palm expansion, observed in Indonesia. Firstly, it investigates how the increased specialization affects dietary quality over time. Secondly it explores links between oil palm expansion and household welfare and intra-household gender roles in smallholder farming systems.

1.2 Research objectives

This thesis has two main research objectives that will be covered over the course of three essays. The first research objective is to analyze how agricultural specialization has affected diets in rural Indonesian households over time. The second research objective is to examine how the oil palm expansion has affected smallholder farmers in terms of household economic welfare and intra-household gender roles. The following sections discuss the specific research objectives of the three essays and state the contribution to existing body of literature.

Despite the observed economic development over the past few decades poor diet quality remains still a major challenge in Indonesia (Global Nutrition Report GNR 2020; Shrimpton and Rokx 2013; Vermeulen et al. 2019). Agriculture is an important income source for millions of rural poor, but it is also the main provider of food. Thus the question arises – how can agriculture be leveraged for nutrition security? This topic has been debated in the academic literature. A key issue is whether farmers are nutritionally better off from producing a diverse set of food crops or from specializing in crop production for sale and then purchasing food (Jones et al. 2014; Sibhatu et al. 2015; Jones 2017a; Sibhatu and Qaim 2018; Gupta et al. 2020).

Indonesia is an ideal case study to explore this question as the country has underwent economic and social major changes and still fights malnutrition, but also as the oil palm expansion marked a major land-use change in Indonesia over the past few decades. Due to higher profitability farmers increasingly replaced other crops with oil palms (Byerlee et al. 2017; Krishna and Kubitza 2021). This leads to the question whether the resource reallocation away from food production has adverse effects for food and nutrition security.

So far most studies exploring the determinants of dietary diversity rely on cross sectional data and thus have one major drawback as potential endogeneity issues are hard to deal with in these type studies. With panel data, we can reduce potential bias by using a fixed effects estimator which controls for unobserved household characteristics that do not change over time, but that could impact diets. The objective of the first essay is to analyze how changes in the structure of agricultural production have affected diets in rural Indonesian households over time. It examines whether increases in farming specialization

over a period of 15 years were associated with better dietary quality as proxied by household dietary diversity and consumption of nutrient-rich food groups.

After studying the first research objective in essay one, this dissertation continues with the second research objective, examine how the oil palm expansion has affected smallholder farmers in terms of household economic welfare and intra-household gender roles, in essay two and three. To do so it zooms into Sumatra, more specifically Jambi Province. This province is a hotspot of the recent oil palm expansion in Indonesia and thus a perfect case study to explore socio-economic effects and gender implications for producing farmers. Large parts of the positive economic effects of the oil palm expansion are due to the strong involvement of smallholder farmers in Indonesia. Studies from Sumatra, where smallholders dominate the sector, record how these farmers benefit from oil palm cultivation in terms of improved living standards (Euler et al. 2016; Kubitza et al. 2018a; Sibhatu 2019). While in Kalimantan, mainly dominated by large scale producers, only communities with prior experience with market economy are shown to benefit (Santika et al. 2019).

Existing studies exploring household-level welfare effects are mostly based on cross-section surveys and look at economic effects in only one year. However, the effects of oil palm cultivation can vary over time (Kubitza et al. 2018a). As oil palm comprises a long-term investment and world market prices fluctuate over time (Cramb and Curry 2012; Cahyadi and Waibel 2016) farmers' ability to switch to other crops when output prices decline is limited. In such situations, downside risk can potentially lead to considerable social hardship (Morduch, 1994). The objective of this second essay is to provide more reliable estimates of the effects of oil palm cultivation on smallholder welfare by using three waves of panel data and regression models with pseudo fixed effects to control for time-invariant unobserved heterogeneity. Furthermore, possible dynamic effects of oil palm cultivation on downside economic risk shall be analysed. This is particularly interesting because our panel data cover a period of six years (2012-2018) during which substantial price fluctuations on international commodity markets were observed. And lastly, the essay has the objective to shed light on the main mechanisms underlying the effects of oil palm cultivation on smallholder welfare and economic risk.

Although welfare benefits exist at the household level, the intra-household implications of oil palm cultivation might be heterogeneous. Economic opportunities via the production of a relatively new cash crop such as oil palm can alter land use, gender

roles and labor allocation, thereby causing household members to be distinctly affected (Doss 2001). Existing studies indicate a gender bias in oil palm production, compared to other crops, such as rice or rubber, women are less involved in oil palm cultivation (Villamor et al. 2015; Chrisendo et al. 2020). This is argued to be due to the physical strength required for harvesting oil palm (Villamor et al. 2015). However, we do not know how the freed labor is reallocated and what that means for intra-household decision-making. As gender equity as such is an important goal, but also as female empowerment is shown to be linked to other social welfare goals such as child health and nutrition.

The research objective of this essay is to explore effects of oil palm cultivation on gender roles within farming households in Indonesia. It contributes to the literature by examining the labor dynamics of oil palm cultivation over a 6-year period using three waves of panel data. Furthermore, it analyzes 24-hour individual time allocation to track the reallocation of released labor. This is of particular importance to better understand what male and female household members spent their time on, on-farm work, off-farm activities, and household and care work or leisure activities. Lastly, this essay sheds light on shifts in female asset ownership and decision-making power when households move from rubber to oil palm cultivation. Cross-sectional and panel data from are combined in this study. It applies random and fixed-effects estimators for the three-wave panel and OLS and Logit estimation methods for the cross-sectional data.

1.3 Study area and data

This dissertation builds on a combination of primary and secondary data sets from Indonesia. The first essay (Chapter 2) uses three waves, 2000, 2007/8 and 2014/5, of the Indonesian Family and Life Survey (IFLS) that is a nationally representative data set collected by the RAND organization. While the remaining two essays (Chapter 3 and 4) use primary data collected in Jambi Province, Sumatra. This household survey will be described in detail in the following sections.

Jambi Province is of particular interest as it is a major hotspot of the land-use change in Indonesia with the expansion of oil palm. Smallholders are increasingly getting involved in the Indonesian oil palm sector. Currently 45% of the area under oil palm is cultivated by smallholders and this share is expected to increase (BPS 2019).

Household survey data were collected in three waves, 2012, 2015 and 2018. While the first two waves were collected by previous researchers of our team, wave 2012 (Euler et al. 2016) and wave 2018 (Kubitza et al. 2018a), the data collection in 2018 was led by the author herself in a joint team effort. Sampling was based on a multistage framework, where first five regencies, Sarolangun, Batanghari, Muaro Jambi, Tebo, and Bungo, were selected purposively followed by a random selection of 40 villages out of these five regencies. To allow for interdisciplinary overlaps within the research project, five additional villages were selected into the sample. From a complete list of all farm households (i.e. all households that owned any agricultural land in the last 5 years compiled by the research team with the help of the village leaders) 6 to 24 households were selected randomly. To control for possible sampling bias the number of randomly selected households per village was proportional to total village population. Thus a total of 700 farm households were interviewed in the first wave. Data collection was repeated for the same households in 2015 and 2018. Between the first and second wave an attrition rate of 6% and between first and third wave an attrition rate of 4.6% occurred. Households dropped out due to outmigration, death or old age or refusal.

All three waves of the data were collected between, August and November, which is the dry season on the island of Sumatra. Structured questionnaires (last questionnaire used in 2018 is in the General Appendix of this dissertation) were used in face-to-face interviews in the local language by trained enumerators. Household level information on socioeconomic characteristics, on farming and non-farm income generation activities, household consumption and individual level time allocation were collected. A special subsection focused on plot level farming activities with all the material but also labor input and yield and so forth.

1.4 Outline of the dissertation

This dissertation is organized as follows: Chapter 2 presents the first essay, exploring the linkages between agricultural commercialization and diet quality in rural Indonesia. Chapter 3 presents the second essay, analyzing long-term welfare effects of smallholder oil palm cultivation and chapter 4 presents essay three, looking at gendered intra-household implications of oil palm cultivation. The final chapter summarizes this thesis and concludes by deriving policy implications and future research ideas.

Chapter 2

Dietary diversity of rural Indonesian households declines over time with agricultural production diversity even as incomes rise[1]

[1] This essay was published as: Mehraban, N. and Ickowitz, A. 2021. Dietary diversity of rural Indonesian households declines over time with agricultural production diversity even as incomes rise. Global Food Security (28): 100502. https://doi.org/10.1016/j.gfs.2021.100502 NM and AI developed the research idea, NM compiled the data, conducted the analysis and wrote the first draft. AI commented on the data analysis and results interpretation and revision of the paper.

2.1 Introduction

Whether farmers are nutritionally better off from producing a diverse set of food crops or from specializing in crop production for sale and then purchasing food has been the subject of debate among researchers (Jones, Shrinivas and Bezner-Kerr, 2014; Sibhatu, Krishna and Qaim, 2015; Hirvonen and Hoddinott, 2016; Jones, 2017a; Sibhatu and Qaim, 2018; Gupta et al. 2020). This debate has important implications for national and international development policies; if greater specialization and commercialization also improves diet quality, then governments, donors, and international organizations can continue to focus their policies in this direction with the hope that they will bring higher incomes, more food, and better quality diets. However, if greater diversity of production results in better diet quality, then more nuanced policies might be necessary to support these multiple objectives. In this paper, we use panel data from rural Indonesia to investigate whether increases in farming specialization over a 15 year period were associated with better dietary quality as proxied by dietary diversity and nutrient-rich food group consumption. Indonesia has experienced a substantial decrease in undernourishment over the last two decades (from 17% of the population in 1999 to 8.3% in 2017), however, other nutritional problems have not improved much and some have gotten worse. Child stunting and wasting have remained stubbornly high at 36% and 13.5% respectively (Global Nutrition Report 2020). Poor dietary quality is a widespread problem in Indonesia and micronutrient deficiencies in vitamin A, iron, and zinc are high (Shrimpton and Rokx 2013). There are some signs of a nutrition transition (Popkin and Gordon-Larsen 2004) characterized by increasing consumption of simple carbohydrates, fats, and animal foods and away from complex carbohydrates, fruits, legumes, and vegetables taking place in Indonesia (Vermeulen et al. 2019). Overnutrition is increasingly a concern (Hanandita and Tampubolon 2015); overweight and obesity are on the rise, with 31% of adult women overweight and 9% obese (GNR 2020) and rates of overweight and obesity among young children are increasing rapidly (GNR 2016, 2020).

We use data from three waves of the Indonesian Family and Life Survey (IFLS) – 2000, 2007/8, and 2014/15 – covering about 83% of Indonesia's population. During this period, Indonesia went through rapid economic and social changes; annual income per capita increased from $2 144 in 2000 to $4 285 in 2018 (World Bank 2019), resulting in a

change in Indonesia's status from a 'low income' to a 'upper middle income' country as classified by the World Bank. The landscapes of much of rural Indonesia were rapidly transforming over this period as well with increased production of cash crops, particularly of oil palm (Austin et al. 2019). Infrastructure and access to markets also improved with an increase in road density from 18.3 km per 100 sq km in 2000 to 26.1 km in 2011 (Knoema 2020); an increase in electricity consumption of 108% between 2000 and 2014 (World Bank 2019); an explosion of mobile phone use with an increase of 75 times the number of subscriptions between 2000 and 2015 (World Bank 2019) and an increase in passenger air traffic of over 800% during that same period (World Bank 2019). The increased specialization of Indonesian farmers accompanied by the rise in incomes over the last two decades, make Indonesia an excellent 'case study' for investigating how reductions in agricultural production diversity accompanied by economic development have affected diets over time.

2.2 Research hypothesis

There are several pathways through which agricultural specialization (i.e., a reduction in production diversity) and commercialization could affect household dietary diversity both positively and negatively: first, commercialization tends to be accompanied by improvements in infrastructure since producers need to connect to markets in order to sell their output for cash. This can improve access to different kinds of foods which would be expected to have a positive effect on dietary diversity. Higher incomes from more commercially oriented farms and plantations would enable people to purchase more kinds of foods from markets, again with a positive effect on dietary diversity. Second, replacement of diverse crops that were formerly produced and consumed with crops produced for sale, is likely to have a negative effect on dietary diversity. Third, loss of fallows and uncultivated lands with changes in production systems that normally accompany commercialization, could mean of loss of wild foods (wild meat, fruits, and leaves) normally collected in those areas (Powell et al. 2015; Broegaard et al. 2017) resulting in a negative effect on dietary diversity. While all of these pathways are possible in theory, the ultimate effects on diet will depend on how they interact and which effects dominate, if any. Most studies that explore the determinants of dietary diversity use cross

sectional data and then assume that the dietary responses of households that exhibit different degrees of specialization is equivalent to what would happen in the same household if it were to become more specialized. With panel data, we can observe these changes directly without the additional assumption. We can also reduce potential bias by using a fixed effects estimator which controls for unobserved household characteristics that do not change over time, but that could impact diets. The objective of this study is to understand how changes in the structure of agricultural production has affected diets in rural households in Indonesia over time as the country has experienced economic growth and development. We test the following hypotheses:

i. Reductions in production diversity associated with agricultural specialization are associated with reductions in household dietary diversity due to reductions in consumption of crops that are no longer produced by the household;

ii. Greater market access as a result of improvements in infrastructure is associated with increases in household dietary diversity through market purchases of diverse foods;

iii. The effects of changes in 'own production' and market access will differ for the different food groups that comprise the dietary diversity score; the impact of 'own production' is likely to be more important for some food groups and market access will likely be more important for others.

If both hypotheses i and ii are correct, they would each pull dietary diversity in a different direction with the overall effect depending on their relative strength. If hypothesis iii is correct, understanding which food groups are more responsive to own production and which to market use can help us to move beyond generalizations and ideological debates to design policies that are more effective at improving diets.

2.3 Data and variables

We use household-level information from the Indonesian Family and Life Survey (IFLS), a longitudinal survey conducted by the RAND Corporation for Indonesia. It was first carried out in 1993–1994 and four more waves have followed including IFLS3 in 2000 (Strauss et al. 2004), IFLS4 in 2007–2008 (Strauss et al. 2009) and IFLS5 in 2014–2015 (Strauss et al. 2016). With 13 out of the initial 26 provinces (including the most

populous ones), 83% of the Indonesian population is represented in the survey. For the present study, waves three to five, covering the period between 2000 and 2014/15 are used, as only these three waves contain specific information about farm production. The re-contact rate for the waves used here is over 90% from the first IFLS survey. We combine parts of the community level data for infrastructural development, which is available for the 130 IFLS original villages with the household level data. Data from the first wave used for this study contain observations for 10,251 households. After excluding duplicates and incomplete observations (9), urban households (4,917) and non-farming households (2,113), the data provide a base of 3214 rural farmers in 2000. Combined data from 2000, 2007 and 2014/15 builds a balanced panel with 2785 households.

2.3.1 Dietary diversity and consumption of individual food groups

We use a count of food groups consumed by the household over the previous seven days to create a household dietary diversity score (henceforth HDDS) as a proxy for household diet quality. Although dietary diversity scores have only been validated as measures of nutrient adequacy and food security using 24 h recall periods for children and women (Verger et al. 2019), Fongar et al. (2019) show that 7-day household dietary diversity scores were significantly correlated with individual 24 h recall scores. Several other studies use the 7-day household recall to proxy for dietary quality (Arimond and Ruel 2004; Jones 2015; Sibhatu et al. 2015).

In order to measure household dietary diversity, we categorized reported food items into food groups, to align as closely as possible with the FAO guidelines[2] (Kennedy, Ballard, and Dop 2013). Food groups included are: cereals, tubers, vegetables, fruits, meats, eggs, fish, legumes, dairy, oils and fats, sweets, spices and beverages. For further details on the food groups and the included food items, please refer to table A1.1 and A1.2 in the appendix.[3]

[2] For example, the IFLS did not have separate data on vitamin A rich vegetables, tubers and fruits, dark green leafy vegetables, or organ meat: we therefore could not construct a measure to align with the Women´s Minimum Dietary Diversity Score.

[3] All prepared foods eaten outside and inside the house are aggregated into one group, however, this group is only used for descriptive purposes.

The composition of dietary diversity scores used in the literature varies: a 12 food group HDDS recommended by the FAO reflects the household's economic ability to access a diverse diet (Kennedy et al. 2013). Other researchers suggest using only nutrient relevant groups for a nutrient adjusted HDDS (Swindale and Bilinsky 2005) and excluding food groups that are not nutritious. In this study, we use different measures of household dietary diversity, namely 12 group, 10 group, and a 9 group measure - HDDS12 uses all food groups reported by IFLS; HDDS10 uses the 10 food groups which are more likely to have positive nutritional impact (spices-condiments-beverages and sweets are excluded), and the HDDS9 uses the food groups which we can align directly to our production data (this starts with the same food groups as HDDS10, but excludes fats and oils since IFLS did not collect production data for these foods). We use HDDS9 as our main outcome variable, while the other two measures are used in the supplementary analysis (Table A1.3 and Table A1.4).

In addition to the analysis of dietary diversity, we also run a series of models exploring the factors associated with the consumption of the individual food groups that comprise the household dietary diversity scores. We use the recall data to generate dummy variables, indicating whether the household consumed each food group in the past seven days or not. Since we are most interested in the impact of 'own production' on consumption, we exclude sweets and eggs which are rarely produced at the household level in Indonesia.

2.3.2. Production diversity

We use a count of crops and livestock produced by the household as a measure of production diversity. While some studies only include crops, we also include livestock since it can be a source of animal source foods such as milk and meat. We use information from two sections of the survey to create this index: farm business and household consumption. In the farm business module, households are asked for information on production of crops and livestock in the last 12 months. However, the food groups covered in this section are limited. In the consumption module, households are also asked how much they consumed out of their own production for each food item. When they report a positive amount, we assume that to mean that they produced foods in that food group and use this information to expand the food groups included in a wider production diversity index. We generate three production diversity indices: PD9, PD10, and PD12 which use

the same food groups as are used in our dietary diversity indicators (Berti 2015). PD9 uses only the data from the production module and uses the same food groups as HDDS9. The other two production diversity indices also include information from the consumption module as described and are used in supplementary analysis. In addition, we generate dummy variables indicating whether or not the household has produced foods in each food group for the second part of our analysis.

2.3.3. Market access

The second key explanatory variable of interest is 'market access', which we proxy by actual reliance on markets for consumption at the village level. Commonly used market measures are self-reported distance to nearest markets, existence of markets in the village or town (Sibhatu et al. 2015), nearest roads, and ownership of vehicles (Snapp and Fisher 2014). Jones (2017b) proposes proportion of harvest sold to proxy for market access at the household level. We use a similar measure for market access but focus on the consumption side – the proportion of foods purchased out of total food consumption during the past seven days. However, because this measure could potentially suffer from endogeneity bias at the household level[4], we average this measure across each community and use this average which we call 'community market reliance' as a proxy for market access. In addition to our main market measure, we include distance to the nearest market from the village, as a robustness check since this measure is more commonly used in the literature.

2.3.4. Other control variables

We control for socio-economic factors, such as education, age, sex and religion of the household head. Education can affect knowledge about healthy diets and thus is expected to increase dietary diversity. We use dummy variables for completion of primary, secondary or higher education of the household head. We note that female decision maker's education is potentially more important for household diets since women are more often responsible for purchasing and preparing food within households (Bhagowalia et al. 2012; Malapit and Quisumbing 2015). However, due to a large number of missing observations, we use the information of the household head instead, as there is evidence of positive correlation between husbands' and wives' educational attainment due to positive assortative matching in marriages based on education (Breierova and Esther 2004).

[4] For example, there may be omitted variables such as having a well-informed person in the household who understands the value of a diverse diet, but also is well informed about market opportunities.

Women have been shown to play an important role in improving the diets of their families (Amugsi et al. 2016; Chiputwa and Qaim 2016; Bhagowalia et al. 2012), hence we control for female headed households. The age of household head is included since age may shape taste and preference for food (Westenhoefer 2005). And as 87% of Indonesia is Muslim and Muslims have religious dietary restrictions, we add a dummy for Muslim household heads. Total household size might affect dietary quality as well since more people may be reflected in more diverse preferences as well as more diverse activities resulting in different types of production and processing.

We control for the household's economic status with an asset and housing quality-based wealth index. We use Multiple Correspondence Analysis (MCA) to represent information on ownership of many assets and living conditions in a single index which we use to proxy for household wealth (Greenacre and Blasius 2006). We include: ownership of vehicles, TV, type of cooking stove (gas, electric, kerosene), own toilet, usage of piped or bottled drinking water, type of outer walls (bricks or cement), roof material (concrete, wood, metal), floor material (ceramic, marble, stone, tiles, cement or bricks). These assets and measures of living conditions are commonly used in the literature to reflect socio-economic well-being (Filmer and Pritchett 2001). We categorized the highest tertile as rich and the lowest one as poor. The middle class is our comparison group. We include a variable for off-farm income generated by the household and total landholding. Some of the initially rural households moved to urban areas over time and since diets may differ in urban compared to rural areas, we add a dummy variable taking the value 1 if the household resides in a rural area. We include dummies for the year of the survey to control for year- specific effects such as the state of the economy or weather patterns. In order to control for seasonality, which varies across Indonesia depending on the respective island, we include dummy variables for the month of interview.

2.4 Methods

We use a Poisson fixed effects model on a balanced panel to analyze the association between dietary diversity and production diversity and market access of the households over time. An advantage of a fixed effects regression is that unobserved characteristics of a household that do not change over time and might affect its dietary behaviour do not bias results. Thus such things that are difficult to measure and include in a model such as cultural norms, individual tastes and preferences for certain diets, knowledge about dietary

decisions (that do not change over time) are all potentially important omitted variables which could bias estimates in a cross-sectional model, but do not present a problem in a fixed effects panel model.[5]

Since the dependent variable is a count of food groups, we use a Poisson fixed-effects model:

$$HDDS_{it} = ß_1 PD_{it} + ß_2' \boldsymbol{X_{it}} + ß_3' \boldsymbol{M}_{jt} + ß_4' \boldsymbol{S}_{it} + ß_5 yr2007 + ß_6 yr2014 + u_{it} \quad (1)$$

where the dependent variable $HDDS_{it}$, represents the dietary diversity score of household *i* at time *t*; PD_{it} is the production diversity score of household *i* at time *t*; $\boldsymbol{X}_{it}$ is a vector of all potentially time-varying household characteristics such as gender, age, religion, education level of household head, household size, as well as information on whether the household resides in a rural area, has non-farm income, and size of landholding; $\boldsymbol{M}_j$ is a measure of market access (measured by average village market reliance and distance to nearest market) for village *j;* $\boldsymbol{S_{it}}$ controls for seasonality by including the interview month, and u_{it} is a random error term. We run the model for the different dietary diversity and production diversity scores described above.

Next, we run a set of random effects probit regressions for consumption of each food group on 'own production' of the same food groups and the controls used above. These regressions take the form:

$$Pr\,(C_{git} = 1) = \theta_1 P_{git} + \theta_2' \boldsymbol{X}_{it} + \theta_3' \boldsymbol{M}_{jt} + \theta_4' \boldsymbol{S}_{it} + \theta_5 yr2007 + \theta_6 yr2014 + \mu_{it} \quad (2)$$

where *C* indicates whether household *i* consumed from food group g at time t; *P* indicates whether or not household *i* produced foods from food group g at time t. Vectors $\boldsymbol{M}$ and $\boldsymbol{X}$ and $\boldsymbol{S}$ contain the same control variables as in eq. (2) and μ_{it} is a random error term.

[5] A Hausman test failed to reject that a fixed effects model is appropriate for the dietary diversity poisson model.

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2.5 Results

The descriptive data presented in Table 1.1 show that between 2000 and 2015, production diversity in rural Indonesia declined. During this period, community market reliance did not change significantly. However, income in the sample increased over this period as did the proportion of the sample that were considered to be 'rich' based on an asset index and there was a decline in the proportion of the 'poor'. Despite these signs of economic development, average dietary diversity declined.

Table 1.2 presents the results of the panel fixed-effects regressions for each of the dietary diversity scores as incident rate ratios (irr) (since the poisson model is non-linear, the results are easier to interpret as rate ratios in response to a one unit change in the predictor). We see a positive and statistically significant association between household dietary diversity and production diversity; increasing production diversity by one food group is associated with a change in household dietary diversity of between 4.9% and 5.8% depending on the market access variables and other co-variates included in the model. As a robustness check, we run the regressions using HDDS10 and HDDS12 as outcomes and report the results in Table A1.4 in the appendix. These results are qualitatively the same, but slightly smaller.

Table 1.1 Descriptive statistics

	(1) 2000	(2) 2007	(3) 2014	(4) Δ 2000 - 2014
HDDS9	6.60	6.62	6.51	-0.095*
	(1.59)	(1.61)	(1.81)	(0.046)
PD9	3.31	2.89	2.76	-0.56***
	(1.54)	(1.65)	(1.71)	(0.044)
Cultivates cash crop (=1)	0.33	0.27	0.28	-0.049***
	(0.47)	(0.44)	(0.45)	(0.012)
Landholding (ha)	1.14	0.67	0.68	-0.46***
	(2.84)	(1.73)	(2.16)	(0.070)
Wealth Index: Poor (=1)	0.51	0.33	0.15	-0.36***
	(0.50)	(0.47)	(0.36)	(0.012)
Wealth Index: Rich (=1)	0.16	0.28	0.56	0.40***
	(0.37)	(0.45)	(0.50)	(0.012)
Annual real income (IDR/AE)	1628.7	2565.6	3359.5	1730.8***
	(2370.8)	(5580.6)	(6696.2)	(134.6)
Annual real non-farm income (IDR/AE)	1592.7	2565.6	3348.4	1755.7***
	(2345.1)	(5580.6)	(6684.6)	(134.2)
Annual real expenditures in (IDR/AE)	2065.2	3603.4	3752.0	1686.8***
	(2111.9)	(24000.7)	(6429.8)	(128.3)
Market access in community (%)	74.7	77.2	75.3	0.67
	(21.2)	(21.8)	(22.4)	(0.58)
Rural area (=1)	1	0.91	0.82	-0.18***
	(0)	(0.28)	(0.39)	(0.0073)
Nearest market (km)	4.10	5.25	4.51	0.42**
	(3.39)	(6.38)	(4.02)	(0.13)
Household size	4.40	4.01	3.78	-0.62***
	(1.86)	(1.75)	(1.77)	(0.049)
HH has primary education (=1)	0.60	0.58	0.54	-0.063***
	(0.49)	(0.49)	(0.50)	(0.013)
HH has secondary education (=1)	0.19	0.22	0.27	0.076***
	(0.39)	(0.42)	(0.44)	(0.011)
HH has higher education (=1)	0.032	0.041	0.051	0.019***
	(0.18)	(0.20)	(0.22)	(0.0053)
Female HH (=1)	0.12	0.16	0.19	0.069***
	(0.32)	(0.37)	(0.39)	(0.0096)
Muslim HH (=1)	0.88	0.88	0.88	0.0025
	(0.32)	(0.32)	(0.32)	(0.0086)
HH is married (=1)	0.88	0.83	0.79	-0.087***
	(0.33)	(0.37)	(0.41)	(0.0099)
Observations	2785	2785	2785	5570

Notes: Mean values are shown with standard deviation (sd) in columns (1), (2) and (3). Column (4) shows the coefficients with standard error (se) in parenthesis from a simple t-test, comparing the means in 2000 to 2014/15. Income and expenditure values are constant to 2000. AE= Adult Equivalent. IDR = Local currency. HH= Household head. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level

Table 1.2 Factors associated with household dietary diversity

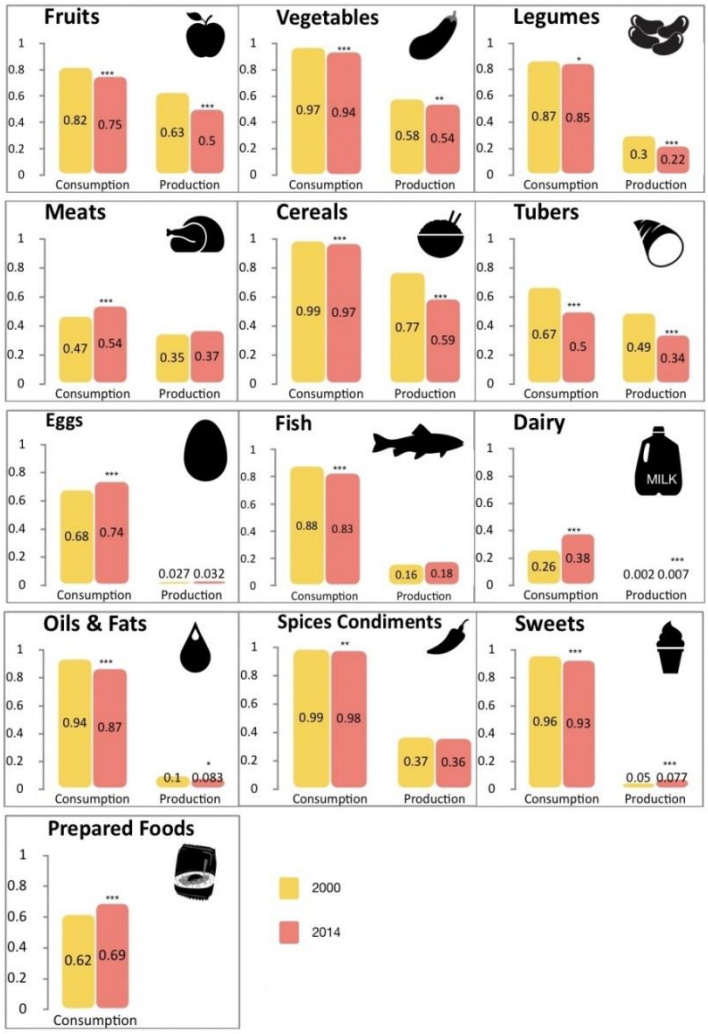
	(1) HDDS9	(2) HDDS9	(3) HDDS9	(4) HDDS9
PD9	1.058***	1.058***	0.057***	1.049***
	(0.003)	(0.003)	(0.003)	(0.003)
Community market reliance (%)	1.002***	1.002***	1.002***	
	(0.000)	(0.000)	(0.000)	
Annual real non-farm income (IDR/AE)			1.007***	
			(0.002)	
Nearest market (km)				-1.000
				(0.001)
Wealth Index: Poor (=1)	-0.963***	-0.963***	-0.964***	-0.962***
	(0.009)	(0.009)	(0.008)	(0.013)
Wealth Index: Rich (=1)	1.032***	1.032***	1.029***	1.058***
	(0.008)	(0.008)	(0.008)	(0.011)
Landholding (ha)	-1.000	-1.000	-1.000	-1.000
	(0.002)	(0.002)	(0.002)	(0.002)
Household size	1.020***	1.020***	1.020***	1.022***
	(0.002)	(0.002)	(0.002)	(0.003)
Cultivates cash crop (=1)		1.002		
		(0.008)		
HH is married (=1)	1.104***	1.104***	1.107***	1.137***
	(0.020)	(0.020)	(0.020)	(0.029)
Muslim HH (=1)	1.052	1.052	1.059	1.104
	(0.057)	(0.057)	(0.057)	(0.083)
Female HH (=1)	1.074***	1.075***	1.085***	1.113***
	(0.017)	(0.017)	(0.019)	(0.028)
Age HH (Yrs)	-1.000	-1.000	-1.000	-1.000
	(0.000)	(0.000)	(0.000)	(0.000)
HH has primary education (=1)	1.015	1.015	1.015	1.026
	(0.014)	(0.014)	(0.014)	(0.020)
HH has secondary education (=1)	1.005	1.005	1.005	1.005
	(0.018)	(0.018)	(0.018)	(0.025)
HH has higher education (=1)	1.031	1.031	1.024	1.028
	(0.026)	(0.026)	(0.026)	(0.036)
Rural area (=1)	-0.978*	-0. 978*	-0. 981	-0.980
	(0.012)	(0.012)	(0.012)	(0.018)
Survey year 2007	1.038***	1.038***	1.036***	1.056***
	(0.014)	(0.014)	(0.014)	(0.020)
Survey year 2014	1.004	1.004	1.005	1.004
	(0.012)	(0.012)	(0.012)	(0.018)
Month dummies	YES	YES	YES	YES
Observations	7,932	7,932	7,932	4,335

Notes: Results from Poisson fixed-effects regressions with HDDS9 as outcome variable. Incidence rate ratios are shown with robust and clustered (at household level) standard errors in parentheses. Income variable is used in natural log. AE= Adult Equivalent. IDR = Local currency. HH= Household head. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level

There is a significant and positive association between our preferred measure of market access - *community market reliance* with HDDS. This implies that households living in communities which are more integrated into market systems, tend to have access to more diverse diets controlling for other factors. However, the effect is quite small: an increase of 1% in *community market reliance* is associated with an increase of .02% in the household dietary diversity score. Market access proxied by the distance to the nearest market shows no effect.

Figure 1.1 shows the mean values of consumption and production of each of the individual food groups in 2000 and 2014/15.

Figure 1.1 Consumption and production of each food group in 2000 and 2014/15



Notes: Figure 1.1 presents mean values of consumption and production of all 13 food groups in 2000 and 2014/15. Values present the proportion of the sample that consumed/produced the relevant food groups. p-Values values of a t-test determining if the difference over time is statistically significant are indicated above the bars: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

We see that household consumption of fruits, vegetables, legumes, tubers, cereals, fish, and tubers all declined over that period. Household production of all of these food groups (except for fish), also declined over that same period. By contrast, consumption of meat, eggs, and dairy all increased as did their production. Consumption of prepared foods eaten inside and outside the house increased over the period. This decline in consumption of plant-based foods, increases in consumption of animal foods, and increases in prepared foods are very typical of a nutrition transition (Popkin and Gordon-Larsen 2004) with the exception of declines in sweets.[6]

Table 1.3 presents the results of Probit random-effects regressions as described in equation (2) for consumption of eight of the food groups. Since we are particularly interested in the impact of 'own production' we focus on the eight food groups which are produced by households in more than marginal quantities in Indonesia.[7] We see that 'own production' is positive and statistically significant for all of the food groups -- the probability of each food group being consumed by the household increases when the household produces it, but the magnitude of this relationship varies widely. The range of 'own production' effects for the different food groups is quite large from an effect of 66 percentage points for dairy to only 3 percentage points for cereals. Market access as measured by *community market reliance* also shows a positive and significant association with the consumption of all food groups: an increase of 1% in market access is associated with an increase of the probability of consuming each of the food groups by 1-2 percentage points.

[6] We suspect that this does not reflect an actual decline in sugar consumed, but instead the data that we used to construct the food group (sugar and soft drinks only) since detailed data on much of the packaged foods that contain sugar were not included in the survey.

[7] These are the same food groups as in HDDS9, except for eggs. Only 2.3% of the sample owned chickens.

Table 1.3 Probability of consumption of each food group

	(1) Vegetables	(2) Legumes	(3) Fruits	(4) Meats	(5) Fish	(6) Tubers	(7) Dairy	(8) Cereals
Production of food group (=1)	0.109***	0.115***	0.325***	0.188***	0.241***	0.441***	0.670***	0.030***
	(0.008)	(0.010)	(0.007)	(0.011)	(0.018)	(0.007)	(0.122)	(0.004)
Community market reliance (%)	0.001***	0.002***	0.001***	0.001***	0.001***	0.001***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Wealth Index: Poor (=1)	-0.010*	-0.060***	-0.046***	-0.097***	0.009	-0.016	-0.113***	-0.002
	(0.005)	(0.009)	(0.010)	(0.013)	(0.009)	(0.012)	(0.013)	(0.004)
Wealth Index: Rich (=1)	0.004	0.010	0.069***	0.134***	0.030***	0.049***	0.062***	0.001
	(0.006)	(0.010)	(0.010)	(0.014)	(0.010)	(0.012)	(0.013)	(0.004)
Annual real non-farm income (IDR/AE)	0.003***	0.002	0.008***	0.014***	0.008***	0.005**	0.011***	0.001
	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)
Rural area (=1)	0.003	-0.030**	-0.025*	-0.028	0.053***	-0.071***	-0.030*	-0.003
	(0.007)	(0.015)	(0.014)	(0.020)	(0.013)	(0.017)	(0.018)	(0.005)
Landholding (ha)	-0.001*	-0.003**	-0.000	0.004*	0.010***	0.000	0.003	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)
Household size	0.011***	0.012***	0.004	0.005	0.021***	0.018***	0.025***	0.005***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.001)
HH is married (=1)	0.039***	0.088***	0.066***	0.079***	0.062***	0.049**	0.062***	0.020***
	(0.007)	(0.014)	(0.015)	(0.022)	(0.014)	(0.019)	(0.021)	(0.005)
HH is muslim (=1)	0.002	0.142***	0.018	0.031	-0.007	0.077***	0.043**	0.013***
	(0.008)	(0.011)	(0.013)	(0.019)	(0.013)	(0.017)	(0.017)	(0.004)
HH is female (=1)	0.028***	0.081***	0.057***	0.096***	0.054***	0.057***	0.087***	0.017***
	(0.007)	(0.015)	(0.016)	(0.022)	(0.015)	(0.020)	(0.021)	(0.005)
Age HH	-0.000	0.001*	-0.000	0.001***	-0.001***	0.002***	0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HH has primary education (=1)	0.000	0.019*	0.003	0.062***	-0.008	0.047***	0.062***	-0.001
	(0.006)	(0.011)	(0.012)	(0.017)	(0.012)	(0.015)	(0.017)	(0.004)
HH has secondary education (=1)	0.002	0.018	0.029*	0.119***	-0.025*	0.062***	0.131***	-0.011**
	(0.008)	(0.014)	(0.015)	(0.021)	(0.015)	(0.019)	(0.020)	(0.005)
HH has higher education (=1)	0.015	0.020	0.113***	0.236***	-0.041*	0.082***	0.176***	-0.021***
	(0.014)	(0.023)	(0.029)	(0.035)	(0.023)	(0.029)	(0.030)	(0.008)
Survey year 2007 (=1)	-0.009	0.029*	-0.004	0.075***	-0.039**	-0.042*	0.058**	0.021***
	(0.010)	(0.017)	(0.018)	(0.024)	(0.017)	(0.022)	(0.023)	(0.007)
Survey year 2014 (=1)	-0.027***	-0.027*	-0.068***	-0.003	-0.039***	-0.121***	0.053***	0.013**
	(0.009)	(0.015)	(0.016)	(0.021)	(0.014)	(0.019)	(0.020)	(0.006)
Month dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	7,932	7,932	7,932	7,932	7,932	7,932	7,932	7,932

Notes: Results from Probit random-effects models using consumption of individual food groups as outcome variable are presented. Average marginal effects are shown with standard errors in parenthesis. Income variable is used in natural log. AE= Adult Equivalent. IDR = Local currency. HH= Household head. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

2.6 Discussion

The results from the analysis provide support to all three hypotheses that we set out to test in this study. We find that in the panel sample of households, production diversity has a very strong positive association with household dietary diversity and market access is also positively associated with household dietary diversity. Both effects are relatively small. When looking at the individual food groups, the impact of own production on consumption varies widely with large effects for some food groups and negligible effects for others.

Over time, this sample of Indonesian households has experienced increased agricultural specialization, higher incomes, and lower household dietary diversity. Thus it appears that while markets did enable households to increase their household dietary diversity, this was not enough to outweigh the dietary diversity that was lost from more diverse 'own production'. Three recent studies that review the past literature on production diversity and dietary diversity (Jones 2017a; Sibhatu and Qaim 2018; Ruel, Quisumbing, and Balagamwala 2018) reach a similar conclusion – most studies find a positive and statistically significant association between production and dietary diversity, but with small effect sizes. Most of the previous literature used cross-sectional data (Sibhatu and Qaim 2018), but we identified a few that used panel data: Linderhof et al. (2016) used three waves of the LSMS-ISA data for Uganda, to analyze the effect of plot level production diversity on household dietary diversity and calorie consumption. They found a positive impact of production diversity on both outcome variables. Parvathi (2017) analyzed this relationship with a two year panel dataset from Lao and found small but positive effects of farm production diversity and market access on dietary diversity. Islam et al. (2018) used a two-round panel from Bangladesh and found a positive, but small association between various measures of production diversity and dietary diversity. Using panel data from Tanzania, another study also found that agricultural production diversity had a positive and statistically significant, but small effect on dietary diversity (Chegere and Stage 2020). They also found, however, that market access had no significant effect on household dietary diversity.

We find a bigger effect size when using HDDS9 compared with HDDS10 and HDDS12 (see Appendix). One interpretation of this finding is that the relationship between

own production and diet quality is strongest for 'healthier' foods. Sibhatu et al. (2015) show a similar pattern with larger effects in their model that uses only healthy food groups. HDDS12 is a measure of 'access to food security' (Hoddinott and Yohannes 2002) and is supposed to be an indicator of the socio-economic status of a household. Thus it is surprising to see that it declined as assets (and income) increased.

The variables used to measure market access did not show greater access over the period (see Table 1.1). While community market reliance increased slightly over the period, the increase was not statistically significant. And the variable often used in other studies to indicate market access – distance to nearest market – actually increased. We hypothesize that this may be because respondents interpreted the question to mean 'wet markets' or weekly markets, as opposed to shops and mini-markets, which is why we think that this measure is not ideal for capturing market access. Vermeulen et al. (2019) report that Indonesia has been relatively slow in developing its food retail sector compared to other countries with similar income levels and compared to the rest of Asia. While the size of the association between production diversity and dietary diversity in the sample is relatively small, the magnitude of the association between own production and probability of consuming several nutrient-rich food groups is quite substantial. Focusing on fruits for example, the results imply that the probability that a household consumes fruits increases by 32.5 percentage points if it produces its own fruit. This result is of particular importance given that fruit is one of the most-nutrient rich food groups with important positive health effects (Afshin et al. 2019) and fruits are under-consumed in Indonesia – with Indonesian consuming less than half of the recommended amounts (Vermeulen et al. 2019).

This study has several limitations. First, the IFLS surveys were not designed as dietary surveys, but to look primarily at income and expenditures. This makes the data less than ideal for investigating dietary intake. However, despite the fact they are not able to tell us about individual dietary intake, they still have useful information that we exploit to tell us about overall patterns of food group consumption. They also have the advantages of being close to nationally representative and having repeated observations for the same households over time – two features which are rare to find in dietary surveys in LMICs. Second, the consumption data that we use are from a 7-day recall period instead of 24-hour recall. While the 7-day

recall period has the advantage of better capturing a household's food consumption pattern compared with a 24-hour recall, it is more prone to recall bias as people have a more difficult time recalling foods that they ate in the more distant past (Coates et al. 2012). Second, we use household level data on consumption instead of individual level data. This is not ideal for consumption information because normally there is one respondent per household and s/he is unlikely to be able to recall all of the foods consumed by everyone in their household in the preceding week. This could present a problem for the results if the respondent systematically over-reports or under-reports consumption for some members of the household who more/less frequently consume out of own production. Third, dietary diversity scores have only been validated as measures of nutrient adequacy using 24 hour individual level recall data from children under two and for adult women (Working Group on Infant and Young Children Feeding Indicators 2006; Arimond and Ruel 2004). Fongar et al. (2019), however, conclude that 7 day household level recalls were acceptable proxies for individual level dietary quality in a sample of rural households in Kenya and that therefore "household-level data can be used to calculate valid proxies of the diets of children and male and female adults when individual-level data are not available". Fourth, while using household fixed-effects in the dietary diversity regressions is able to control for time invariant unobserved heterogeneity, omitted variables that change over time could still potentially bias results. And finally, since a Hausman test rejects the use of fixed effects methods for the food group consumption regressions, there is still a possibility of bias from both time-invariant omitted household level characteristics as well as those that change over time.

2.7 Conclusion

Indonesia, like many other emerging and developing countries, is facing several nutritional challenges – declining, but still existing, undernourishment, widespread micronutrient deficiencies, and a high and rising rate of overweight and obesity. Poor diets are one important contributing factor to these nutritional challenges. Recent research has used dietary diversity as a measure of diet quality and has debated the role of agricultural specialization in changing rural diets. Agricultural specialization seems to have mixed effects on dietary diversity – a loss of as a result of decreases in the number of food groups consumed

from ‘own production’ and a gain in diversity as a result of increases in food groups consumed from market purchases enabled by higher incomes. Here we try to answer the question of which of these two effects has dominated in rural Indonesia? In the panel of Indonesian households studied here, the increase in food group consumption from the use of markets did not compensate for the decline in food group consumption from ‘own production’. We follow up with an investigation into the food groups that are responsible for this decline and estimate how much changes in own production of these food groups was associated with the declines in their consumption.

The overall impact of increased specialization on household dietary diversity for rural households in Indonesia appears to have been negative; households did not fully replace the food groups that they no longer consumed out of their own production through market purchases**.** What is especially concerning, is that the food groups that have been declining are amongst the most nutrient-rich and protective against non-communicable diseases, i.e., fruits, vegetables, legumes, and fish (Afshin et al. 2019). While some of the food groups that have increased over this period are also nutrient-rich, i.e. dairy, eggs, and meats, and can be important components of healthy diets, they also pose future risks for a population that is experiencing a rapid increase in cardiovascular diseases and overweight and obesity (Vermeulen et al. 2019).

In the end, it is not whether dietary diversity is associated more strongly with markets or ‘own production’ that matters most in order to understand how to nudge societies towards healthier diets. Dietary diversity is, after all, a summary measure that has its uses as an overall indicator, but in order to understand which food groups people are consuming and how to influence them, we have to go deeper. Particularly in the context of the nutrition transition, it is important to see the factors most strongly associated with the increase and decline of the different food groups. Here the picture is quite clear: As people are growing fewer fruits, vegetables, and legumes, they are also eating less of these nutrient-rich foods; conversely, as people’s incomes are rising they are increasingly purchasing dairy, eggs, and meat. Thus there appear to be nutritional gains and losses. The policy challenge is how to maintain the improvements in dietary quality that accompany increased specialization and rising incomes, while doing something to minimize the dietary ‘losses’ that seem to arise from declining production diversity.

2.8 Appendix

Table A1.1 Food groups and included items in dietary and production diversity indicators

Food Group	Included items in HDDS	Included items in PD	Food Group	Included items in HDDS	Included items in PD
Cereals	staples/rice, corn, sago/flour, noodles, rice noodles, macaroni, shrimp - chips, other chips, and the like	rice, corn, own production of cereals	Legumes (Legumes, Nuts, Seeds)	tofu, tempe, beans, peanuts	groundnuts, cashews and other nuts, soybean, own production of legumes
Tubers	cassava, other staples like potatoes, sweet potatoes, yam	cassava, other tubers, own production of tubers	Dairy	fresh milk, canned milk, powdered milk and the like	Cattle, own production of dairy
Vegetables	kangkung, cucumber, spinach, mustard greens, tomatoes, cabbage, katuk, green beans, string beans and the like.	red onion, other vegetables, own production of vegetables	Oils and Fats	butter, cooking oil like coconut/ peanut/ corn/ palm and the like	Own production of oils and fats
Fruits	fruits like papaya, mango, banana etc	coconut, bananas, other fruits, own production of fruits	Sweets	granulated sugar, brown sugar, cocoa drink, soft drinks, / cookies, breads, crackers	Sugarcane, own production of sweets
Meats	beef, mutton, water buffalo and the like, chicken	chickens, pigs, goats, cattle, own production of meats	Spices (Spices, Condiments, Beverages)	spices like shallot, garlic, chili, coriander, candle nuts, MSG and the like, shrimp paste, salt, sauce, soy sauce, tea, coffee, Alcoholic beverages	chili, spice, coffee, own production of spices
Eggs	bird/chicken eggs	Chickens, own production of eggs	Fish	fresh fish/seafood, salted/smoked fish	Fish, own production of fish
Prepared foods	Prepared foods eaten outside and inside the house				

Notes: This table shows the food items asked in the questionnaires and how we grouped them into each food group comparable to the FAO guidelines.

Table A1.2 Components of dietary and production diversity measures

Production Diversity Measures		Household Dietary Diversity Measures	
PD12	Cereals, tubers, vegetables, fruits, meat, eggs, fish, legumes, dairy, oils and fats, spices and condiments, sugar	**HDDS12**	Cereals, tubers, vegetables, fruits, meats, eggs, fish, legumes, dairy, oils and fats, spices-condiments and beverages, sweets
PD10	Cereals, tubers, vegetables, fruits, meat, eggs, fish, legumes, dairy, oils and fats	**HDDS10**	Cereals, tubers, vegetables, fruits, meats, eggs, fish, legumes, dairy, oils and fats
PD9	Cereals, tubers, vegetables, fruits, meat, eggs, fish, legumes, dairy	**HDDS9**	cereals, tubers, vegetables, fruits, meats, eggs, fish, legumes, dairy

Table A1.3 Describing HDDS, PD and consumption of individual food groups

	(1) 2000	(2) 2007	(3) 2014	(4) Δ 2000 - 2014
HDDS10	7.54	7.55	7.38	-0.16***
	(1.66)	(1.68)	(1.94)	(0.05)
HDDS12	9.49	9.49	9.28	-0.21***
	(1.76)	(1.77)	(2.09)	(0.05)
PD10	3.41	2.95	2.84	-0.57***
	(1.60)	(1.69)	(1.77)	(0.04)
PD12	3.84	3.28	3.28	-0.56***
	(1.80)	(1.92)	(2.04)	(0.05)
Consumption of fruits (=1)	0.82	0.81	0.75	-0.069***
	(0.38)	(0.39)	(0.43)	(0.01)
Consumption of vegetables (=1)	0.97	0.96	0.94	-0.029***
	(0.18)	(0.19)	(0.24)	(0.01)
Consumption of legumes (=1)	0.87	0.87	0.85	-0.019*
	(0.34)	(0.34)	(0.36)	(0.01)
Consumption of tubers (=1)	0.67	0.57	0.50	-0.16***
	(0.47)	(0.50)	(0.50)	(0.01)
Consumption of cereals (=1)	0.99	0.99	0.97	-0.013***
	(0.11)	(0.12)	(0.16)	(0.00)
Consumption of meats (=1)	0.47	0.51	0.54	0.069***
	(0.50)	(0.50)	(0.50)	(0.01)
Consumption of fish (=1)	0.88	0.87	0.83	-0.043***
	(0.33)	(0.34)	(0.37)	(0.01)
Consumption of eggs (=1)	0.68	0.72	0.74	0.056***
	(0.47)	(0.45)	(0.44)	(0.01)
Consumption of dairy (=1)	0.26	0.32	0.38	0.11***
	(0.44)	(0.47)	(0.48)	(0.012)
Production of fruits (=1)	0.63	0.56	0.50	-0.13***
	(0.48)	(0.50)	(0.50)	(0.013)
Production of vegetables (=1)	0.58	0.52	0.54	-0.040**
	(0.49)	(0.50)	(0.50)	(0.013)
Production of legumes (=1)	0.30	0.23	0.22	-0.082***
	(0.46)	(0.42)	(0.41)	(0.012)
Production of tubers (=1)	0.49	0.39	0.34	-0.15***
	(0.50)	(0.49)	(0.47)	(0.013)
Production of cereals (=1)	0.77	0.70	0.59	-0.19***
	(0.42)	(0.46)	(0.49)	(0.012)
Production of meats (=1)	0.35	0.33	0.37	0.016
	(0.48)	(0.47)	(0.48)	(0.013)
Production of fish (=1)	0.16	0.15	0.18	0.018
	(0.37)	(0.36)	(0.38)	(0.010)
Production of eggs (=1)	0.027	0.012	0.032	0.0047
	(0.16)	(0.11)	(0.17)	(0.0045)
Production of dariy (=1)	0.0022	0.0018	0.0068	0.0047**
	(0.046)	(0.042)	(0.082)	(0.0018)
Observations	2785	2785	2785	5570

Notes: Mean values are shown with standard deviation (sd) in columns (1), (2) and (3). Column (4) shows the coefficients with standard error (se) in parenthesis from a simple t-test, comparing the means in 2000 to 2014. Significant at 10% level. **Significant at 5% level. ***Significant at 1% level

Table A1.4 Determinants of household dietary diversity using HDDS10 and HDDS12

	(1) HDDS10	(2) HDDS10	(3) HDDS10	(4) HDDS12	(5) HDDS12	(6) HDDS12
PD10	1.052***	1.052***	1.052***			
	(0.002)	(0.002)	(0.002)			
PD12				1.039***	1.040***	1.039***
				(0.002)	(0.002)	(0.002)
Market access in community (%)	1.002***	1.002***	1.002***	1.002***	1.002***	1.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Wealth Index: Poor	-0.966***	-0.966***	-0.967***	-0.968***	-0.968***	-0.969***
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
Wealth Index: Rich	1.026***	1.026***	1.024***	1.022***	1.022***	1.019***
	(0.008)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Landholding (ha)	-1.000	-1.000	-1.000	-0.999	1.000	-0.999
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cultivates cash crop (=1)		-0.998			-0.988**	
		(0.007)			(0.006)	
Annual real non-farm income (IDR/AE)			1.007***			1.005***
			(0.002)			(0.001)
Household size	1.018***	1.018***	1.018***	1.015***	1.015***	1.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
HH is married (=1)	1.104***	1.104***	1.107***	1.093***	1.093***	1.096***
	(0.019)	(0.019)	(0.019)	(0.016)	(0.015)	(0.016)
Muslim HH (=1)	1.028	1.028	1.035	1.009	1.008	1.014
	(0.048)	(0.047)	(0.048)	(0.037)	(0.036)	(0.037)
Female HH (=1)	1.073***	1.073***	1.083***	1.064***	1.063***	1.072***
	(0.018)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)
Age HH	-1.000	-1.000	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HH has primary education (=1)	1.015	1.015	1.015	1.010	1.010	1.010
	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.011)
HH has secondary education (=1)	1.007	1.007	1.006	1.003	1.002	1.002
	(0.016)	(0.016)	(0.016)	(0.014)	(0.014)	(0.014)
HH has higher education (=1)	1.033	1.033	1.027	1.022	1.021	1.016
	(0.025)	(0.025)	(0.024)	(0.021)	(0.021)	(0.021)
Rural area (=1)	-0.981*	-0.981*	-0.983	-0.983*	-0.983*	-0.984
	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)
Survey year 2007 (=1)	1.034***	1.034***	1.032**	1.028***	1.028***	1.027**
	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.011)
Survey year 2014 (=1)	-0.996	-0.996	-0.997	-0.990	-0.989	-0.991
	(0.011)	(0.011)	(0.011)	(0.009)	(0.009)	(0.009)
Month dummies	YES	YES	YES	YES	YES	YES
Observations	7,932	7,932	7,932	7,932	7,932	7,932

Notes: Results from Poisson fixed-effects regressions with HDDS10 and HDDS12 as outcome variable. Incidence rate ratios are shown with robust and clustered (at household level) standard errors in parentheses. Income variable is used in natural log. AE= Adult Equivalent. IDR = Local currency. HH= Household head. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level

Chapter 3

Oil palm cultivation, household welfare, and exposure to economic risk in the Indonesian small farm sector[8]

[8] This essay will be published as: Mehraban, N., Kubitza, C., Alamsyah, Z., and Qaim, M. (2021). Oil palm cultivation, household welfare, and exposure to economic risk in the Indonesian small farm sector. *Journal of Agricultural Economics* 72(1). Doi: 10.1111/1477-9552.12433. NM and CK collected the survey data. NM developed the research idea, compiled the data, conducted the regression analysis and wrote the first draft. CK and MQ commented on data analysis, results interpretation and revision of the paper. ZA supported the data collection and commented on the paper.

3.1 Introduction

The rapid growth in global demand for vegetable oil over the past two decades has led to a massive expansion of oil palm in tropical regions, especially in Southeast Asia (Byerlee, Falcon, and Naylor 2017). In Indonesia, the world's largest palm oil producer, the area cultivated with oil palm more than tripled from 4 million hectares in 2000 to over 12 million hectares in 2018 (BPS 2019). This major land-use change has various implications for sustainable development (Qaim et al. 2020). Apart from environmental problems, social issues and land conflicts between palm oil companies and local communities have been reported (Abood et al. 2015; Drescher et al. 2016; Santika et al. 2019; Sarwosri et al. 2020).

However, oil palm cultivation can also have positive socioeconomic effects for local communities. In Indonesia, around 45% of the oil palm land is cultivated by small family farms rather than large companies (BPS 2019). Recent studies with village-level or regency-level data from Indonesia illustrate how oil palm production has contributed to rural economic development and poverty reduction (Edwards 2019; Gatto et al. 2017; Kubitza and Gehrke 2018). There are also several studies that used household survey data to show that smallholder farmers benefit from oil palm cultivation in terms of higher incomes and living standards (Rist, Feintrenie and Levang, 2010; Euler et al. 2017; Krishna et al. 2017a).

One drawback of existing studies with household-level data is that most are based on cross-section surveys, meaning that potential issues of endogeneity in the impact evaluation are hard to address. A second drawback is that these studies mostly look at economic effects in only one year, whereas the effects of oil palm cultivation can vary over time, for instance through fluctuating world market prices or changing policies in importing regions (Taheripour, Hertel, and Ramankutty 2019). Fluctuating world market prices can lead to significant income variability and downside economic risk for smallholders (Cramb and Curry 2012; Cahyadi and Waibel 2016; Rist, Feintrenie, and Levang 2010; Klasen et al. 2016). Oil palm is a perennial crop that requires significant capital investment for plantation establishment. Hence, farmers' ability to switch to other crops when output prices decline is limited. In such situations, downside risk can potentially lead to considerable social hardship (Morduch 1994). One recent study used two waves of survey data and confirmed that the economic effects of oil palm cultivation can vary significantly between different years (Kubitza et al. 2018a). Downside

risk was not analysed explicitly by Kubitza et al. (2018a). Nor were endogeneity issues due to unobserved heterogeneity properly addressed.

Here, we add to the literature in three particular ways. First, we provide more reliable estimates of the effects of oil palm cultivation on smallholder welfare by using three waves of panel data and regression models with pseudo fixed effects to control for time-invariant unobserved heterogeneity. Our panel data were collected in one of the hotspots of Indonesia's recent oil palm boom. Second, we analyse possible dynamic effects of oil palm cultivation on downside economic risk. This is particularly interesting because our panel data cover a period of six years (2012-2018) during which substantial price fluctuations on international commodity markets were observed. Third, we analyse the main mechanisms underlying the effects of oil palm cultivation on smallholder welfare and economic risk. Direct effects could be due to differences in per-hectare profits between oil palm and alternative crops. In addition, indirect effects could occur through the reallocation of household resources, especially labour, to other economic activities. As is known from earlier studies, oil palm requires less labour per hectare than alternative crops (Krishna et al. 2017a; Chrisendo et al. 2020), meaning that family labour can be used to cultivate a larger land area and/or for off-farm employment. In particular, reallocating labour to off-farm employment can reduce economic risk, since off-farm earnings can offset fluctuating farm earnings.

3.2 Materials and methods

3.2.1 Study region and household survey

We use data from a farm household survey conducted in Jambi Province, Sumatra, as part of a large interdisciplinary research project (Drescher et al. 2016). Jambi is one of Indonesia's main palm oil producing provinces. The traditional cash crop in Jambi is rubber, which has been widely grown since the first half of the twentieth century, mostly by smallholder farmers. Rubber is still one of the dominant crops in the region, but the importance of oil palm has grown substantially during the last 30 years (Bou Dib et al. 2018; Qaim et al. 2020).

The expansion of oil palm in Jambi started in the 1980s as part of the Indonesian government's transmigration programs. During the transmigration programs, families from densely populated Java and Bali were relocated to less populated islands such as Sumatra or

Kalimantan, where they settled in newly established transmigrant villages and received small plots of land as well as technical and financial support for oil palm cultivation (Cramb and Curry 2012). At first, these transmigrant smallholders cultivated oil palm under contract with public or private sector palm oil companies (Gatto et al. 2017). However, smallholders continued cultivating oil palm also when the company contracts expired (Euler et al. 2016; Feintrenie, Chong, and Levang 2010). In addition, many of the previous rubber farmers from the autochthonous population also gradually switched to oil palm due to its higher returns to labor (Bissonnette and Koninck 2017; Euler et al. 2017). In Jambi, an estimated 75% of the total oil palm area is cultivated by smallholder farmers, as compared to 45% for Indonesia as a whole (BPS 2019).

For our survey in rural Jambi, we selected farm households in 2012 using a multi-stage sampling framework (Euler et al. 2017). Five lowland regencies, covering most of the oil palm area in Jambi, were purposively selected. In each regency, we randomly selected four districts, and in each district, we randomly selected two villages, resulting in a total of 40 villages (including autochthonous and transmigrant villages). Five additional villages in the same regencies, where other project activities were located, were selected non-randomly (we control for non-randomly selected villages in all our regressions). In each of the 45 villages, farm households were randomly sampled proportional to village size, resulting in a total sample of 683 observations. The first survey wave was carried out in 2012, followed by two additional waves in 2015 and 2018. Over the six-year period, we experienced sample attrition of 10%, mostly due to outmigration or household dissolution after cases of death, divorce, or other reasons. We find no systematic differences in key variables between attrition households and the rest of the sample (Table A2.1 in the appendix).[9] For the analysis, we use the balanced panel of 615 households observed in all three survey waves (1845 observations). The sample can be considered representative of family farm households in the lowland areas of Jambi.

In all three survey waves, we used structured questionnaires for personal interviews with the household head. The interviews were always carried out between September and December in Bahasa Indonesia by a team of local interviewers who were trained and supervised by the researchers. The questions covered topics related to farm production and other income-generating activities over the past 12 months. Furthermore, data on household

[9] We also carried out a regression-based test for attrition bias as suggested by Wooldridge (2010). Results are shown in Table A2.2 in the appendix. The dummy testing for attrition bias is statistically insignificant.

demographics, assets, and other socioeconomic and contextual variables were collected, including a section on household consumption with a detailed breakdown of food and non-food goods and services.

3.2.2 Conceptual framework

The large majority of farm households in our sample grow either rubber, or oil palm, or both. In addition, a few farmers grow small plots with food crops. However, due to the higher profitability of rubber and oil palm and the good accessibility to purchased food from the market, food crop production has become rather uncommon in the lowland areas of Jambi. We are particularly interested whether cultivating oil palm affects household welfare and economic risk in comparison to cultivating rubber as the more traditional cash crop. In other words, we analyze the effects of adopting oil palm on household welfare and economic risk.

In general, we would assume that a farmer decides to adopt and cultivate a new crop only if this crop is more profitable and adds to household income. However, both rubber and oil palm are crops that require relatively large initial investments for plantation establishment and where the plantations then produce for several decades. Hence, farmers' profitability expectations at the time of the initial adoption decision may be wrong, or the profitability may change with evolving prices on international commodity markets. Moreover, profitability may not be fully captured by just looking at the profit per hectare of land, because oil palm adoption may have spillovers to other household economic activities. Using farm-level data from Jambi, Euler et al. (2017) showed that oil palm does not have higher average gross margins than rubber per hectare of land, whereas the return to labor is significantly higher. The reason for the higher return to labor is that oil palm requires much less labor per hectare than rubber, especially less family labor (Rist, Feintrenie and Levang, 2010; Krishna et al. 2017a; Chrisendo et al. 2020). This is also reflected in our data (Figure A2.1 in the appendix). Hence, farm households adopting oil palm instead of rubber (or switching from rubber to oil palm) can reallocate the labor saved to other economic activities, either on-farm or off-farm.

On-farm labor reallocation would mean that oil palm adopting farmers expand their farm size and cultivate additional land. Of course, this requires that additional land is available and accessible, which actually holds true in many parts of Jambi. Kubitza et al. (2018b) showed

that forest encroachment has been a common way for farm size expansion in Jambi in recent years and decades. In addition, land market transactions have become common especially in regions where forestland is scarce (Krishna et al. 2017b). And indeed, several earlier studies suggested that oil palm adoption contributes to farm size expansion in a causal way, partly driven by the lower labor requirements per hectare of land (Krishna et al. 2017a; Kubitza et al. 2018a).

Off-farm labor reallocation would mean that oil palm adopting farmers use the labor time saved for pursuing wage employment or self-employed business activities. Indeed, many farm households in Jambi have off-farm jobs or businesses in transport, trade, or other types of services (Chrisendo et al. 2020). Earnings from off-farm activities contribute to total household income and welfare. Moreover, off-farm income can help to smooth total income and consumption and thus reduce downside economic risk, especially in years with low agricultural commodity prices.

How exactly the saved labor time of oil palm adopters is used will depend on many factors, including access to land, capital, and education, all of which may vary between households. In any case, it is clear that looking at gross margins or profits per hectare alone would be insufficient to capture the broader welfare effects of oil palm adoption. The different mechanisms are explicitly considered in our regression models below.

3.2.3 Estimating effects of oil palm on household welfare

Our first research objective is to evaluate the average welfare effects of oil palm cultivation over the six-year time period covered by the survey. We measure welfare in terms of annual household consumption expenditure (including the value of purchased and home-produced goods). Especially among rural households in developing countries, consumption expenditures are usually considered a better indicator of living standard than income (Deaton 1997). Consumption expenditures are expressed per adult equivalent (AE) and deflated to 2012 prices using consumer price indices.

To estimate the effect of oil palm cultivation (adoption), we use the following regression model:

$$C_{i,t} = \beta_0 + \beta_1 \, OP_{i,t} + \, \beta_2{}' \, \boldsymbol{X}_{i,t} + \varepsilon_i \, + \sigma_{i,t} \qquad (1)$$

where $C_{i,t}$ is consumption expenditure of household i at time t, $OP_{i,t}$ is a dummy variable indicating whether or not household i cultivated oil palm at time t, $\boldsymbol{X}_{i,t}$ is a vector of control variables, ε_i is a household specific time-invariant error term, and $\sigma_{i,t}$ is a time-varying error term.[10]

We use a log-transformation of consumption expenditures for a better empirical fit. As mentioned above, households in our sample that do not cultivate oil palm grow rubber (some also grow both cash crops). Hence, the coefficient β_1 measures the effect of oil palm adoption/cultivation on consumption expenditures in percentage terms, using rubber farmers as the reference group. If oil palm has a positive effect on household welfare, β_1 would be positive and significant.

In terms of the control variables $\boldsymbol{X}_{it,}$, we include socioeconomic variables such as the household size, the number of adults, the age, sex, and education level of the household head, asset ownership, access to credit and remittances, and market distance, among others. We also control for whether or not the village in which the farm household lives was founded as part of the government's transmigration program. Finally, we include survey year dummies to control for time fixed effects, such as changes in weather conditions or commodity prices. As all households were sampled in the lowland regions of Jambi, where soil, climate, and topographical conditions are similar, regional differences in the suitability for oil palm and rubber cultivation are negligible. Specific definitions of all variables used in the regressions are shown in Table A2.3, in the appendix.

The asset variables, such as farm size and ownership of other household assets, deserve further discussion. On the one hand, larger farms and wealthier households, who have higher consumption expenditures anyway, may be more likely to adopt oil palm. Hence, not controlling for these asset variables could lead to an overestimation of the effects of oil palm

[10] In addition to the dummy variable specification of $OP_{i,t}$, we also run models with the share of the total farmland under oil palm as a robustness check, to account for differences in the scale of operation and the level of specialization.

adoption in equation (1). On the other hand, as explained above, the labour savings associated with oil palm adoption can also allow farm size expansion and off-farm activities. In that case, controlling for current asset ownership at the time of the survey might lead to an underestimation of the effects of oil palm adoption. We address this problem by controlling for initial farm size and initial wealth prior to the widespread adoption of oil palm in Jambi, for which we obtained data in the survey through recall questions.[11] Initial farm size is measured in hectares. Initial household wealth is measured through an asset-based wealth index. As suggested by Filmer and Pritchett (2001), we employ principal component analysis to construct the wealth index using information on past ownership of different types of assets, including mobile phones, motor cycles, cars, air conditioners, fridges, washing machines, and televisions. Based on this index, we construct five wealth quintiles. A variable capturing these initial wealth quintiles is included in equation (1).

To gain further insights into the mechanisms underlying the oil palm adoption effects on consumption expenditures, we include additional control variables in a stepwise manner. First, we add current farm size, which is often different from initial farm size. If it is true that oil palm adoption causes some farmers to expand their farmland, the coefficient for current farm size would likely be positive, whereas the oil palm coefficient itself would shrink. Second, we add variables to test the off-farm employment mechanism. Off-farm activities are captured through two variables, namely the number of wage employments and owned businesses within a household. In the absence of data on the exact time spent in different off-farm activities, looking at the number of own businesses and jobs seems appropriate, as most off-farm activities in rural Jambi are rather informal and related to businesses that have limited potential to grow, such as managing small shops, services in transport, working as a driver, or sometimes also working on other farms. Hence, if family members have additional time available they will likely start an additional business or job rather than investing much more time into already existing off-farm activities.

[11] For some of the households, data on initial farm size and wealth are missing so that the number of observations slightly drops to below 1800 for the three-wave panel models.

3.2.4 Estimating effects of oil palm on downside risk

Our second objective is to evaluate whether oil palm cultivation contributes to downside economic risk. Again, we use household consumption expenditures as our welfare measure but now pay explicit attention to expenditure variation over time. Even though the farm households in Jambi often do not belong to the poorest of the poor, many of them are moderately poor and therefore vulnerable to income shocks. We are particularly concerned about negative income and consumption shocks (Townsend 1995). Hence, we analyse whether oil palm cultivation influences the probability of declines in consumption expenditures using the following model:

$$Prob\ (C_{i,t} < C_{i,t-1}\ ) = \gamma_0 + \gamma_1\ OP_{i,t} + \gamma_2{}'\ \boldsymbol{X}_{i,t} +\ \varepsilon_i + \sigma_{i,t} \qquad (2)$$

where $C_{i,t-1}$ is consumption expenditure in the previous time period, and the other variables are as defined above. As our survey was conducted with three years between the different waves, we compare expenditures in the survey year with those three years earlier. As lagged expenditures are required, we estimate this specification only with observations from the 2015 and 2018 waves, using 2012 and 2015 lagged expenditure values respectively. A positive and significant coefficient γ_1 would indicate that oil palm cultivation increases the probability of downside risk, whereas a negative coefficient would point at a decreasing effect on risk. Due to the binary nature of the dependent variable, we use a logit estimator.

Again, we estimate this model in equation (2) with and without farm size and off-farm income activities included in the vector $\boldsymbol{X}_{i,t}$, to better understand the impact mechanisms. Off-farm activities are of particular interest here, as access to off-farm income may help to smooth household consumption in years with unfavourable agricultural prices or weather conditions.

3.2.5 Dealing with endogeneity

The models in equations (1) and (2) can be estimated with random effects (RE) panel data estimators. However, one potential issue with RE estimates is that they are biased when explanatory variables are correlated with the error term. Such correlation is possible especially for oil palm cultivation, $OP_{i,t}$, as farmers decide themselves whether or not to adopt based on various observed and unobserved characteristics. If correlation with the error term occurs, the fixed effects (FE) estimator is preferred, as it controls for time-invariant unobserved

heterogeneity, thus reducing endogeneity bias (Wooldridge 2010). We use the Hausman (1978) test to compare RE and FE specifications and to choose the most appropriate estimator.

One drawback of the FE estimator is that it is less efficient than the RE estimator, especially when the variation of key variables within households over time is small. In our case, variation in the oil palm cultivation dummy over time exists but is not very large; between 2012 and 2018 the proportion of farm households cultivating oil palm increased from 35% to 46%. In that case, the CRE estimator, which is often also called pseudo fixed effects, is a more efficient choice (Mundlack 1978). The CRE model controls for time-invariant unobserved heterogeneity through including household-level time means of all time-variant explanatory variables. Since these time means are held constant, the coefficients of the explanatory variables themselves only capture the within variation, similar to the standard FE model.

3.3 Results

3.3.1 Descriptive statistics

Table 2.1 presents descriptive statistics of key variables in 2012, 2015, and 2018. The average farm in our sample has a size of 4 hectares with a slight increase observed over time. The share of farmers cultivating oil palm has increased since 2012, and so has the average oil palm area per farm. Analogously, the average area grown with rubber has decreased, even though rubber remains the dominant crop. In terms of living standard, the average farm household had annual consumption expenditures of 14.5 million Indonesian Rupiah (IDR) per adult equivalent (AE) in 2012, which is around 1540 US dollars.[12] The mean expenditure level was lower in 2015, but then increased again until 2018 (all deflated to 2012 price levels).

Figure 2.1 shows factory-gate prices for oil palm fresh fruit bunches (FFB) and rubber in Jambi for the 2012-2018 period, indicating considerable price volatility. Both prices were significantly lower in 2015 than in 2012. While the price decline during this period was more pronounced for rubber, the price for oil palm showed larger fluctuations. By 2018, both prices were again higher than in 2015. As oil palm and rubber are the main income sources of farm

[12] Around 10% of the farm households fall below the extreme international poverty line of $1.90 per capita and day; around 45% are classified as moderately poor (less than $3.20).

households in Jambi, these output price variations can partly explain the changes in consumption expenditures over time. However, the consumption expenditures between 2015 and 2018 increased more than the oil palm FFB and rubber prices. Moreover, Figure 2.2 shows that the 2015 decline in consumption expenditures was only observed among the rubber farmers and not the oil palm adopters, suggesting that commodity price trends are not the only factors influencing household living standard. Indeed, Table 2.1 shows that the share of households running a small business and also the total number of businesses per household increased over time, which is especially true among the oil palm adopters. Similarly, off-farm activities also gained in importance, especially between 2012 and 2015, possibly to compensate for lower oil palm and rubber prices and revenues.

Table 2.1: Descriptive statistics for key explanatory variables

	2012		2015		2018	
	Mean	SD	Mean	SD	Mean	SD
Current farm size (ha)	3.94	(4.35)	3.99	(4.65)	4.07	(4.85)
Cultivates oil palm (0/1)	0.35	(0.48)	0.37	(0.48)	0.46	(0.50)
Cultivates rubber (0/1)	0.83	(0.38)	0.81	(0.39)	0.78	(0.42)
Oil palm area (ha)	1.02	(2.53)	1.16	(2.76)	1.44	(3.11)
Rubber area (ha)	2.73	(3.10)	2.72	(3.82)	2.52	(3.37)
Consumption expenditure (million IDR/AE/year)	14.47	(19.66)	13.90	(10.65)	15.18	(15.73)
Own business (0/1)	0.19	(0.39)	0.26	(0.44)	0.26	(0.44)
Number of own businesses	0.22	(0.49)	0.32	(0.57)	0.36	(0.67)
Employed (0/1)	0.46	(0.50)	0.56	(0.50)	0.55	(0.50)
Number of wage employments	0.62	(0.79)	0.81	(0.88)	0.82	(0.93)
Market distance (km)	6.67	(7.46)	5.47	(5.68)	4.72	(5.24)
Observations	615		615		615	

Notes: Mean values are shown with standard deviations (SDs) in parentheses. AE, adult equivalent; IDR, Indonesian Rupiah (all monetary values deflated to 2012; 1 USD = 9390 IDR in 2012).

Table 2.2 compares two subsamples over time, namely households that cultivated oil palm already in 2012 (early oil palm adopters) and those that had not cultivated oil palm during any of the survey years (non-adopters). Early oil palm adopters show an increase in mean farm size over time, whereas it decreases for the non-adopters. Furthermore, both

subsamples show an increase in off-farm activities, especially between 2012 and 2015. The increase in self-employed own businesses is much stronger for the early adopters than for non-adopters. These patterns are consistent with our conceptual framework, namely that oil palm adopters reallocate the labour time saved per hectare to expanding their farm size and to off-farm economic activities.

Figure 2.1. Price movement of rubber and palm oil between 2012 and 2018

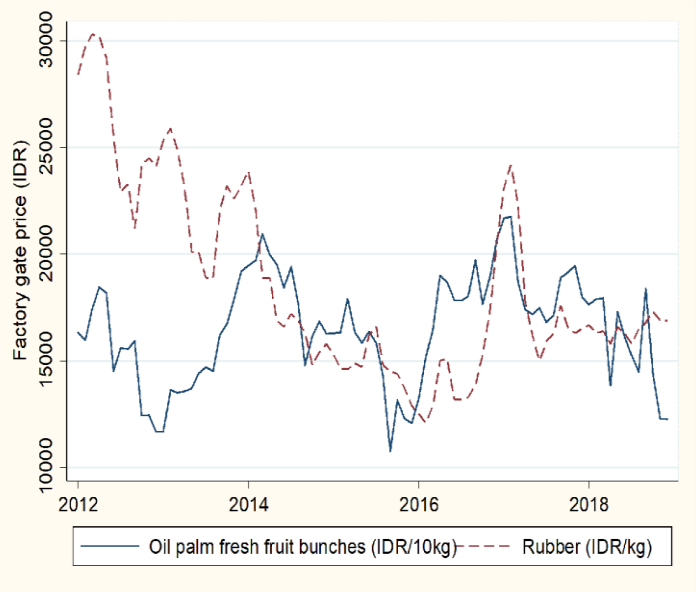


Figure 2.2. Mean consumption expenditures among oil palm adopters and non-adopters (2012-2018)

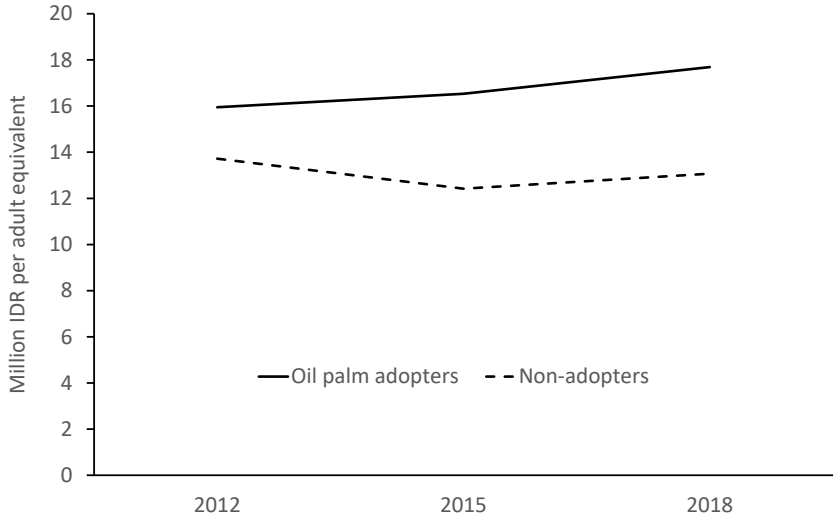


Table 2.2 compares two subsamples over time, namely households that cultivated oil palm already in 2012 (early oil palm adopters) and those that had not cultivated oil palm during any of the survey years (non-adopters). For the early oil palm adopters, we observe an increase in the mean farm size over time, whereas for the non-adopters we observe a decrease. Furthermore, for both subsamples we observe an increase in off-farm activities, especially between 2012 and 2015. Interesting to note is that the increase in self-employed own businesses is much stronger for the early adopters than for the non-adopters. These patterns are in line with our conceptual framework, namely that oil palm adopters reallocate the labor time saved per hectare to expanding their farm size and to off-farm economic activities. These mechanisms will be analyzed in more detail below.

Table 2.2 Comparison of early oil palm adopters and non-adopters

	Early oil palm adopters (had adopted oil palm before 2012)			Non-adopters (had not adopted oil palm until 2018)		
	2012	2015	2018	2012	2015	2018
Current farm size (ha)	5.20 (5.00)	5.41 (5.29)	5.59 (5.62)	3.05 (2.86)	2.86 (2.79)	2.76 (2.87)
Number of own businesses	0.26 (0.54)	0.40 (0.68)	0.40 (0.72)	0.21 (0.46)	0.26 (0.50)	0.29 (0.61)
Number of wage employments	0.59 (0.81)	0.79 (0.81)	0.75 (0.87)	0.68 (0.80)	0.87 (0.92)	0.93 (0.99)
Observations	214	214	214	307	307	307

Notes: Mean values are shown with standard deviations in parentheses.

3.3.2 Effects of oil palm cultivation on consumption expenditures

Table 2.3 presents estimation results of the consumption expenditure model (equation 1), with consumption expenditures per AE expressed in logs as dependent variable. The Hausman test rejects the null hypothesis that the RE estimator leads to unbiased results (p=0.037), so we use the CRE specifications for all models shown. Column (1) is the base model, which does not include current farm size and off-farm activities as expected impact mechanisms. The

coefficient of 0.13 for oil palm suggests that cultivating this crop is associated with a 13% increase in consumption expenditures on average.

In the other columns in Table 2.3, we analyse some of the impact mechanisms. As mentioned, oil palm requires much less labour per hectare than rubber or alternative crops, so that oil palm farmers can reallocate some of the family labour saved to cultivating additional land or to off-farm activities. In column (2) we control for current farm size, in columns (3) and (4) for different off-farm activities, and in column (5) we jointly control for current farm size and off-farm activities. In most models, these farm and off-farm activities are positively associated with consumption expenditures, as one would expect. Especially own business activities seem to be quite lucrative. On average, each additional business helps to increase consumption expenditures by 12% (column 3). At the same time, the oil palm cultivation coefficient decreases in magnitude.

These results confirm that a large part of the welfare benefits of oil palm cultivation is channelled through farm size expansion and additional off-farm activities. After controlling jointly for the different mechanisms, the direct effect of oil palm cultivation becomes statistically insignificant (column 5 in Table 2.3). This is in line with earlier research showing that the average gross margin per hectare of oil palm is not higher than that of rubber (Euler et al. 2017). Alternative model specifications with oil palm measured in terms of the share of the farmland area cultivated with this crop are shown in Table A2.4, in the appendix. These additional results confirm the positive welfare effects of oil palm cultivation and the relevance of the farm size expansion and off-farm activity mechanisms.

In Table A2.5 in the appendix, we look more specifically at impact dynamics by estimating the effects of oil palm cultivation separately for each of the three survey waves. These are OLS regressions, so that endogeneity may potentially be an issue. Nevertheless, the estimates suggest that the welfare effects of oil palm cultivation vary over time. The largest effects were observed in 2015. This is interesting because in 2015 the prices of both palm oil and rubber were particularly low. Due to the lower labour requirements in oil palm, farmers growing this crop are better able to cope with decreases in farm revenues through reallocating more of their labour time to off-farm activities. It is important to note here that the welfare effects in our models are evaluated with rubber farmers as the reference group.

Table 2.3 Effects of oil palm cultivation on consumption expenditures

	(1)	(2)	(3)	(4)	(5)
Cultivates oil palm (0/1)	0.13***	0.09**	0.11**	0.13***	0.07
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Current farm size (ha)		0.03***			0.03***
		(0.01)			(0.01)
Number of own businesses			0.12***		0.13***
			(0.03)		(0.03)
Number of wage employments				0.02	0.04*
				(0.02)	(0.02)
Household size	-0.09***	-0.09***	-0.09***	-0.10***	-0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Number of adults	0.03	0.02	0.02	0.02	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Education household head (years)	0.00	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age household head	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Female head (0/1)	-0.19***	-0.18***	-0.17**	-0.20***	-0.18***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Transmigrant village (0/1)	-0.00	0.02	0.02	-0.00	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Non-random village (0/1)	0.11**	0.08*	0.11**	0.11**	0.07
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Market distance (km)	-0.00	0.00	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Initial farm size (ha)	0.00	-0.00	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Initial wealth quintile (1-5)	0.11***	0.09***	0.08***	0.11***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Credit access (0/1)	0.10***	0.10***	0.10***	0.10***	0.09***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Remittances (0/1)	-0.04	-0.04	-0.05	-0.04	-0.05
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Survey round 2015 (0/1)	-0.05**	-0.05**	-0.06**	-0.05**	-0.07***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Survey round 2018 (0/1)	-0.03	-0.02	-0.04	-0.03	-0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Time means included [a]	Yes	Yes	Yes	Yes	Yes
Observations	1,783	1,783	1,783	1,783	1,783

Notes: Results of correlated random effects (CRE) models with annual consumption expenditures per adult equivalent (expressed in log form) as dependent variable. Coefficient estimates are shown with robust standard errors in parentheses. [a] Means over time of all time-varying observables are included. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

3.3.3 Effect of oil palm cultivation on economic risk

Table 2.4 shows estimation results of the downside risk model (equation 2), with a dummy for consumption expenditure declines as dependent variable. The Hausman test fails to reject the null hypothesis that the RE estimator leads to unbiased results (p=0.866), so that we use an RE logit estimator. The estimates shown in Table 2.4 can be interpreted as marginal effects. Column (1) shows results of a model where we do not control for the impact mechanisms. The estimate of -0.06 suggests that oil palm cultivation reduces the probability of downside economic risk by six percentage points. As discussed above, one reason for the risk-reducing effect is that oil palm adopters have more time available to earn off-farm income. This mechanism is further supported by the results in column (2) of Table 2.4, where especially the number of own businesses significantly decreases downside risk.[13]

In Table 2.5, we summarize results from additional regression models, where off-farm activities are explained by oil palm cultivation and other control variables. As the dependent variables in these models are count variables (number of own businesses and employed jobs), we use a Poisson CRE specification. Oil palm cultivation has a positive and significant effect on own business activities (column 1), whereas the effect on the number of employed jobs is statistically insignificant (column 2).

[13] The same findings are also confirmed in alternative model specifications where oil palm cultivation is measured in terms of the share of the farmland under this crop (Table A2.6, appendix). Figure A2.2 shows that the contribution of off-farm income varies over time and was particularly high in 2015, when agricultural commodity prices were low. This is another clear indication that off-farm earnings are used by farm households to smooth total income and consumption.

Table 2.4 Effects of oil palm cultivation on downside economic risk

	(1)	(2)
Cultivates oil palm (0/1)	-0.06**	-0.06**
	(0.03)	(0.03)
Current farm size (ha)		0.00
		(0.00)
Number of own businesses		-0.04*
		(0.02)
Number of wage employments		0.00
		(0.02)
Household size	0.01	0.01
	(0.01)	(0.02)
Number of adults	0.04*	0.04*
	(0.02)	(0.02)
Education household head (years)	0.00	0.00
	(0.00)	(0.00)
Age household head	0.00	0.00
	(0.00)	(0.00)
Female head (0/1)	0.05	0.05
	(0.05)	(0.05)
Transmigrant village (0/1)	0.06**	0.05*
	(0.03)	(0.03)
Non-random village (0/1)	0.00	-0.00
	(0.04)	(0.04)
Market distance (km)	0.00	0.00
	(0.00)	(0.00)
Initial farm size (ha)	0.00	0.00
	(0.00)	(0.00)
Initial wealth quintile (1-5)	0.01	0.01
	(0.01)	(0.01)
Credit access (0/1)	0.02	0.02
	(0.03)	(0.03)
Remittances (0/1)	0.10*	0.11*
	(0.06)	(0.06)
Survey round 2018 (0/1)	-0.09***	-0.09***
	(0.03)	(0.03)
Observations	1,187	1,187

Notes: Results of random effects (RE) logit models with a dummy indicating whether or not annual consumption expenditures were lower than in previous survey wave (three years ago) as dependent variable. Only observations from 2015 and 2018 included. Average marginal effects are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 2.5 Effect of oil palm cultivation on off-farm activities

	(1) Number of own businesses	(2) Number of wage employments
Cultivates oil palm (0/1)	0.17***	0.01
	(0.06)	(0.07)
Other control variables included	Yes	Yes

Notes: Marginal effects from correlated random effects (CRE) Poisson models are shown with robust standard errors in parentheses. Full model results are shown in Table A2.7, appendix. ***Significant at 1% level.

3.4 Discussion and conclusion

The rapid expansion of oil palm in tropical regions is sometimes associated with socioeconomic problems, including land conflicts between large palm oil companies and local communities. However, in Indonesia much of the oil palm land is managed by family farms. In this article, we use three waves of panel data collected over a period of six years on the Indonesian Island of Sumatra to analyse whether oil palm cultivation contributes to average welfare gains among smallholder farmers. Regression models with pseudo fixed effects showed that oil palm cultivation raises household living standards by 13% on average, after controlling for possible confounding factors. Oil palm requires much less labour per hectare than rubber or other alternative crops, allowing oil palm farmers to expand their farm activities or to pursue more off-farm economic activities. Both these mechanisms contribute to the gains in income and consumption expenditure.

These results are consistent with earlier research that analysed the effects of oil palm cultivation on smallholder welfare (e.g., Euler et al. 2017; Feintrenie et al. 2010; Krishna et al. 2017a). However, these previous studies used cross-sectional data, where endogeneity is more difficult to control. Moreover, since commodity prices are subject to international price fluctuations, data from just one year may potentially be misleading. Our panel data results are more robust and confirm that oil palm cultivation is welfare-enhancing for smallholder farmers, controlling for endogeneity and accounting for price fluctuations.

A second objective was to analyse whether oil palm cultivation affects downside economic risk. Given the observed price fluctuations on international palm oil markets, it could be expected that oil palm farmers are more vulnerable to income variations and temporary decreases in living standards. However, our data showed the opposite, namely a decrease in downside economic risk through oil palm cultivation. The main reason is that oil palm adopters have more time for off-farm activities than rubber farmers, and off-farm income is an important household mechanism to cope with economic risk. The important role of off-farm income for reducing income risk of rural households in developing countries is well established (Barrett et al. 2001; Morduch 1994; Townsend 1995), but had not previously been shown for oil palm producing households. In our study setting, self-employed off-farm business activities seem to be more important than employed jobs. Indeed, we showed that oil palm cultivation increases the number of own businesses that a household operates, even after

controlling for initial wealth levels. The same effect was not observed for employed off-farm activities, which is likely due to the limited availability of lucrative off-farm jobs in rural Sumatra.

Overall, our results suggest that oil palm cultivation has positive economic and social effects in the small farm sector of Sumatra. While studies with country-wide data show that oil palm helps to reduce poverty and promotes economic growth in Indonesia also more generally (Edwards 2019; Kubitza and Gehrke 2018; Krishna and Kubitza 2021), our micro-level results from Sumatra cannot be generalized. A recent study with data from Kalimantan suggests that not all local communities benefit to the same extent from the recent oil palm boom (Santika et al. 2019). Unlike Sumatra, where much of the oil palm land is cultivated by smallholders, in Kalimantan large palm oil companies play a more dominant role. Another important difference is that smallholder farm households in Sumatra have long been quite market-oriented, whereas many farmers in Kalimantan are still more subsistence-oriented. Depending on the context, oil palm adoption and cultivation can have different effects on local communities (Cramb and McCarthy 2016).

Our results have some important policy implications, not only for Indonesia but also more generally, as oil palm is now also expanding in other parts of the world, especially in Africa (Byerlee et al. 2017). First, oil palm cultivation can contribute to welfare gains for smallholder farmers without increasing economic risk, so long as palm oil supply chains are smallholder-inclusive. Smallholder involvement can be supported through strengthening land property rights for local farmers and communities and through improving smallholder access to credit, technologies, and technical support. Second, as the welfare effects of oil palm also depend heavily on farm households' access to off-farm activities, policies should strengthen rural off-farm development. In our study, oil palm farmers reallocated some of the labour time saved to self-employed business activities, but the availability of lucrative off-farm jobs is limited in rural Sumatra. More off-farm jobs could further improve the welfare effects and also help smallholder farmers to better cope with economic risk.

Finally, our study also has some research implications. First, while we improved on previous cross-section evaluations through using three waves of panel data collected over a period of six years, analysing welfare dynamics in more detail would benefit from longer panels. Second, longer-term studies in different regions would help to illuminate the role of

varying institutional factors. Third, while economic and social effects are two important dimensions of sustainability, the environmental dimension must not be neglected. Recent studies suggest that oil palm in diverse smallholder landscapes may be more environmentally-friendly than large-scale monoculture plantations (Qaim et al. 2020). More research that jointly considers the various sustainability dimensions is certainly warranted.

2.5 Appendix

Table A2.1 Comparison of attrition and panel households

	(1) Attrition households	(2) Panel households	(3) Difference
Cultivates oil palm (1/0))	0.43	0.35	-0.08
	(0.50)	(0.48)	(0.06)
Consumption expenditure (million IDR/AE/year)	15.42	14.47	-0.94
	(14.14)	(19.67)	(2.36)
Farm size (ha)	5.08	3.94	-1.14
	(6.20)	(4.35)	(0.59)
Household size	4.07	4.22	0.15
	(1.69)	(1.52)	(0.20)
Age of head	47.43	45.53	-1.90
	(13.71)	(12.04)	(1.57)
Education of head (years)	7.57	7.45	-0.12
	(4.02)	(3.62)	(0.47)
Observations	68	615	683

Notes: Columns (1) and (2) show mean values (standard deviations in parentheses) of variables in 2012. Panel households are defined as those that were observed in all three survey waves. Column (3) shows mean differences and standard errors in parentheses. None of the mean differences is statistically significant at the 10% level or lower.

Table A2.2 Regression-based test for attrition bias

	(1)	(2)	(3)	(4)	(5)
Cultivates oil palm (0/1)	0.28***	0.25***	0.27***	0.28***	0.23**
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Current farm size (ha)		0.02			0.02*
		(0.01)			(0.01)
Number of own businesses			0.07*		0.08**
			(0.04)		(0.04)
Number of wage employments				0.05**	0.06**
				(0.02)	(0.02)
Household size	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Number of adults	-0.02	-0.02	-0.02	-0.03	-0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Education household head (years)	0.02	0.02	0.02	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age household head	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Female head (0/1)	-0.15	-0.15	-0.14	-0.17*	-0.17*
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Market distance (km)	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Credit access (0/1)	0.02	0.02	0.02	0.02	0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Remittances (0/1)	0.06	0.06	0.06	0.07	0.07
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Survey round 2015 (0/1)	-0.05**	-0.05*	-0.06**	-0.06**	-0.07**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Attrition test dummy (0/1)	0.02	0.03	0.02	0.01	0.02
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Wald test: Attrition dummy = 0					
Prob > F	0.8668	0.7807	0.8451	0.9480	0.8367
Observations	1,322	1,322	1,322	1,322	1,322

Notes: The dependent variable is household consumption expenditure in log terms, as for the regression models in Table 3 of the main paper. The models are run with only two waves of data (2012 and 2015), because an "attrition test dummy" (whether or not the farmer was re-interviewed in the subsequent wave) is required. We add this attrition test dummy to fixed effects models. In these fixed effects models, the relevant variation for identifying a potential effect of attrition comes from households that dropped out in 2018. After estimating each model, we run a Wald test with the null hypothesis that the coefficient equals zero, which tests the null hypothesis of no attrition bias conditional on the observed covariates and time-invariant unobserved heterogeneity. The Wald test is insignificant in all models. Coefficient estimates are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Figure A2.1 Average labour input per hectare of rubber and oil palm

Table A2.3 Variable descriptions

Variable name	Variable description
Household level	
Cultivates oil palm (0/1)	Dummy indicating if household cultivates oil palm (1=oil palm cultivation; 0=otherwise)
Share of oil palm (%)	Share of total household farmland cultivated with oil palm
Consumption expenditure (per AE/year in million IDR)	Yearly consumption expenditure of the household divided by the adult equivalent score and deflated to 2012 (million IDR)
Economic shock (0/1)	Dummy indicating whether annual consumption expenditures were lower than in the previous survey wave (three years ago)
Age of household head (years)	Age of household head in years
Female headed household (0/1)	Household is headed by a female (1=female household head; 0=otherwise)
Education of household head (years)	Years of schooling of household head
Number of adults	Number of adult household members (older than 18 years)
Household size	Number of persons living in the household
Initial wealth quintile (1-5)	Asset-based wealth index referring to time period before widespread oil palm adoption occurred, generated by PCA using household assets
Remittances (0/1)	Dummy indicating whether household received any remittances in the last 12 months
Credit access (0/1)	Dummy indicating whether household had access to formal or informal credit during the last 12 months
Market distance (km)	Distance from household residence to the closest market
Current farm size (ha)	Total farm size in hectares, which includes all land owned by the household with or without formal title
Initial farm size (ha)	Total farm size referring to time period before widespread adoption occurred, which includes all land owned by the household with or without formal title
Number of wage employments	Total number of wage employment jobs of all household members
Number of own businesses	Total number of family owned businesses by the household
Village level	
Transmigrant village (0/1)	Village in which household lives was founded as part of the government's transmigrant program
Non-random village (0/1)	Village in which household lives was purposively selected during the sampling process to enable interdisciplinary collaboration. In total five out of 45 villages were purposively selected (the other 40 were selected randomly)

Table A2.4 Effect of share of farmland under oil palm on consumption expenditures

	(1)	(2)
Share of oil palm (%)	0.003***	0.002**
	(0.001)	(0.001)
Current farm size (ha)		0.031***
		(0.010)
Number of own businesses		0.130***
		(0.025)
Number of wage employments		0.039**
		(0.019)
Household size	-0.089***	-0.092***
	(0.018)	(0.017)
Number of adults	0.023	0.003
	(0.022)	(0.022)
Education household head (years)	0.009	0.007
	(0.009)	(0.009)
Age household head	-0.003	-0.004
	(0.003)	(0.003)
Female head (0/1)	-0.194***	-0.186***
	(0.071)	(0.069)
Transmigrant village (0/1)	-0.004	0.037
	(0.035)	(0.033)
Non-random village (0/1)	0.148***	0.087*
	(0.049)	(0.046)
Market distance (km)	0.000	0.001
	(0.003)	(0.003)
Initial wealth quintile (1-5)	0.116***	0.059***
	(0.012)	(0.012)
Credit access (0/1)	0.102***	0.090***
	(0.032)	(0.031)
Remittances (0/1)	-0.010	-0.031
	(0.064)	(0.064)
Survey round 2015 (0/1)	-0.044*	-0.064**
	(0.025)	(0.026)
Survey round 2018 (0/1)	-0.023	-0.043
	(0.032)	(0.031)
Time means included	Yes	Yes
Observations	1,837	1,837

Notes: Results of correlated random effects (CRE) models with annual consumption expenditures per adult equivalent (expressed in log form) as dependent variable. Coefficient estimates are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table A2.5 Effect of oil palm cultivation on consumption expenditures by survey wave

	2012		2015		2018	
	(1)	(2)	(3)	(4)	(5)	(6)
Cultivates oil palm (0/1)	0.16***	0.12***	0.22***	0.16***	0.19***	0.11**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Current farm size (ha)		0.02***		0.02***		0.03***
		(0.01)		(0.00)		(0.01)
Number of own businesses		0.13***		0.15***		0.22***
		(0.04)		(0.04)		(0.04)
Number of wage employments		0.03		-0.00		0.01
		(0.03)		(0.02)		(0.03)
Household size	-0.11***	-0.10***	-0.09***	-0.08***	-0.08***	-0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Number of adults	0.06***	0.05**	-0.00	-0.01	0.02	-0.01
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Education household head (years)	0.02***	0.02***	0.02***	0.02***	0.02**	0.01**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age household head	-0.00	-0.00	-0.00	-0.00	-0.00*	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Female head (0/1)	-0.15	-0.14	-0.15**	-0.13*	-0.17*	-0.14
	(0.11)	(0.10)	(0.07)	(0.07)	(0.10)	(0.09)
Transmigrant village (0/1)	0.07*	0.10**	0.04	0.06	-0.09*	-0.03
	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
Non-random village (0/1)	0.14***	0.10*	0.10*	0.06	0.13*	0.07
	(0.05)	(0.05)	(0.06)	(0.06)	(0.08)	(0.07)
Market distance (km)	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Initial wealth quintile (1-5)	0.11***	0.07***	0.12***	0.08***	0.11***	0.06***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Credit access (0/1)	0.05	0.05	0.09**	0.07*	0.20***	0.15***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)
Remittances (0/1)	-0.07	-0.06	0.06	0.05	-0.04	-0.05
	(0.08)	(0.08)	(0.13)	(0.14)	(0.08)	(0.07)
Observations	614	614	615	615	608	608

Notes: Results of OLS models with annual consumption expenditures per adult equivalent (expressed in log form) as dependent variable for each of the three survey years separately. Coefficient estimates are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table A2.6 Effect of share of farmland under oil palm on downside economic

	(1)	(2)
Share of oil palm (%)	-0.001**	-0.001**
	(0.000)	(0.000)
Current farm size (ha)		0.002
		(0.004)
Number of own businesses		-0.049**
		(0.023)
Number of wage employments		0.008
		(0.018)
Household size	0.013	0.010
	(0.014)	(0.015)
Number of adults	0.036*	0.040*
	(0.022)	(0.022)
Education household head (years)	0.002	0.001
	(0.004)	(0.004)
Age household head	0.001	0.001
	(0.001)	(0.001)
Female head (0/1)	0.055	0.052
	(0.049)	(0.050)
Transmigrant village (0/1)	0.062**	0.058**
	(0.028)	(0.028)
Non-random village (0/1)	0.003	0.003
	(0.043)	(0.043)
Market distance (km)	0.001	0.001
	(0.002)	(0.002)
Initial wealth quintile (1-5)	0.007	0.011
	(0.009)	(0.009)
Credit access (0/1)	0.021	0.026
	(0.031)	(0.032)
Remittances (0/1)	0.091	0.097
	(0.059)	(0.060)
Survey round 2018 (0/1)	-0.083**	-0.082**
	(0.032)	(0.032)
Observations	1,223	1,223

Notes: Random effects (RE) logit models with a dummy indicating whether or not annual consumption expenditures were lower than in previous survey wave (three years ago) as dependent variable using *share of farm under oil palm* as main explanatory variable. Only observations from 2015 and 2018 were included. Average marginal effects are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Figure A2.2 Share of farm and off-farm income (2012-2018)

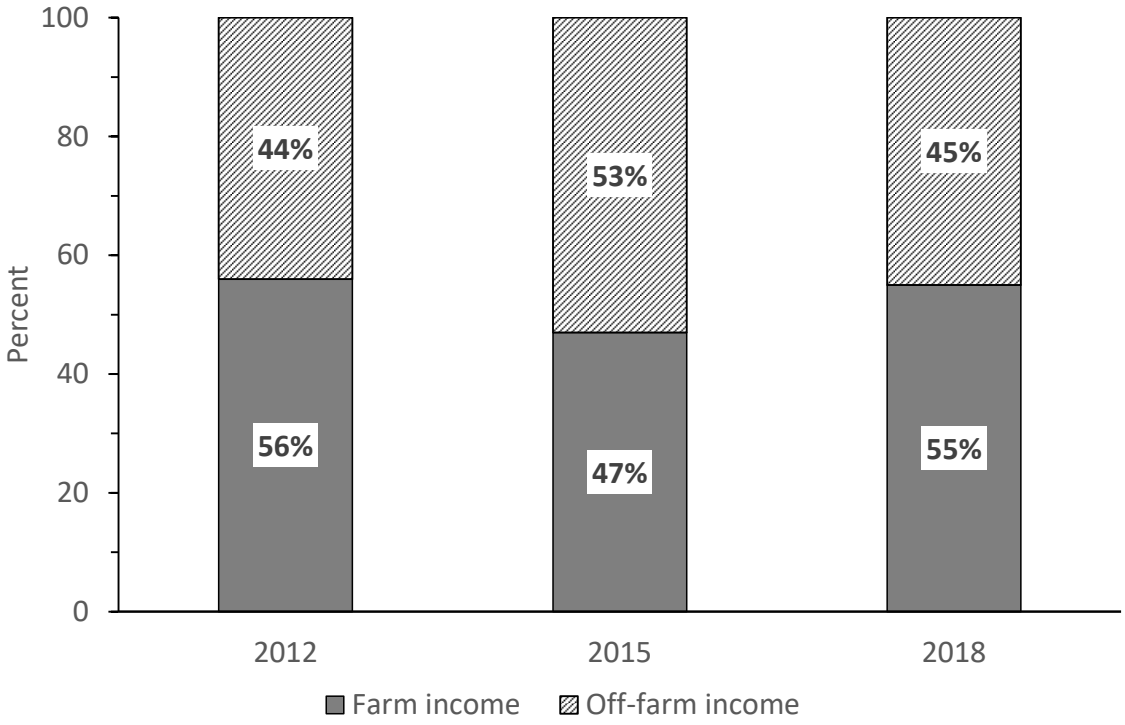


Table A2.7 Effect of oil palm cultivation on off-farm activities (full model results)

	(1) Number of own businesses	(2) Number of wage employments
Cultivates oil palm (0/1)	0.17***	0.01
	(0.06)	(0.07)
Household size	0.01	0.07***
	(0.02)	(0.03)
Number of adults	0.05*	0.16***
	(0.03)	(0.04)
Education household head (years)	0.00	0.01
	(0.01)	(0.01)
Age household head	0.00	0.00
	(0.00)	(0.00)
Female head (0/1)	-0.13	0.40***
	(0.12)	(0.10)
Transmigrant village (0/1)	-0.08**	-0.05
	(0.04)	(0.06)
Non-random village (0/1)	0.03	-0.12
	(0.05)	(0.09)
Market distance (km)	-0.00	0.00
	(0.00)	(0.00)
Initial wealth quintile (1-5)	0.10***	-0.07***
	(0.01)	(0.02)
Credit access (0/1)	0.05	0.06
	(0.03)	(0.04)
Remittances (0/1)	0.18**	0.01
	(0.08)	(0.09)
Survey round 2015 (0/1)	0.10***	0.20***
	(0.03)	(0.04)
Survey round 2018 (0/1)	0.10***	0.19***
	(0.03)	(0.05)
Time means included	Yes	Yes
Observations	1,838	1,838

Notes: Results of correlated random effects (CRE) Poisson models. Average marginal effects are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Chapter 4

What about her?
Oil palm cultivation and
intra-household gender roles[14].

[14] This essay was co-authored by Bethelhem Legesse Debela. NM had the initial research idea, which was extended by BLD. NM collected the household survey, compiled the data, analyzed the data and wrote the first draft. BLD commented on the data analysis, results interpretation and structure of the paper.

4.1 Introduction

Gender equality is recognized as a fundamental human right, and yet disparities persist everywhere. Inequalities faced by women and girls stagnate the potential of half of global population and translate into slower social progress (United Nations 2021). Female empowerment is known to be leverage towards numerous social welfare goals such as health, nutrition and education (UN 2021; Debela, Gehrke and Qaim, 2020). Gender roles and responsibilities, determining access to opportunities, change with economic circumstances (Doss 2001). Especially the adoption of new technologies such as cash crops can alter gender roles (Kaaria and Ashby 2000; Njuki et al. 2011).

One cash crop that is being increasingly adopted globally is oil palm. Indonesia has evolved into the largest producer of palm oil worldwide (FAOSTAT 2020) as the sector has been expanding in the country to meet the global demand. Oil palm cultivation in Indonesia has resulted in positive welfare effects, especially among smallholder farmers. Households gain in terms of household living standards (Euler et al. 2016; Gatto et al.,2017; Kubitza et al. 2018a). Although welfare benefits exist at the household level, the intra-household implications of oil palm cultivation might be heterogeneous. Especially in smallholder systems economic opportunities via the production of a relatively new cash crop such as oil palm can alter land use, gender roles and labor allocation, thereby causing household members to be distinctly affected (Doss 2001). This paper explores the gender-disaggregated intra-household implications of oil palm cultivation in smallholder farm households in Indonesia.

The increasing importance of oil palm can affect gender specific social relations (de Vos and Delabre 2018). In the context of rural Indonesia, women are traditionally involved in agriculture, but their role changes over time with land-use decisions and a gender bias could be observed, especially in oil palm. Compared to other crops, such as rice or rubber, women are less involved in oil palm cultivation (Villamor et al. 2015; Chrisendo et al. 2020). Since oil palm is more labor productive than competing crops such as rubber and the main activity requires physical strength (Feintrenie, Chong, and Levang 2010; Euler et al. 2016), it is mainly female labor that is released when the household moves from rubber to oil palm (Chrisendo et al. 2020).The question arises what happens with this freed labor time? Moreover, what does the land-use transition from oil palm to rubber imply for intra-household decision-making?

Despite the numerous studies existing on smallholder oil palm production in Indonesia (Feintrenie, Chong and Levang, 2010; Klasen et al. 2016; Euler et al. 2017; Bou Dib et al. 2018), only few explore gender roles (de Vos and Delabre 2018; Villamor et al. 2015; Chrisendo et al. 2020; Elmhirst et al. 2017). Those that focused on gender examined gendered experiences and responses to plantation development (de Vos and Delabre 2018), gendered engagement in oil palm using case studies (Elmhirst et al. 2017), perceptions of gender-specific roles in agriculture (Villamor et al. 2015) and female farm labor input (Chrisendo et al. 2020) and did not investigate the implications on details of labor allocation and women's decision making power. In this paper we aim to examine the effects of oil palm cultivation on gender roles within smallholder farming households. Our contribution to the literature is threefold: first, we explore the on-farm labor dynamics of oil palm cultivation. Compared to Chrisendo et al. (2020) we use three waves of panel data covering a 6-year period. Furthermore we offer a more detailed analysis of the labor dynamics, by looking at different on-farm activities and type of labor used. Second, we analyze 24-hour individual time allocation to track the reallocation of released labor. These individual-level time-use statistics are a unique tool to analyze the division of labor between men and women by covering not just the market work but also the unpaid and often unseen work inside the households. And third, we shed light on shifts in female asset ownership and decision-making power when households move from rubber to oil palm cultivation.

We use data from over 700 smallholder farm households in Jambi Province, Indonesia. For the first part of the analysis, we employ a three-wave panel data covering the period between 2012 and 2018. Using random effects estimators, we analyze the effect of oil palm cultivation on farm labor input. We then explore the cross-sectional data set from 2018 to examine the links between oil palm cultivation and male and female time allocation and female decision-making power.

This paper is structured as follows: the next section explains the conceptual framework of our study. Section three describes the research context of Jambi Province, Indonesia. While section four gives an overview of the household survey used, description of variables and empirical methods applied. Section five presents the results and the last section discusses our findings and gives some concluding remarks.

4.2 Conceptual framework

Livelihood changes among smallholder farm households - in terms of the production of relatively new cash crop - have multiple implications on the labor dynamics over time and within the households. On the one hand, farmers may expand their agricultural land use to accommodate the new crop (Krishna et al. 2017a) and thereby require more labor. On the other hand, responsibilities for the new crop by household members might alter. It can result in labor reallocation between tasks and among members of the households. Depending on the type of crop adopted, the change might free labor within the household and off-farm activities maybe sought for (Chrisendo et al. 2020). Importantly, gender roles can change as a response to changes in livelihood strategies (Fischer and Qaim 2012).

The gender aspects to labor reallocation within the household can have three different mechanisms. First, cash crop production and income are mainly controlled by males in developing countries while women are responsible for food crops (Njuki et al. 2011; von Braun and Kennedy 1994). A review by Kaaria and Ashby (2000) finds that men take over the more lucrative crops in rural areas in different contexts. Hence, male labor may potentially be disproportionately reallocated to the new cash crop.

Second, the type of crop determines how labor is reallocated along the gender lines. That is, the effect depends on whether the crop is labor intensive or labor saving. Existing studies have established that oil palm is less labor-intensive than other crops, especially rubber (Rist, Feintrenie, and Levang 2010; Euler et al. 2017). Higher labor productivity in the production of oil palms compared to traditional cash crop such as rubber releases female labor (Kubitza and Gehrke 2018). Released labor from labor intensive crops such as oil palm can result in increased off-farm participation (Chrisendo et al. 2020), especially among women (Ruml and Qaim 2020). In relation to the type of crops, cash crops that require physical strength could potentially require more male labor than female labor.

The third aspect is the effect on women's time allocation between tasks. Women in agricultural households have high labor burden and are constrained in time as they shoulder most agricultural work in addition to other household responsibilities. Labor saving cash crops such as oil palm can therefore allow women to reallocate time to compensate for potentially forgone time that could have been spent for child care and household chores.

A closely related gender dimension is the effect on the decision-making power of women. As mentioned, agricultural commercialization can bring a decline in female control

over production and income (Chege, Andersson, and Qaim 2015; Fischer and Qaim 2012; Njuki et al. 2011). However, one of the ways that women's empowerment can be enhanced is through creating income earning opportunities, including off-farm employment (Majlesi 2016; Rangel 2006) and on-farm income earning possibilities. If economic gain from cash crop production is geared towards male household members, it can potentially reduce women's decision-making power within the household. This indirectly compromises the welfare of the household as women mainly invest their income on nutrition and health, especially for their children (Hoddinott and Haddad 1995; Sraboni et al. 2014).

The different factors observed suggest that transitioning to a new cash crop can result in gender differentiated labor reallocation as well as time allocation among different activities. The labor dynamics and women's decision-making power are potentially determined by gender-based responsibility for the cash crop, the specific characteristics of the cash crop production and the time constraint of women. In this study, we investigate how the transitioning to oil palm affects gender roles by focusing on (a) how labor is distributed between males and females within the households, (b) the time allocation of males and females among on-farm work, off-farm work, domestic and care work or leisure and (c) female decision making on cash crop production and other economic activities and income allocation from cash crop and other sources.

4.3 Data and methods

4.3.1 Study context: Jambi Province, Indonesia

Jambi province, Sumatra Island is known as a hotspot of Indonesia's recent oil palm expansion (Bissonnette and Koninck 2017). Long before the palm was introduced in Jambi, natural rubber was dominating the landscapes (Otten et al. 2020). The oil palm started spreading on Sumatra in the late 1980s with the governmental transmigration program where families from the overpopulated islands such as Java were supported to move to the outer islands such as Sumatra (Feintrenie and Levang, 2009). Starting with large public sector estates, smallholders were included in the sector by contract farming schemes (Zen, Barlow, and Gondowarsito 2006). Local and transmigrant smallholders continued adopting the oil palm independently even after the state intervention declined (Euler et al. 2016). Since 2011,

the area under oil palm exceeds rubber in Jambi and is expected to expand further (Sibhatu 2019).

4.3.2 Household Survey

We use three rounds of farm household survey from Jambi province. The sampling procedure followed a multi-stage framework. First, five regencies were purposively selected. In the next step, four districts per regency with two villages per district were a random selected. Finally, 15 households on average per village (depending on the total number of households residing in a village) were selected randomly. To enable the interdisciplinary work within the project, 5 villages were selected purposively. These are found where research sites from other subprojects are located at. In the empirical models, we control for non-random selection of these villages. Our sample is representative of small-scale plantation farmers in Jambi Province. Most households cultivate rubber or oil palm or a combination of both. Only a few cultivate other crops such as cocoa, bananas, duku or rice (23 households in 2012 and 2015 and 44 households in 2018).

Data was collected through face-to-face interviews in the local language using structured questionnaires. The interviews had two parts. The first part covered topics such as cropping patterns, livestock, and other economic activities over the past 12 months. Asset endowment of the household was also asked in this part. The second part elicited consumption of food and non-food items. While the first part was usually answered by the household head, mostly men in our context, the second part was done so by the spouse of the household head or the most knowledgeable female. In about one-third of our interviews, the female household member in the households answered both parts.

Sample attrition rate over the six-year period is about 10%. Households dropped out mostly due to outmigration or household dissolution after cases of death, divorce, or other reasons. These household were then replaced by randomly selected replacement in each wave. The unbalanced panel contains 754 households interviewed in 2012, 2015 and 2018. For the first part of this paper, the three-wave panel will be used, while the second and the third part will use cross-sectional data from 2018 only as the variables of interest were only asked in the last wave.

4.3.3 On-farm labor allocation

To measure on-farm labor allocation, we use farm labor input in hours worked per year per hectare. The total labor is disaggregated into hired labor and family labor. As we are interested in the gender dimension of farm labor input within the household, the latter is further divided into female and male family labor. Three outcome variables are therefore used- hired labor, male family labor and female family labor- measuring the total hours worked by each group. For better understanding of the dynamics of on-farm work, we disaggregate labor input in different groups of activities: maintenance work, harvesting, post-harvest handling and marketing. Maintenance work includes spraying pesticides, applying fertilizer or manure, and manual weeding. Harvesting includes harvesting, pruning the oil palm leaves and tapping the rubber trees. Post-harvest handling and marketing include processing, transportation and marketing activities. In this set up, pre-planting, planting and replanting activities are omitted since these tasks rarely occur and thus are of less importance for yearly labor input. For the main variables of interest, outliers were corrected applying the 99-percentile rule.

4.3.4 Individual time allocation

We measure individual-level time allocation by looking at 24-hour time allocation data of the main female and male household members (Daum, Capezzone, and Birner 2020; Badgett and Folbre 1999). The person is asked about which activity he/she undertook at each hour, starting from 5 a.m., until midnight. These activities are grouped into six categories: working on-farm; working off-farm; household chores and care work (including childcare and caring for the sick or elderly family members); leisure activities; grooming activities; and resting or sleeping. Off-farm work sums up wage and self-employment. Most wage employment is in agriculture but also in forestry or service sector while self-employment comprises having small shops, food stalls, renting our transport or trading with goods. In 2018 only 12% of the male were self-employed and 36% wage-employed, while 10% of female were self-employed and 13% were wage-employed (see Table A3.1 in the appendix). Leisure includes activities such as watching TV, doing sports or visiting family and neighbours. While resting/ sleeping includes only napping and sleeping. We have six outcome variables, showing the hours spent on each of these groups of activities. Individual time allocation was asked from the person directly. The main male and female family members (if aged between 15-65 years) are asked about their typical working day.

4.3.5 Female decision-making power

Female decision-making power is measured by three groups of variables indicating female household member's control over assets and income. The first group measures asset ownership by females using two variables; the share of household assets owned jointly by male and female or by the female alone and a dummy variable taking a value of one if the female's name is on the land titles. In the second group, three variables are used to measure females' involvement regarding economic activities in the household. These are dummy variables measuring whether the female involved in management decisions regarding the farm, her off-farm activities and livestock. We created dummy variables taking the value 1 if the respective decision is taken by female or by both jointly. The third group uses dummy variables indicating whether the female household member is involved in the income allocation decisions from farm, her off-farm activities and livestock. These variables are a proxy of the economic decision-making power of the respective person. Women's access to productive resources and control over income can improve her status and thus her decision-making power within the household (Doss and Quisumbing 2018; Rangel 2006; Haddad, Hoddinott, and Alderman 1997). The decision-making variables were asked at every subsection at household level to the respondent of that subsection. We asked whether these decisions are taken by the male, female or by both members jointly.

4.3.6 Empirical methods

We build on a combination of descriptive and regression analyses in this study. First, three different livelihood groups are generated, by dividing the households according to what they grow, namely cultivating oil palm, cultivating rubber, and cultivating rubber plus oil palm. We then look at the variables measuring on-farm labour allocation, individual-level time allocation and female economic decision making power descriptively by comparing mean values for households cultivating oil palm or oil palm and rubber to those cultivating only rubber using a simple t-test.

Next, we continue with a regression analyses, using the share of farm under oil palm, a measure share of the total landholding currently covered by oil palm, as main outcome variable as main outcome variable. This measures the degree of specialization in the sector, which can have implications on the labor input and individual time allocation. We employ econometric models which are presented in the following subsections.

i. Household- level analysis of farm labor input

To analyse the effect of oil palm cultivation on farm labor, we run the following equation:

$$L_{it} = \beta_1 OP_{it} + \beta_2 '\boldsymbol{X}_i + \beta_3 '\boldsymbol{V}_{it} + \beta_4\, y2015 + \beta_5\, y2018 + \varepsilon_i + \upsilon_{it} \qquad (1)$$

where L_{it} refers to the specific type of labor of household *i* at time *t*. This includes hired labor, female family labor and male family labor. OP_{it} represents our main variable of interest, oil palm cultivation, measured as the share of land under oil palm. $\boldsymbol{X}_i$ is a vector of time-fixed household characteristics, such as residing in a non-random village or being of Javanese ethnicity[15]. $\boldsymbol{V}_{it}$ is a vector of time-variant household characteristics including the size of landholding in hectare to control for differences stemming from different farm sizes; an asset-based wealth index[16] to control for household economic status ; age, education (schooling years) and marital status of the household head. Lastly, we add year dummies for the years 2015 and 2018 to control for aggregated time effects, such as commodity price differences between the years.

To choose the suitable panel data model, we compared random effects and fixed effects estimators using the Hausman specification test (Hausman 1978). The test fails to reject the null hypothesis that the differences in the coefficients are not systematic for all three outcome labor input variables[17]. Thus, we conclude that the random effects model is appropriate for these models and continue by using this approach.

ii. Individual level analysis of 24-hour time allocation

Using the 2018 data, we analyse how oil palm cultivation affects individual level time allocation using the following equation:

$$H_{ij} = \alpha_1 OP_i + \alpha_2 '\boldsymbol{W}_i + \alpha_3 '\boldsymbol{P}_{ij} + \epsilon_{ij} \qquad (2)$$

H_{ij} represents hours spent on each group of activity (working on-farm; working off-farm; household chores and care work; leisure; grooming; and resting), of individual *j* from household *i*, which are regressed independently. OP_i is the share of farm under oil palm as in

[15] There are two main ethnicities in our study region: Melayu, the indigenous group and Javanese, transmigrant descendants. Only 7% of the households are of mixed or other ethnicities.

[16] The Wealth Index was constructed using household asset ownership information and Principle Component Analysis. A higher index indicates higher wealth levels.

[17] Hausman test results are shown in Table 3.3 in the results section.

equation (1). We include a set of household level controls such as ethnicity, household wealth index, household size and size of landholding in the vector $\boldsymbol{W}_i$. Additionally, we add a set of individual level controls such as age, schooling years and marital status of the individual, as represented by the vector $\boldsymbol{P}_{ij}$. ϵ_{ij} is the error term. We use OLS estimator in equation (2) as the data is cross-sectional and the dependent variables are continuous variables.

iii. Female decision-making power

We aim to explore how oil palm cultivation affects female decision-making power using the following equation:

$$D_{ij} = \theta_1 OP_i + \theta_2{}'\boldsymbol{W}_i + \theta_3{}'\boldsymbol{P}_{ij} + \sigma_{ij} \qquad (3)$$

D_{ij} represents female control over assets or income as described above. We include the same set of controls as in equation (2). σ_{ij} is the model error term. We estimate the first model of eq. (3) using an OLS estimator, as the outcome variable, share of assets owned, is a continuous variable. The other models have binary dependent variables and hence we use Logit regressions to estimate them.

4.4 Results

4.4.1 Oil palm cultivation over time

Oil palm cultivation increased over time in our sample. As we see in Table 1, the share of households cultivating any oil palm increased from 35% in 2012 to 46% in 2018. Households specializing in oil palm also increased over time, with a total of 13% and 16% in 2012 and 2018, respectively. In line with this, the share of farm under oil palm increased by about 6 percentage points on average when comparing the first and third rounds of surveys. At the same time, the share of households cultivating only rubber decreased from 61% to 48%. As established in other studies from this context (Kubitza et al. 2018a; Krishna et al. 2017a), land seems to be reallocated from rubber to oil palm plantations and households cultivating both crops are likely in this transition phase.

Table 3.1 Descriptive statistics

	2012	2015	2018
Cultivating oil palm only	0.13	0.15	0.16
	(0.34)	(0.35)	(0.37)
Cultivating rubber only	0.61	0.60	0.48
	(0.49)	(0.49)	(0.50)
Cultivating rubber and oil palm	0.22	0.22	0.30
	(0.41)	(0.41)	(0.46)
Share of farm under oil palm (%)	22.3	23.5	27.9
	(35.9)	(36.8)	(37.3)
Observations	671	680	687

Notes: Mean coefficients are presented with standard deviation in parentheses. Share of farm under oil palm is calculated for all farmers in the sample. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.4.2 Effects on farm labor division

How does the labor division between males and females look like in different faming households? Table 3.2 presents summary statistics of all farm labor input variables, first showing the total hours worked in each type of household, then hours worked by hired workers, male and female family members and then the disaggregated labor inputs by different activities.

Results suggest that oil palm cultivation is significantly less labor-intensive than rubber cultivation. The relative decrease is higher for female labor than male labor. Female family members of households specializing in oil palm cultivation seem to be rarely on farms, with only 26 hours compared to 294 hours per hectare per year in rubber cultivation. This same pattern is evident for hired labor, for oil palm growers, 80 hours out of a total of 246 hours (33%) is worked by hired labor, while only 125 out of 10246 (12%) hours is hired out in rubber growing households.

The gendered labor dynamics, namely lower female involvement, is commonly explained by the physical strength required for oil palm on-farm work (Kubitza and Gehrke 2018; Villamor et al. 2015). To better understand this dynamic we take a closer look into selected activities among the three livelihood groups. In maintenance tasks, we see no significant differences in family labor inputs between the different livelihood groups, neither for male nor for female hours worked. However, a larger share of maintenance work is done by hired laborers in oil palm and oil palm plus rubber cultivating households compared to households cultivating rubber only (Table 3.2).

Table 3.2 Household-level farm labor input in oil palm and rubber on selected activities

	(1) Farms with only rubber	(2) Farms with only oil palm	(3) Farms with rubber and oil palm
Total labor[a] all activities (hours/year/ha)	1046.55	246.17***	681.36***
	(956.47)	(284.59)	(884.21)
Hired labor[b] all activities (hours/year/ha)	125.64	80.09*	122.20
	(366.64)	(130.91)	(336.93)
Female labor[c] all activities (hour/year/ha)	294.22	26.41***	155.03***
	(452.11)	(68.50)	(371.55)
Male labor all activities (hour/year/ha)	608.50	138.21***	388.86***
	(649.34)	(230.58)	(563.21)
Hired maintenance (hours/year/ha)	4.98	9.67***	8.08**
	(19.80)	(24.04)	(24.55)
Female maintenance (hours/year/ha)	6.56	8.60	7.30
	(22.08)	(27.82)	(25.38)
Male maintenance(hours/year/ha)	26.29	32.62	26.53
	(54.05)	(57.82)	(56.19)
Hired harvesting and tapping (hours/year/ha)	111.15	63.87*	101.64
	(334.21)	(113.54)	(300.51)
Female harvesting and tapping (hours/year/ha)	275.30	15.10***	140.09***
	(429.57)	(48.20)	(350.57)
Male harvesting and tapping (hours/year/ha)	535.24	87.36***	327.12***
	(582.47)	(171.01)	(506.31)
Hired post-harvest handling and marketing (hours/year/ha)	6.58	5.47	6.88
	(26.44)	(21.64)	(27.94)
Female post-harvest handling and marketing(hours/year/ha)	10.06	0.49***	4.56***
	(23.91)	(4.24)	(17.19)
Male post-harvest handling and marketing (hours/year/ha)	39.39	14.63***	30.98***
	(70.60)	(46.29)	(71.79)
Observations	1147	299	501

Notes: Mean values of hours worked on farm on average are presented with standard deviations in parenthesis. Preplanting, planting and replanting activities are not presented as these activities are rather rare thus of less importance in labor input considerations. Comparison of mean values were undertaken using t-tests.
[a]Total labor is the sum of total hours worked by family members plus hired laborers. [b] For hired labor we do not differentiate between male and female labor input. [c] Family labor is divided into male and female.
Significance levels are shown based on the comparison of oil palm growers and oil palm plus rubber growers to rubber growers: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Harvesting is the most time-intensive activity in both cash crops, however, for oil palm it is the harvesting itself, while for rubber it is mainly the tapping of the trees that requires most labor input. Table 3.2 shows that females in oil palm cultivating households are significantly less involved in harvesting than in rubber cultivating households. At the same time, harvesting activities are to a larger extent done by hired workers in oil palm cultivating households. Turning to post-harvest activities such as transport and marketing, female

working time is negligible in all livelihood groups, but significantly lower in households with any oil palm cultivation. Although the activities are not physically demanding for females, it seems that gender norms play a role and these tasks are predominantly undertaken by males in both cash crops.

Table 3.3 Results from panel analysis of household-level farm labor input

	(1) Hired labor (hour/year/ha)	(2) Female family labor (hour/year/ha)	(3) Male family labor (hour/year/ha)
Share of farm under oil palm (0-1)	-63.99***	-218.51***	-379.46***
	(19.12)	(21.99)	(34.37)
Landholding (ha)	9.54***	-7.80***	-21.07***
	(3.05)	(2.03)	(4.26)
Household size	-8.41	-4.03	12.42
	(6.17)	(6.97)	(10.07)
Age HH	1.33*	0.04	0.62
	(0.73)	(0.97)	(1.48)
Female headed (=1)	116.38**	-39.52	-307.19***
	(45.79)	(44.50)	(64.12)
Education HH (Yrs)	4.15	-5.39	-2.35
	(3.17)	(3.62)	(4.98)
Ethnicity: Javanese	-2.50	24.15	41.63
	(17.02)	(21.35)	(33.38)
Non-random village (=1)	20.33	37.77	67.92
	(32.81)	(34.89)	(48.36)
Wealth Index	36.06***	-12.84*	-21.23*
	(8.13)	(6.90)	(11.02)
Year 2015 (=1)	76.75	190.01**	103.25
	(71.06)	(77.51)	(84.57)
Year 2018 (=1)	20.48	137.57***	125.30***
	(15.57)	(21.86)	(29.87)
Hausman P-values	0.4639	0.8769	0.6563
Observations	1,349	1,349	1,349

Notes: Coefficients from panel random-effects analysis are shown with cluster-robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

To further explore the linkages between oil palm cultivation and farm labor input, we continue with the regression results. Table 3.3 presents the results from a panel estimation of hired labor input (model 1), female family labor (model 2) and male family labor (model 3) as a function of share of farm under oil palm and other control variables. Findings show that the coefficients for 'share of farm under oil palm' is negative in all three models, but significant in

the models using male and female family labor. As the share of farm under oil palm increases by one unit, farm labor input by male and female members decrease by roughly 376 and 205 hours per hectare per year, respectively (Table 3.3). This is in line with the labor saving characteristics of oil palm cultivation compared to rubber cultivation. In absolute terms, the decrease in hours spent on farm is higher for male labor compared to the hours for female labor. However, in relative terms, this decrease is higher for females. Male family labor in oil palm cultivation is about 23% of the time spent in rubber cultivation; for females, only about 9% of the time spent on rubber cultivation is still worked on oil palm plantations (see hours worked on each crop in Table 3.2).

4.4.3 Effects on male and female time allocation

How is the labor division inside the households? And how is the freed female labor reallocated? To answer these questions, we take a closer look at individual time allocation by male and female household members. Table 3.4 presents the summary statistics of hours spent on each group of activity in different livelihood groups. We first describe female time allocation and then discuss the male time allocation. As shown in column (2), hours worked on-farm by females is significantly lower in oil palm cultivating households than in rubber cultivating ones. Off-farm work is slightly lower, but this difference is not statistically significant. Leisure time however, is significantly higher in oil palm cultivating households than in households producing rubber. Further, female hours worked inside the house, including doing household chores or care work, is also higher among households with oil palm as their major livelihood source. Mean values of hours worked for households cultivating both crops are mostly between the ones specialized in rubber or oil palm. Only off-farm work is lowest in households growing both cash crops. This could be due to restrictions faced in terms of financial or other resources in these families as these are in the process of transitioning to the relatively new cash crop (oil palm) which requires initial investment.

Table 3.4 Comparing 24-h time allocation in different livelihood groups

	(1)	(2)	(3)	(4)	(5)	(6)
		Female			Male	
	Farms with only rubber	Farms with only oil palm	Farms with rubber and oil palm	Farms with only rubber	Farms with only oil palm	Farms with rubber and oil palm
Working on-farm (hours)	2.74	1.50***	2.47	4.38	4.28	4.88
	(2.86)	(2.61)	(2.62)	(2.98)	(3.05)	(2.89)
Working off-farm (hours)	1.37	1.29	1.08	2.18	2.24	1.71
	(2.66)	(2.76)	(2.60)	(3.20)	(3.29)	(3.09)
Leisure activities e.g. TV, sports, others (hours)	3.34	3.96*	3.70	3.23	3.89**	3.33
	(2.28)	(2.52)	(2.49)	(1.90)	(2.35)	(1.95)
HH chores and care work (hours)	4.16	4.85*	4.38	0.43	0.52	0.51
	(2.83)	(2.69)	(2.59)	(0.92)	(1.18)	(1.52)
Grooming, eating/drinking, attending meetings (hours)	3.48	3.86*	3.61	4.42	4.20	4.32
	(1.49)	(1.93)	(1.78)	(1.43)	(1.46)	(1.55)
Resting/ sleeping (hours)	8.78	8.51	8.64	8.62	8.40	8.62
	(1.21)	(1.18)	(1.24)	(1.34)	(1.33)	(1.48)
Observations	268	94	173	264	96	179

Notes: Mean values of individual level time allocation data (24 h) are shown with standard deviation in parenthesis. Comparison of mean values of oil palm growers and oil palm plus rubber growers to rubber growers using a t-Test are presented with significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

These descriptive statistics show that female family members work less on-farm but spend more time working inside the house and also have more leisure time. For male household members, we only see a statistically significant difference in leisure time (columns 4 to 6). Males in households producing only oil palm have more leisure time compared to males in rubber cultivating households. We see in column (5) that male in oil palm only farms spend slightly less time on farm, but a bit more in rubber plus oil palm farms (column 6) compared to rubber only households (column 4). They spend slightly more time off-farm, less time for grooming activities and a few minutes more on household chores or child care in oil palm cultivating households than in rubber producing households. As mentioned, these differences are not statistically significant.

To test whether it is oil palm cultivation that drives the observed differences in time allocation, we continue by regressing each of the time allocation variables on the share of farm under oil palm and other control variables. Table 3.5 presents the results from the regression analysis of female time allocation. Model (1) shows that an increase in the share of farm under oil palm is significantly associated with 1.05 hours decrease in time worked on-farm by the

female household members. This is in line with the results from the household level analysis of farm labor input in Table 3.3, where we see that yearly female farm labor input decreases with the increase in the share of farm under oil palm. Time worked off-farm shows a negative coefficient, but this result is not statistically significant. As shown in the descriptive results, this variable's variation is relatively small, probably too small to show significant changes.

Table 3.5 Regression results of individual level female 24-h time allocation

	(1) Working on-farm	(2) Working off-farm	(3) HH chores and care work	(4) Leisure	(5) Grooming	(6) Resting
Share of farm under oil palm (0-1)	-1.05***	-0.18	0.61**	0.64**	0.35*	-0.31**
	(0.30)	(0.33)	(0.30)	(0.27)	(0.21)	(0.14)
Landholding (ha)	0.05**	-0.05	0.00	0.01	-0.02	0.01
	(0.02)	(0.04)	(0.02)	(0.03)	(0.02)	(0.01)
Household size	-0.19**	-0.03	0.33***	-0.10	-0.01	0.01
	(0.08)	(0.08)	(0.08)	(0.07)	(0.05)	(0.03)
Female is married (=1)	-0.91	-0.21	0.13	-0.47	1.22***	0.16
	(1.89)	(1.55)	(1.30)	(0.45)	(0.42)	(0.82)
Age of female	-0.00	-0.00	-0.06***	0.04***	0.01	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Ethnicity: Javanese (=1)	0.01	0.02	-0.10	-0.09	-0.08	0.21**
	(0.23)	(0.24)	(0.22)	(0.20)	(0.15)	(0.10)
Education of female (Yrs)	-0.05	0.08**	0.05	-0.05*	0.01	-0.04**
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)
Non-random village (=1)	-0.68**	-0.07	-0.60**	1.12***	0.36	-0.16
	(0.34)	(0.33)	(0.30)	(0.36)	(0.23)	(0.19)
Wealth Index	-0.26***	0.16	-0.01	0.08	0.01	0.02
	(0.08)	(0.10)	(0.09)	(0.07)	(0.07)	(0.04)
Observations	562	562	562	562	562	562

Notes: Coefficients from OLS regression on female time allocation are shown with robust standard errors in parentheses. Outcome variables are transformed to share of time spend on each activity in % of 24 hours. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

The coefficient estimates for the share of farm under oil palm in the models for household chores and care work (model 3), leisure (model 4) and grooming (model 5) are both positive and significant. An increase in share of farm under oil palm is associated with an increase in time spent on household activities by 0.61 hours (37 minutes), leisure activities by 0.64 hours (38 minutes) and grooming by 0.38 hours, i.e. 23 minutes. Further, we see a significant decrease in sleeping and resting time by 0.31 hours, i.e. 19 minutes (model 6).

In the following we will interpret some of the control variables in Table 3.5. Landholding size is associated with an increase in female time on-farm while household wealth is associated with a decrease in on-farm working time. This implies that females are more involved on bigger farms, but less so in wealthier households. Female education has a significant and positive coefficient in the off-farm work model but a negative and significant one in the household chores and care work model, suggesting that more educated females work more off-farm and spend less time doing house work or enjoy leisure time.

Table 3.6 contains the results from the regression analysis of male time allocation. We observe a statistically significant positive association between share of farm under oil palm and male leisure time (coefficient estimate of 0.6 hours or 36 minutes) (model 4). Further, findings show a significant decrease in resting and sleeping time by 0.35 hours, i.e. 21 minutes (model 6) as the farm under oil palm increases by one unit. Resting, which includes resting and sleeping time, is decreasing for males and females with oil palm expansion.

Table 3.6 OLS analysis of individual level male 24-h time allocation

	(1) Working on-farm	(2) Working off-farm	(3) HH chores and care work	(4) Leisure	(5) Grooming	(6) Resting
Share of farm under oil palm (0-1)	0.37	-0.16	-0.00	0.59**	-0.13	-0.35**
	(0.35)	(0.37)	(0.13)	(0.24)	(0.17)	(0.15)
Landholding (ha)	0.07**	-0.10**	0.01	0.02	-0.01	0.02
	(0.03)	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)
Household size	0.04	-0.00	0.08	-0.04	-0.02	-0.07*
	(0.09)	(0.09)	(0.05)	(0.06)	(0.04)	(0.04)
Male is married (=1)	3.00***	-5.28***	0.22	0.97	-0.02	1.54***
	(0.65)	(1.90)	(0.26)	(1.07)	(0.61)	(0.52)
Age of male	-0.00	-0.08***	0.00	0.03***	0.02***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Education of male (Yrs)	-0.02	0.05	-0.01	-0.05**	0.03*	-0.02
	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)
Ethnicity: Javanese(=1)	0.10	-0.19	0.05	-0.03	0.03	0.17
	(0.26)	(0.27)	(0.11)	(0.17)	(0.13)	(0.12)
Non-random village (=1)	-0.09	-0.03	-0.09	0.07	0.60***	-0.13
	(0.41)	(0.43)	(0.15)	(0.31)	(0.22)	(0.22)
Wealth Index	-0.27***	0.17	0.03	0.04	-0.00	-0.00
	(0.10)	(0.11)	(0.04)	(0.06)	(0.05)	(0.04)
Observations	562	562	562	562	562	562

Notes: Coefficients from OLS regression on male time allocation are shown with robust standard errors in parentheses. Outcome variables are hours spent on each group of activity in absolute terms. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

4.4.4 Effects on female decision-making power

How is her decision-making power affected when households move from rubber to oil palm? Table 3.7 compares female decision-making power between the different livelihood groups. We observe that women are involved in farm management decisions in 35% of the households cultivating rubber only (column 1) and 22-23% in households cultivating oil palm (column 2 and 3). Compared to rubber cultivating households, females are significantly less involved in the decisions regarding the farm in oil palm and oil palm plus rubber cultivating households. Overall, females are more involved in management decisions regarding the households' off-farm activities, which are more pronounced in rubber cultivating households with 65% female involvement compared to 49% in the oil palm plus rubber cultivating households. Livestock seems to be more managed by female members without significant differences among the three livelihood groups.

Table 3.7 Comparing female asset ownership and decision-making in different livelihood groups

	(1) Farms with only rubber	(2) Farms with only oil palm	(3) Farms with oil palm and rubber
Female involved in decision-making regarding			
Farm (=1)	0.35	0.23*	0.22**
	(0.48)	(0.42)	(0.42)
Off-farm activities (=1)	0.65	0.55	0.49*
	(0.48)	(0.50)	(0.50)
Livestock (=1)	0.65	0.68	0.58
	(0.48)	(0.47)	(0.50)
Female involved in income allocation from			
Farm (=1)	0.89	0.77**	0.81**
	(0.31)	(0.42)	(0.39)
Off-farm (=1)	0.88	0.92	0.84
	(0.32)	(0.27)	(0.37)
Livestock (=1)	0.85	0.86	0.81
	(0.36)	(0.35)	(0.39)
Asset ownership			
Female name on land title (=1)	0.14	0.09	0.13
	(0.35)	(0.29)	(0.34)
Share of household assets owned by female or both	0.48	0.46	0.50
	(0.35)	(0.33)	(0.33)
Observations	324	108	207

Notes: Mean values are shown with standard deviation in parenthesis. Cross-sectional data from 2018. t-Test comparing mean value of female asset ownership and decision-making between different livelihood group with significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

We observe a significant difference in involvement in farm income allocation decisions between the groups. While 89% of females are involved in the use of farm income among rubber cultivating households, 77% of females are involved among the oil palm cultivating families, hence showing less involvement among households producing oil palm. Income from household off-farm activities is mostly (84-92%) controlled by females in all households. In the families cultivating both crops, she is less involved in decisions regarding the use of income from off-farm activities. Income from livestock is also mainly controlled by female members, with no significant differences across the three livelihood groups. The summary statistics reveal that females in general are more involved in the use of household income rather than management decisions; this pattern is apparent in farm, off-farm and livestock activities. This finding is in line with prior studies in the study area, suggesting that rural women are in general more involved in household finance rather than doing physical agricultural work (Villamor et al. 2015).

Share of assets owned jointly or by females only is slightly lower in households cultivating oil palm only. The proportion of women with their names on land titles is less in oil palm and oil palm plus rubber cultivating households than rubber cultivating households. However, the differences in these two asset-based variables are not statistically significant.

Results from the regression analyses of decision-making variables on share of farm under oil palm, conditional on further control variables are presented in Table 3.8. We run eight models with asset ownership and decision-making variables. Only two models show significant results for the main variable of interest, the share of farm under oil palm. These are the decisions regarding the farm (model 1) and farm income allocation (model 4). An increase in the share of farm under oil palm is significantly associated with a decrease in the probability of females being involved in decisions regarding the farm and farm income allocation decisions.

We conclude that females lose decision-making power regarding farming activities and the use of income from farm when households move from rubber to oil palm cultivation.

Table 3.8 Results from OLS regressions on share of assets and female involvement in decision making

	(1) Farm (=1)	(2) Off-farm activities (=1)	(3) Livestock (=1)	(4) Income allocation from farm (=1)	(5) Income allocation from off-farm	(6) Income allocation from livestock (=1)	(7) Female name on land title (=1)	(8) Share of household assets owned by female or both
Share of farm under oil palm (0-1)	-0.53**	-0.12	-0.07	-1.05***	0.16	-0.19	-0.55	-0.01
	(0.26)	(0.36)	(0.30)	(0.28)	(0.55)	(0.36)	(0.42)	(0.04)
Landholding (ha)	-0.02	-0.02	-0.01	-0.02	0.03	0.00	0.07***	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.00)
Household size	-0.05	0.01	0.14*	-0.09	0.06	0.04	0.03	-0.02*
	(0.07)	(0.09)	(0.08)	(0.08)	(0.14)	(0.09)	(0.11)	(0.01)
Married	-0.55		-1.17	0.75		0.10	-0.37	-0.06
	(0.72)		(1.04)	(0.86)		(1.07)	(1.07)	(0.12)
Age of female	0.00	0.01	0.00	0.00	-0.00	-0.00	0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.00)
Education of female (Yrs)	0.00	0.06	-0.07**	0.02	-0.02	-0.06	0.02	0.01*
	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)	(0.05)	(0.05)	(0.00)
Ethnicity: Javanese	-0.01	0.23	-0.32	-0.43*	-0.71*	-0.35	-0.85***	-0.03
	(0.18)	(0.29)	(0.23)	(0.24)	(0.42)	(0.31)	(0.30)	(0.03)
Non-random village (=1)	-0.70**	-0.10	-0.49	-0.38	-0.88	-0.51	-0.12	0.09**
	(0.30)	(0.37)	(0.33)	(0.31)	(0.55)	(0.39)	(0.50)	(0.04)
Wealth Index	0.01	-0.29***	-0.01	-0.02	-0.57***	-0.08	-0.25**	0.01
	(0.07)	(0.10)	(0.08)	(0.09)	(0.15)	(0.11)	(0.11)	(0.01)
Observations	627	245	375	627	248	375	418	666

Notes: Coefficients are shown with robust standard errors in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

4.5 Discussion and conclusion

This study has explored the labor dynamics and the implications for gender roles of smallholder oil palm cultivation in Jambi province. Findings reveal that oil palm cultivation is associated with lower on-farm family labor as well as lowered hired labor. However, in oil palm production a higher share of the on-farm labor requirement is done by hired workers. This could be due to the short time span that the fruits have to be harvested and sold.

We find that female family members in households cultivating oil palm spend less time on-farm compared to households cultivating rubber only. This freed labor is reallocated towards household chores and childcare as well as towards leisure activities. A study from Vietnam describes a similar pattern; after farm households adopt a labor-saving technology, females reallocate part of their freed labor into child care and community activities (Paris and Chi 2005). This behaviour could benefit other household members and small children in particular, as maternal time is shown to improve child nutrition (Debela et al. 2020). But working off-farm would improve her financial autonomy (Chiputwa and Qaim 2016), meaning that there is a potential trade-off. Results further show that for male household members, only leisure time seems to show significant increase and resting a significant decrease as households increase the cultivation of oil palm.

In relation to the links with shifts in female economic decision-making, results indicate that oil palm cultivation is negatively associated with female involvement in decisions regarding the farm business and farm income allocation. This could imply that female-decision making power is lowered and hence compromises her financial autonomy. A study from Malawi and Uganda, shows that women tend to control higher shares of income from a specific crop if they are actively involved in marketing the commodity (Njuki et al. 2011). This could imply for our context that since women are less involved in the production and marketing of oil palm, their decision-making power regarding farm management and farm income use seems to be lowered.

These results can have different implications. First, decreased market-oriented farm work among women could indicate lowered economic empowerment since the female family member is not earning and thus not controlling the income. In combination with increased

time allotted to reproductive activities, it could imply that females are pushed into traditional gender roles, where males are the breadwinner and women are the homemaker. Second, the increase in leisure time could be empowering for the female as she can spend this time for the benefit of her own well-being. This is a desired outcome since females in many developing countries face time-poverty as they involve in both household and market work (Grassi, Landberg, and Huyer 2015). Results therefore suggest that females are more time-empowered due to more leisure time but less economically empowered due to reduced control over farm income and decision-making. However, we found significant associations for only two aspects of decision-making power, and thus results should be interpreted cautiously. But an important question remains whether she is pushed out of agriculture into a more traditional role, i.e., activities inside the house.

Important policy implications arise from this study. The introduction and expansion of new commercial crop among farm households needs consideration of gendered implication on labor reallocation and the potential impact that follows as a result. Hence, such interventions need to ensure that women are equally benefiting from new cash crop introduction, possibly by ensuring enough representation among female and male farmers. However, the burden of reproductive and domestic work for women should be taken into account in order to avoid excessive burden on women. Further, creation of off-farm employment opportunities is paramount so that freed labor can be followed by gainful opportunities outside of the traditional farm work, especially for women. This contributes to women's economic autonomy within the household. A particular relevance is for cash crops that are less labor intensive, such as oil palm, and hence causing underemployment within the household.

4.6 Appendix

Table A3.1 Household member characteristics

	2012		2015		2018	
	Male	Female	Male	Female	Male	Female
Age	43.3	38.7	45.3	41.6	49.6	44.6
	(10.5)	(10.2)	(9.85)	(10.0)	(11.6)	(10.8)
Married	0.99	0.99	0.99	0.99	0.98	0.99
	(0.12)	(0.10)	(0.11)	(0.094)	(0.12)	(0.12)
Ethnicity: Melayu	0.49	0.49	0.36	0.40	0.47	0.49
	(0.50)	(0.50)	(0.48)	(0.50)	(0.50)	(0.50)
Ethnicity: Javanese	0.43	0.43	0.48	0.44	0.45	0.44
	(0.50)	(0.50)	(0.51)	(0.50)	(0.50)	(0.50)
Ethnicity: Mixed	0.013	0.012	0.071	0.067	0.017	0.013
	(0.11)	(0.11)	(0.26)	(0.25)	(0.13)	(0.12)
Education in schooling years	7.85	6.83	7.62	6.63	7.50	6.56
	(3.47)	(3.53)	(3.54)	(3.64)	(3.56)	(3.63)
Working (=1)	1.00	0.51	0.99	0.64	0.95	0.55
	(0.056)	(0.50)	(0.11)	(0.48)	(0.22)	(0.50)
Working on own agriculture (=1)	0.97	0.38	0.93	0.47	0.84	0.37
	(0.16)	(0.49)	(0.26)	(0.50)	(0.37)	(0.48)
Working outside of farm	0.46	0.19	0.58	0.29	0.48	0.23
	(0.50)	(0.39)	(0.49)	(0.46)	(0.50)	(0.42)
Self employed (=1)	0.14	0.087	0.17	0.13	0.12	0.100
	(0.35)	(0.28)	(0.38)	(0.33)	(0.33)	(0.30)
Employed (=1)	0.33	0.100	0.45	0.18	0.36	0.13
	(0.47)	(0.30)	(0.50)	(0.39)	(0.48)	(0.34)
Observations	633	663	613	672	650	681

Notes: Mean values are presented with standard deviation in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Chapter 5

General conclusion

Rapid land-use change due to an increasing global demand for agricultural goods has had ecological, economic and social implications. Indonesia is an excellent case study to analyze these far-reaching consequences, since the emerging country has underwent large land-use transformations with the expansion of cash crops, especially oil palm, over the past two decades. While the ecological effects have received a lot of attention in previous studies, this dissertation analyzes the social and economic dimensions of recent land-use changes in rural Indonesia.

5.1 Main findings and discussion

This dissertation contains three essays analyzing two broader research objectives related to social and economic dynamics of the recent land-use changes in Indonesia. The first objective is to understand, how changes in the farm production system affect dietary quality over time. While the second research objective is to examine, how the oil palm expansion is associated with household economic welfare and intra-household gender roles in smallholder farming systems.

Essay one contributes to the first research objective by examining changes in households' food choices over time in response to the changes in production systems. It hypothesizes that reductions in production diversity as a result of agricultural specialization are associated with reductions in household dietary diversity due to the reduced consumption of crops that are no longer produced by the household. It further hypothesizes that greater market access resulting from improvements in infrastructure is associated with increases in household dietary diversity through market purchases of diverse foods. Results show positive relationships between production diversity and household dietary diversity as well as between market access and household dietary diversity. However, the overall decline in dietary diversity over time is linked to the same households that have reduced the diversity of food crops produced. Results show that the decline in dietary diversity was mostly driven by the decreased consumption of nutritious food groups (fruits, vegetables, legumes, and fish).

Although the magnitude of the association between dietary diversity and production diversity was relatively small, the association between household production and consumption of some important food groups was quite substantial. Thus it can be concluded that the overall impact of increased specialization in Indonesia during the period 2000–2015 on dietary quality appears to have been negative. Furthermore, this indicates that a nutritional transition is well underway and could lead a double or triple-burden of malnutrition, since the Indonesia has still to fight undernourishment, while at the same time, overweight, obesity and micronutrient deficiencies are emerging. Thus more nuanced policies that tackle nutritional quality, are necessary to shift this trend towards the right direction. Food security should not be understood as access to enough calories but rather access to the right calories that are needed for a healthy and nutritious diet. The process of modernization comes with certain nutritional challenges: as people grow fewer fruits, vegetables, and legumes, they are also consuming less of these nutrition-dense foods, while increase in income has been positively associated with the purchase of dairy, eggs and meat. The challenge here is to maintain the improvements, while acting towards minimizing the losses. In contrast to these findings other studies from Sumatra show that the adoption of oil palm improved the quality of household diets over time (Chrisendo et al. 2020; Sibhatu 2019). This could be because farm households were already market oriented and thus the increased income due to the high-value cash crop oil palm improved household dietary quality (Nurhasan et al. 2020).

Findings from the second research objective of this dissertation underline the positive socio-economic welfare effects of oil palm adoption. Prior studies show that smallholder farmers benefit economically from cultivating oil palm. In addition, the second essay examines whether farm households also benefit in the long term and considers potential exposures that affect economic risk. The results show that oil palm cultivation increases household living standards, measured by annual consumption expenditure during the period 2012-2018. Moreover, the findings demonstrate that oil palm cultivation can reduce households' economic risk, measured in terms of potential decreases in living standard. The risk-reduction effect is evident despite fluctuating international palm oil prices as oil palm requires less labour than alternative crops such as rubber. This freed family labour is then reallocated to other economic activities such as off-farm work, which helps to smooth income and consumption.

The social implications of oil palm specialization present mixed results. The last essay focuses on oil palm cultivating households and explores the impacts of oil palm expansion in Indonesia from a gendered perspective. The essay hypothesizes that male and female household members are affected differently by the increasing expansion oil palm. Three tests are presented. First, this study explores how on-farm labour dynamics differ between males and females in oil palm cultivating households. Second, it examines the association between oil palm cultivation and individual level time allocation of females and males within the household. The last test determines whether female involvement in oil palm cultivation could also influence female economic decision making power in oil palm versus rubber cultivating households. Results show that oil palm cultivation decreases on-farm family labour input, especially female labour. Results also suggest that as the share of farm under oil palm cultivation increases, females spend less time on farms, more time on work inside the house and enjoy more leisure time. For males, time allocation does not differ significantly with land-use type, except for more leisure time among male members as the intensity of oil palm cultivation increases. Findings reveal that females are more likely to lose intra-household decision-making power in terms of decisions regarding farm management and income allocation from the farm.

One important policy implication from these findings is that supporting the rural non-farm sector is crucial to ensure the economic sustainability of oil palm cultivators' livelihoods. Investments in the rural non-farm sector could help farmers to diversify their income and reduce their exposure to potential risks that come with a perennial cash crop such as oil palm. This could for instance happen by investments in rural infrastructure to support economic activities and build stronger markets or credit institutions. Investments in public goods, such as schools or kindergartens, could also help to mitigate potential implications for gender roles. As essay three shows, women are released from on-farm work and reallocate this time towards care and domestic work. Having kindergartens for instance could reduce the care work burden on women and allow them to pursue other economic activities. This will help to insure female economic autonomy. The importance of the rural non-farm sector can also address concerns of gender equity by providing greater work opportunities for women. It is vital to recognize that heterogeneous implications of oil palm expansion. Although there is an overall positive effect on welfare at the household-level, the implications for the females can be mixed.

In conclusion, Indonesia's agricultural sector can serve as an engine for its further development and oil palm could play an important role in this process. However, to achieve sustainable development, the ecological, economic and social implications of agricultural development strategies need to be accounted for. The findings from this dissertation show how complex the interplay between the different dimensions of human well-being is. Economic improvements might not accompany social ones: policies aiming to increase incomes might not improve household health or nutrition. Gains might be realized at household-level but not trickle down to all its members equally due to power structures such as gender. Therefore it is crucial to go beyond income gains in the evaluation of process of interventions and to look into the different spheres of human well-being. Adding the ecological sustainability adds to this complexity, and yet, needs to be included in the equation to ensure the long-term well-being of humans and the planet. The challenge, however, remains how to harmonize these different aspects.

5.2 Limitations and scope for future research

This section describes the limitations of this dissertation and opportunities for future research to address these knowledge gaps.

The first essay analyzes overall consumption patterns for Indonesia and how these change over time with agricultural production systems. Although this is an important contribution for recording these changes and revealing consumption patterns, it falls short in analyzing the individual dietary quality. Future research could identify national-level surveys with actual 24-hour individual food intake data combined with 7-day recall household-level data. Furthermore, looking at vulnerable groups such as women or children separately could mark an important contribution to target these groups adequately. While the IFLS data set used here covers over 83% of Indonesians, it suffers from a regional bias as the eastern islands are underrepresented. Therefore, greater research on consumption patterns in this region is needed to avoid sample biases. Although the existing IFLS EAST data set is only cross-sectional these data could provide important insights into dietary patterns of Eastern

Indonesians who are often more remote from market access and experience higher levels of poverty.

Essay two analyzes the longer term welfare effects and potential economic risk for oil palm cultivating households. The study show that off-farm income helps to reduce exposure to downside risks, but this does not account for the ecological risks that could occur. Climatic change, for example, could increase the frequency and intensity of droughts and other extreme weather events, all of which could endanger specialized smallholders. Furthermore, this study only focuses on smallholders from the island of Sumatra. Future research should explore the welfare effects of oil palm cultivation for different regions of Indonesia to identify the winners and losers and contextual factors that drive these differences.

The last essay explores how gender roles are affected by oil palm cultivation within smallholder farm households. Diving into an under-researched sphere of oil palm expansion, this study offers novel insights. However, there are some limitations. First, this essay looks into farm households cultivating their own land and does not include laborers. Landless female laborers might not be released but pushed out of agriculture and thus lose important income sources. Future research should examine explicitly the effects on gender roles in non-farm households. Second having only cross-sectional data to analyze the implications for individual level time allocation and female economic decision making power falls short in establishing causality. Using panel data sets can overcome this limitation.

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General appendix

CRC 990: "Determinants of land use change and impact on household welfare among smallholder farmers"

University of Göttingen – University of Jambi – IPB

Household survey questionnaire
(Farm survey; round 3; 2018)

1. Household identification

1. Village (name):			
2. Dusun (name or number):			
3. RT (number):			
4. Household code (given by supervisor):			
5. Name of the current household head:			
6. Name of the current respondent:			
7. Was the household interviewed in 2015? (*If no, go to question 14)*	Yes/No		
8. Name of household head in 2015:			
9. Did the household head change since 2015?	Yes/No		
10. Name of respondent in 2015:			
11. Did the respondent change since 2015?	Yes/No		
12. Why did the respondent change? (Code A)			
13. Did the household change place of residence after 2015?	Yes/No		
14. GPS co-ordinates of the household :	……..….S; ……..…. E;……....…Alt		
15. Mobile phone numbers:	Primary: Secondary: Tertiary:		
16. Distance from the household's dwelling to the nearest market /trading center (km)			
17. Household interviewed by other sub-projects?	C01: Yes / No	B09: Yes / No	
18. Interviewer (name):			
19. Supervisor (name):			
20. Date of interview:	...../ ...../ 2015	Enumerator's signature:	
21. Date questionnaire was checked by	...../ ...../ 2015	Supervisor's signature:	

supervisor:			

Code A: currently out of village = 1; moved out of the household = 2; passed away = 3; others (specify) = 4.

2. General farm data

2.1 Cropping activities

What kind of crops are you currently growing **on your farm:**

	Area under cultivation (ha)		For how much of this land (ha), you have		The certificate is under whose name? (1=Male; 2=Female; 3=Both)
	In 2015	In 2015	Systematic certificate	Sporadic certificate	
1. Oil palm (total)					
a. Oil palm (independent)					
b. Oil palm (under contract)					
2. Plantation and jungle rubber (total)					
a. Plantation and jungle rubber (independent)					
b. Plantation and jungle rubber (under contract)					
3. Other plantation crops 1: _____					
4. Other plantation crops 2: _____					
5. Other plantation crops 3: _____					
6. Homestead and kitchen garden					
7. Rice					
8. Other annual crop 1: _____					
9. Other annual crop 2: _____					
10. Other annual crop 3: _____					
11. Fallow land (no cultivation in last 12 months)					

2.2 Land ownership and management

1a. In the last 12 months, did you **own** any land, which is cultivated by some other household? *(e. g. sharecropping as landlord)* (*Land should be included in table 2.1)*	Yes/No	If yes, under output sharing?..... Yes/No
		If yes, share of harvest received as rent:……..% Size of land under output sharing:…… ha
		If no, rent you received for renting out:……..Rp '000/ha/year Size of land under rent arrangements:…… ha
1b. In the last 12 months, did you **own** any land, which is cultivated by a company?	Yes/No	If yes:
		Size of such land: …… ha
		Rent you received for renting out:…… '000/ha/year.
2. In the last 12 months, did you cultivate any land together with another farmer or group of farmers or co-operative society? *(Collective farming)*	Yes/No	If yes:
		Total land under this arrangement:…… ha
		How much of the land you own is under this arrangement? …… ha
		No. of farmers in the group: ……
3a. In the last 12 months, did you cultivate any land, owned by others? *(e.g. sharecropping as tenant)* (*Land should not be included in table 2.1)*	Yes/No	If yes, under output sharing?..... Yes/No
		If yes, share of harvest received as wage:……..% Size of land under output sharing:…… ha
		If no, rent you paid for renting in:……..Rp '000/ha/year. Size of land under rent arrangement:…… ha

3. History of crop cultivation

3.1 Migration **(ONLY FOR NEWLY ADDED FARMERS, OTHERWISE CONTINUE TO 3.2)**

a. Did the household migrate from somewhere to this village? ……. (Yes/No) (*If no, go to 3.2*).

b. If yes, did the household migrate as part of transmigrant programme? …… (Yes/No)

c. If yes, the crop associated with transmigrant programme: Oil palm/ Rubber/Others (specify):……..

Details of starting of cultivation and contract for **transmigrant** households:

1. When did the household migrate to the village? (Year)	
2. Who was the head of the household at the time of migration? (Code A)	
3. If you were **not** the head of household at time of migration, age of the household head at that time (Years)	
4. The place from where the household migrated to this village? (Code B)	
5. What was the major source of income for the household before migration? (Code C)	
6. What was your household size before migration? (number of household members)	
7. How many of **your family members**…. (number)	
a. Came to this village in your group of migration? (including respondent)	
b. Arrived in this village after you came? (exclude the members born here)	

8. Was there a house already built for you in this village (e.g. by the government)?		Yes / No
9. What was the size of land provided by government as part of the transmigrant programme?	a. Plantation (ha)	
	b. Food crops (ha)	
	c. Housing (m^2)	
10. Number of years you obtained livelihood assistance (food, cloths etc.) from government?		

Code A: current HH head = 1, father/mother of current HH head = 2; grandparent of current HH head = 3; brother/sister of current HH head = 4; other (specify)= 5
Code B: Other part of Jambi = 1; Java = 2; North Sumatra = 3; South Sumatra = 4; Kalimantan = 5; Sulawesi = 6; others (specify) = 7
Code C: crops = 1; fisheries and livestock = 2; wage labour = 3; small business = 4; others (specify) = 5

3.2. Household details at plantation start (*Do not include the crop covered under transmigrant programme. But if a transmigrant household started another crop later, that information should be included in this table.*)

	Oil palm	**Plantation or jungle rubber**
1. Have you ever cultivated the crop? (*If no, go to next column*)	Yes / No	Yes / No
a. Was the household already interviewed in 2015? (*If no, go to question 2*)	Yes / No	Yes / No
b. Have you started cultivating the crop after 2015? (*If no, go to next column*)	Yes / No	Yes / No
2. When did the household start cultivating the crop? (Year)		
3. Which of your family members first started the cultivation/ obtained the plantation? (Code A) *(If Code A=1 go to question 5)*		
4. If some other household member (and **not** the current head) started the plantation, then:		
a. Relation of that member with the current household head (Code B)		
b. Age of this member at starting of the estate (Years)		
c. Gender of this household member (male =0, female = 1)		
d. Education of this member when the estate was started (Years in school):		
e. Was he/she residing in this village for all his/her life?	Yes / No	Yes / No
f. If no, when did he/she migrate to this village (Year)		
5. Was the **whole estate** planted by the household? (*If yes, go to question 6*)	Yes / No	Yes / No
a. Size of the estate that was **not** established by household (ha)		
b. Number of oil palm / rubber trees already existing in that		

	Oil palm	Plantation or jungle rubber
field		
c. What was the average age of trees? (years)		
6. **Before** the plantation was started,		
a. How many **adult** family members were there in your household (number)?		
b. How much land did your household have under cultivation? (ha)		
c. For how much of this land did your household have a land title? (ha)		
d. Were any of your relatives already cultivating the crop?	Yes / No	Yes / No
e. How many of the other farmer households in your neighborhood/RT started the cultivation before you? (number)		
7. Total number of households in the neighborhood/ RT at that point of time?		
	Please go to next column	*Please go to next table*

Code A: current HH head = 1; previous HH head = 2; acquired through marriage = 3; others (specify) = 4

Code B: father/mother =1; grandparent = 2; brother = 3; in-laws = 4; others (specify) = 5

3.3. Oil palm

- **If the farmer ever cultivated oil palm (***If not, go to 3.4.):*
  a. Area under oil palm in 2015:……. ha
  b. How many hectares do you have today? ……. ha
- **If newly added farmer:**
  c. With how many hectares did you start cultivation? …….ha
  d. How many times was the area under this crop changed from the start of cultivation until today? ……
- **If the farmer was already interviewed in 2015:**
  e. How many times the area under the crop was changed after 2015 until today? ……times (*if 0, go to 3.4*)

Details of changes (**changes after 2015** for farmers interviewed in 2015**; all changes** for newly added farmers):

		Starting or 2015	Change 1	Change 2	Change 3
1. What was the size of land under oil palm at the beginning OR after the change (ha)?					
2. Nature of change (Expansion=1; Reduction=2)					
3. When did the farmer start cultivating/ changed the area under the crop? (Year)					
4. How did this change in land area happened? (Code A)					
a. *If Code A = 1 or 2*	Land area (ha) purchased/sold				
	Land price paid/received ('000 Rp/ha)				
b. If Code A =1 or 3, what crops/plants were there on the land when converted? (Code B)					
c. If Code A =6, 7 or 8, what crops/plants were there on the land when land was received? (Code B)					
d. If Code A =7 or 8, which year did you got the land title in your name? (NA if not obtained so far).					
5. Total plantation establishment costs per ha ('000 Rp/ha; excluding the land price; only for clearing the land and planting the seedlings)					
6. How did you organize the investment amount (land price + conversion cost)? (Code C) *(If Code C is not 2 go to question 7)*					
a. Source(s) of this credit? (Code D)					
b. Amount of credit ('000 Rp)					
c. (Prescribed) duration of the credit (months)					
d. Interest rate (% annual)					
e. Repayment completed? (Yes/No)					
f. Year of last payment					
In case of reduction of land area					
7. Why was plantation size reduced? (Code E)					
a. If Code E =4, was there a conflict associated?			Yes/ No	Yes/ No	Yes/ No
b. If Code E = 3, what was the total amount compensation obtained ('000 Rp)					

Code A: purchasing = 1; selling = 2; converted from/to other crops = 3; conversion from forest = 4; obtained as part of a government programme (e.g."transmigransi") = 5; established plantation obtained from company=6; inherited = 7; received as gift = 8; others (specify) = 9
Code B: oil palm = 1; plantation rubber = 2; jungle rubber = 3; other plantation = 4; annual crops (specify) = 5; grassland=6; forest=7; bush =8; others (specify) = 9
Code C: savings = 1; credit = 2; parents/spouse = 3; no need to pay at the beginning = 4; others (specify) = 5
Code D: banks = 1; private company = 2; money lender = 3; friends/relatives = 4; farmer cooperative = 5; other farmers =6; others (specify) = 7
Code E: land sold=1; land contracted out to other family = 2; land submitted to a company = 3; land lost without compensation=4; land given away to other family member or relative = 5; other (specify) = 6

3.4. Plantation and Jungle Rubber

- **If the farmer ever cultivated rubber (***If not, go to 3.5.):*
  a. Area under rubber in 2015:……. ha
  b. How many hectares do you have today? ……. ha
- **If newly added farmer:**
  c. With how many hectares did you start cultivation? …….ha

d. How many times was the area under this crop changed from the start of cultivation until today? ……

- **If the farmer was already interviewed in 2015:**

  e. How many times the area under the crop was changed after 2015 until today? ……times (*if 0, go to 3.5*)

Details of changes (**changes after 2015** for farmers interviewed in 2015**; all changes** for newly added farmers):

		Starting or 2015	Change 1	Change 2	Change 3
1. What was the size of land under rubber (plantation and jungle) at the beginning OR after the change (ha)?					
2. Nature of change (Expansion=1; Reduction=2)					
3. When did the farmer start cultivating/ changed the area under the crop? (Year)					
4. How did this change in land area happened? (Code A)					
a. *If Code A = 1 or 2*	Land area (ha) purchased/sold				
	Land price paid/received ('000 Rp/ha)				
b. If Code A =1 or 3, what crops/plants were there on the land when converted? (Code B)					
c. If Code A =6, 7 or 8, what crops/plants were there on the land when land was received? (Code B)					
d. If Code A =7 or 8, which year did you got the land title in your name? (NA if not obtained so far).					
5. Total plantation establishment costs per ha ('000 Rp/ha; excluding the land price; only for clearing the land and planting the seedlings)					
6. How did you organize the investment amount (land price + conversion cost)? (Code C) *(If Code C is not 2 go to question 7)*					
a. Source(s) of this credit? (Code D)					
b. Amount of credit ('000 Rp)					
c. (Prescribed) duration of the credit (months)					
d. Interest rate (% annual)					
e. Repayment completed? (Yes/No)					
f. Year of last payment					
In case of reduction of land area					
7. Why was plantation size reduced? (Code E)					
a. If Code E =4, was there a conflict associated?			Yes/ No	Yes/ No	Yes/ No
b. If Code E = 3, what was the total amount compensation obtained ('000 Rp)					

Code A: purchasing = 1; selling = 2; converted from/to other crops = 3; conversion from forest = 4; obtained as part of a government programme (e.g."transmigransi") = 5; established plantation obtained from company=6; inherited = 7; received as gift = 8; others (specify) = 9

Code B: oil palm = 1; plantation rubber = 2; jungle rubber = 3; other plantation = 4; annual crops (specify) = 5; grassland=6; forest=7; bush =8; others (specify) = 9

Code C: savings = 1; credit = 2; parents/spouse = 3; no need to pay at the beginning = 4; others (specify) = 5

Code D: banks = 1; private company = 2; money lender = 3; friends/relatives = 4; farmer cooperative = 5; other farmers =6; others (specify) = 7

Code E: land sold=1; land contracted out to other family = 2; land submitted to a company = 3; land lost without compensation=4; land given away to other family member or relative = 5; other (specify) = 6

HH number:…….. Name of crop:…… Section 2

4. Cost of cultivation of all crops cultivated during the last 12 months (including the kitchen garden)

a. How many permanent laborers are employed on your farm? ……. (number)
b. Wages paid per month: …….. ('000 Rp/month)

Crop name		Perennials					Annuals				Home-stead and kitchen garden
		Oil palm	Rubber (plantation + jungle)	Other 1	Other 2	Other 3	Crop 1	Crop 2	Crop 3	Crop 4	
1. Name of the main crop (if an annual crop is cultivated in more than one season, consider it as an additional crop)											
3. Total area under cultivation under this crop (ha)											
4. Area under production (ha)											
5. Area under share-cropping (ha)											
6. If yes, which share does the farmer receive?											
7. Do you intercrop the plots? *(If no, go to question 13)*		Yes/ No	Yes/ No	Yes/ No	Yes/ No	Yes/ No	Yes/ No	Yes/ No	Yes/ No	Yes/ No	
8. If yes, number of intercrops (report number of types of crops in homestead and kitchen farm)											
9. Area under intercropping (ha)											
10. Names of major intercrops (different plants/trees in case of homestead farming)	1										
	2										
	3										
11. **Intercrop 1**											
a. Number of harvests during last 12 months											
b. Quantity (kg) produced during last 12 months											
c. Quantity (kg) marketed											
d. Avg. price received during last 12 months ('000 Rp/kg)											
12. **Intercrop 2**											
a. Number of harvests during last 12 months											
b. Quantity (kg) produced during last 12 months											
c. Quantity (kg) marketed											
d. Avg. price received during last 12 months ('000 Rp/kg)											

Crop name	Perennials	Annuals	Home-stead

HH number:…….. Name of crop:…… Section 2

	Oil palm	Rubber (plantation + jungle)	Other 1	Other 2	Other 3	Crop 1	Crop 2	Crop 3	Crop 4	and Kitchen garden
13. **Intercrop 3**										
a. Number of harvests during last 12 months										
b. Quantity (kg) produced during last 12 months										
c. Quantity (kg) marketed										
d. Avg. price received during last 12 months ('000 Rp/kg)										
14. **Main Crop**										
a. Number of harvests during last 12 months										
b. Quantity (kg) produced during last 12 months										
c. Quantity (kg) marketed										
d. Avg. price received during last 12 months ('000 Rp/kg)										
15. **Quantity of inputs** applied for the crop plots (quantity/season for annuals and quantity/year for perennials) for **all main and inter-crops** in last 12 months*										
a. Seeds/Seedlings ('000 Rp spent by household)										
b. Manures ('000 Rp spent by household)										
c. Chemical fertilizers ('000 Rp spent by household)										
d. Pesticides ('000 Rp spent by household)										
e. Herbicides ('000 Rp spent by household)										
f. Hired male and female labour on daily basis ('000 Rp spent by household)										
g. Hired animal/machine labour ('000 Rp. spent by household)										
16. Which household members are more involved in crop management and decisions, like selecting varieties, choosing fertilizers etc. (Code A)										
17. Which household members are more involved in deciding the use of income generated? (Code A)										

Code A: 1=Male; 2=Female; 3=Both

* Remember that we are not asking for the total cost of inputs/labour used for the crop, but the actual amount spent by the household for the crop. In case of sharecropping, these two values may differ.

5. Plantation crops: Plot endowment and production relations (Only **OIL PALM / RUBBER**)

5.1. General plot information [*A plot is defined as a piece of land under one crop, which is not segmented spatially and where the managerial practices are common and palms/trees are of approximately same age. Complete one column before going to the next.*]. How many plots do you own?.....

	Research plot 1	Plot 2 (*C01/B09*)	Plot 3	Plot 4
1. Area of plot (ha)				
2. Number of palms/trees in the plot				
3. Number of productive palms/trees in the plot				
4. Do you intercrop the plot?	Yes/No	Yes/No	Yes/No	Yes/No
5. Ownership of land: Owned/Leased-in	Own/Lsd-in	Own/Lsd-in	Own/Lsd-in	Own/Lsd-in
6. Are you employing sharecropping tenants in this plot? *(If no, go to question 7)*	Yes/No	Yes/No	Yes/No	Yes/No
a. If yes, how many of farm households are involved? (number)				
b. When did this sharecropping arrangement start for this plot? (year)				
c. Does the sharecropping tenant belong to your ethnic group?	Yes/No	Yes/No	Yes/No	Yes/No
d. Is the sharecropping tenant your close relative?	Yes/No	Yes/No	Yes/No	Yes/No
e. Did you sign a written agreement before starting the sharecropping?	Yes/No	Yes/No	Yes/No	Yes/No
f. Input cost (%) provided by your household				
g. Share of output (%) provided as wage				
h. Did the share of output provided as wage increase over last 3 years?	Yes/No	Yes/No	Yes/No	Yes/No
i. If applicable, was the drop in rubber price the main reason for the increase?	Yes/No	Yes/No	Yes/No	Yes/No
7. Who is currently managing the plot? (Code A)[18] (*If Code A is 1 go to question 9)*				
8. If entrusted someone else (e.g. plantation company, other farmer etc.):				

[18] **Code A**: household = 1; entrusted to company = 2; entrusted to farmer cooperative = 3; other farmer =4; others = 5 (specify)
Code B: Yes, Systematic Certificate = 1; Yes, Sporadic certificate = 2; Yes, Letter from village head or Segal = 3; None = 4
Code C: migrant household= 1; transmigrant household = 2; autochonous household = 3.
Code D: Financial needs = 1; Migration = 2; Unproductive land = 3, Other (specifiy) = 4.

a. Monthly costs paid by household ('000 Rp.)				
b. Monthly revenues obtained by household ('000 Rp.)				

	Research plot 1	Plot 2 (*C01/B09*)	Plot 3	Plot 4
9. Is there a land title (certificate) for this land in your (or some other household member's) name, at present? (Code B)[19] *(If none go to question* 10)				
a. If there is a land title or certificate in your (or some other household member's) name, do you have it with you at present (and not with other person/ institution, e.g. a credit institution)?	Yes/No	Yes/No	Yes/No	Yes/No
b. Was there a land title (certificate) for this plot when you obtained the land? (Code B)				
10. Was the plot purchased? *(Ask only if new plots are aquired after 2015)*	Yes/No	Yes/No	Yes/No	Yes/No
a. If yes, year of purchase?				
b. If yes, from whom was the plot purchased? (Code C)				
c. What was the reason of the household for selling the land? (Code D)				
11. Was this plot self-established (that is, the household did **not** obtain an estate established by someone else)? *(If no go to question 11)*	Yes/No	Yes/No	Yes/No	Yes/No
12. In case of self-establishment; year of establishment?				
13. In case plot was **not** established by the household, how did you acquire the plot? (Code E)[20]				
14. If at least part of the estate was not established by the household				
a. Year of procurement/purchase				
b. Number of palms/trees already existing in the plot				
c. Age of palms/trees at the time of procurement				

[20] **Code E**: transmigrant programme = 1; other government programme = 2; purchased from other farmers = 3; inherited = 4; obtained from company = 5; others (specify) = 6.

HH number:…….. Name of crop:…… Section 2

15. Year of first harvest ever				
16. Year of last replanting in the plot (*put NA if never replanted*).				
17. If replanted, year of first harvest after replanting (*if harvesting is not started, indicate expected year of first harvest*)				
18. Varieties grown (1 = Improved; 0 = Local)				

	Research plot 1	Plot 2 (*C01/B09*)	Plot 3	Plot 4
19. Distance from the plot to:				
Home (meters)				
Nearest road (meters)				
Nearest village center (meters)				
20. Have you noticed any land grabbing or land expropriation from any farmers by government, other farmers, plantation company near this plot?	Yes/No	Yes/No	Yes/No	Yes/No
If yes, the year of occurance of this event(s). A time period may be given (e.g., 1998-2001) if the event is occurring over time				
21. Have you ever used an animal/insect/any living being to control a crop pest (including weeds) or disease?	Yes/No	Yes/No	Yes/No	Yes/No
22. Do you keep the cut-off plants and crop residues on the plot?	Yes/ No	Yes/ No	Yes/ No	Yes/ No
23. How do you rate your soil fertility (High = 2; Medium = 1; Low = 0)				
24. What is the color of the soil? (Black=1; Red=2; White/Light=3;Yellow=4; Other=5)				
25. What is the texture of the soil? (Very fine=1; Fine=2; Between coarse and fine=3; Coarse=4;Very coarse=5)				
26. Were there any problems with erosion in the last agricultural season?	Yes/ No	Yes/ No	Yes/ No	Yes/ No
27. What were the causes for the erosion? (Wind=1; Rain=2; Animals=3; Cultivation which does not comply with soil conservation=4; Other=5)				

5.2. Product marketing: **All productive plots of the crop**

a. Number of times output was sold during the last 12 months:…… (number)
b. Through how many outlets the output was sold during last 12 months:……. (number)
c. During the last 12 months, from how many traders **can** you choose one for selling output: ……. (maximum number)

Outlets where the output was sold in last 12 months (name)	Type of outlet (Code A)	Do you have a contract relation with outlet?	% of output sold through this outlet during the last 12 months	Product transport to the outlet point		
				in km (*0 if purchased at farm-gate*)	mode of transportation (Code B)	time taken for transportation (hours)
1.		Yes/ No				
2.		Yes/ No				
3.		Yes/ No				
4.		Yes/ No				
5.		Yes/ No				
6.		Yes/ No				

Code A: private plantation = 1; government plantation = 2; private trader in village = 3; private trader outside village = 4; farmer group or cooperative = 5; others (specify) = 6

Code B: farm-gate selling = 0; walking = 1; cycle = 2; ojek = 3; angkot = 4; bus = 5; truck = 6; tractor = 7; others (specify) = 8

6. Plot identification
   a. Did the farmer start to cultivate the crop after 2015 or is newly added?.....(Yes/No) [*If farmer started to cultivate the crop after 2015* ***or*** *the farmer is newly added use additional pages to report information on* ***all*** *new plots in chapter 5.2; 5.3 and 5.4 and proceed to section 5.1*]

   b. *Please let the farmer identify the plots with the data provided from all his plots.*

Research Plot: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Additional C01/B09/Research Plot: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Additional C01/B09/Research Plot: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Other Plot: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Other Plot: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Other Plot:: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Other Plot:: Size:…… ha; Age of plantation:…….. years; Distance from home:……m
Other Plot:: Size:…… ha; Age of plantation:…….. years; Distance from home:……m

a. Did the farmer clearly identify the research plot? ……...(Yes/No)
b. If applicable, did the farmer clearly identify the additional C01/B09/Research plot? ……...(Yes/No)
c. If applicable, did the farmer clearly identify the additional C01/B09/Research plot? ……...(Yes/No)

6.1. Input use during last 12 months: **Research plot** (*Report only data from the identified research plot*)

Inputs in **research plot**	1. Name of input	2. Number of times used	3. Unit of measurement	5. Quantity used (QU/plot/**year**) *(report in total and not per times)*	6. Average price of input as used during last 12 months ('000 Rp/Unit)
1. Seedlings (I planting)*			Number		
2. Seedlings (replanting)*			Number		
3. Manure: Plant waste			kg		
4. Manure: Animal waste			kg		
5. Soil amendments	Lime / Gypsum		kg		
6. Chemical fertilizers			kg		
			kg		
			kg		
			kg		
			kg		
7. Herbicides			litres		
			litres		
			litres		
8. Pesticides			litres		
			litres		
			litres		
9. Irrigation (excl. labour cost)			'000 Rp		
10. Machinery			'000 Rp / liter		
11. Input transport			'000 Rp / liter		
12. Output transport			'000 Rp /liter		
13. Materials for output processing in rubber			'000 Rp		
14. Others (specify)			'000 Rp		

*only if planting or replanting was done during the last 12 months

6.2. Labor use during last 12 months: **Research plot**

Labour use in **research plot**	1.a Rainy season		1.b Dry season		2. Average working hours per day	3. Contracted out the operation? (Yes = 1/ No = 0)	4. If contracted out, cost of operation ('000 Rp)	5. If not contracted out, hired laborers/ operation (number)		6. Wage rate ('000 Rp/worker day) *(put **sc** if sharecropping)*		7. Family members involved/ operation (Give Member IDs)	
	# of opera-tions	Days per operation	# of opera-tions	Days per operation				Men	Women	Men	Women	Men	Women
1. Land clearing for planting													
2. Other pre-planting activities													
3. Taking pits for planting													
4. Seedling transportation													
5. Planting													
6. Replanting													
7. Manure application													
8. Fertilizer application													
9. Chemical weeding on the ground													
10. Manual weeding on the ground													
12. Manual weeding on trees													
13. Chemical weeding on trees													
14. Pesticide application													
16. Irrigation													
17. Intercultural operations (esp. for soil improvement)													
18. Tapping (only for rubber)													
19. Harvesting													
20. Processing of product													
21. Transportation to market													
22. Marketing													

HH number: ..... Name of crop:…… Kind of plot:…….. Section 2

Labour use in **research plot**	1.a Rainy season		1.b Dry season		2. Average working hours per day	3. Contracted out the operation? (Yes = 1/ No = 0)	4. If contracted out, cost of operation ('000 Rp)	5. If not contracted out, hired laborers/ operation (number)		6. Wage rate ('000 Rp/worker day) *(put **sc** if sharecropping)*		7. Family members involved/ operation (Give Member IDs)	
	# of opera -tions	Days per operation	# of opera -tions	Days per operation				Men	Women	Men	Women	Men	Women
23. Cutting leaves of oil palm													
24. Others (specify)													

6.3. Average harvested quantity in the last 12 months: **Research plot**

Season of year	1. Frequency of harvests (once in how many days?)	2. Quantity harvested per month from this plot (kg/plot)	3. Average price obtained for output in that season ('000 Rp/kg)
1. Dry season (June to November)			
2. Rainy season (December to May)			

7. Risk and Shock events

7.1. Shock events during the last 3 years: **For all plots and crops and livestock**

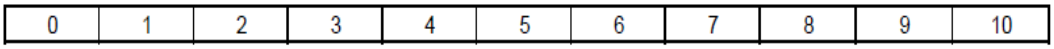
a. Did you suffer from any shocks (e.g. drought, flood, pest) concerning your agricultural activities during the last three years?..... (Yes/No) *(If no, go to next table)*

	1. Did the specific shock occur in the last three years?	2. Year and month of the shock event's start (*MM.YYYY*)	3. Year and month of the shock event's end (*MM.YYYY*)	4. Which plots were affected? (Code A) (*Multiple answers possible*)	5. How much of your total harvest/ livestock did you lose in total over the whole shock period? (%)
1. Drought	Yes/No				
2. Too much rain (Flood)	Yes/No				
3. Late rain	Yes/No				
4. Fire	Yes/No				
5. Theft (Eg*: Livestock or crops*)	Yes/No				
6. Crop pest/disease	Yes/No				
7. Livestock disease	Yes/No				
8. Critical illness or demise of HH members	Yes/No				
9. Other…….	Yes/No				

Code A: Main plot reported for oil palm = 1; Main plot reported for rubber = 2; Additionally reported core/C01/B09 plot = 3; Other plot = 4.

7.3 Risk and time preferences

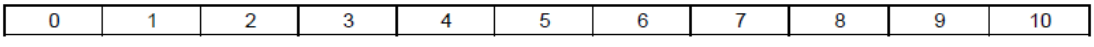
1) Are you generally a person who is fully prepared to take risks or do you try to avoid taking risk? (Please choose a number on a scale from 0 to 10)



0 = unwilling to take risks

10 = fully prepared to take risk

2) Are you generally a person who is fully prepared to give up something now in order to gain more in the future?



0 = unwilling to wait

10 = fully prepared to wait

8. Forest dependent activities (*Include all the timber and non-timber products your household collects or used to collect*)

1. Forest product collected	2. How often do you collect it or do it? (Once in how many days)	3. How many members of **your HH** are involved in collection (number)	3.a Which household members are more involved in this activity? (Code A)	4. How many **other** households are involved in this activity? (number)	5. Quantity obtained during last 12 months		6. Quantity sold during last 12 months		7. Average price obtained (000 Rp/Unit) during last 12 months	8. Share of revenue (%) for your household if more than 1 households are involved	9. Which **household members are more involved in deciding the use of income generated? (Code A)**
					a. Quantity	b. Unit	a. Quantity	b. Unit			
Timber											
Honey											
Firewood											
Hunting birds in forest											
Other hunting											
Other:…….											

Code A: 1=Male; 2=Female; 3=Both

10. Livestock production

a. Animals possessed and produced by the household during the last 12 months

		Cow/ Buffalo/ Bullock	Goat/ Sheep	Poultry
1. Did you own any of these livestock in the last 12 months? (*If no, go to next column or table*)		Yes/No	Yes/No	Yes/No
3. How many heads do you own at this point of time? (number)				
4. If you were to sell all of them today, how much money would you receive? ('000 Rp)				
5. If sold in last 12 months	a. Number of animals sold			
	b. Amount obtained in total from sale(s) ('000 Rp)			
6. Animals you consumed as meat in last 12 months?	c. Number of animals/birds			
	b. Total quantity of meat consumed (kg)			
	c. Market price of meat ('000 Rp/kg)			
7. How many animals did you give to someone as gift in the last 12 months? (number)				
8. How many died or were lost during the last 12 months? (number)				
9. If purchased in last 12 months	a. Number of animals purchased			
	b. Total amount spent for purchasing ('000 Rp)			
10. How many were born on your farm during the last 12 months? (number)				
11. How many animals did you receive as gift during the last 12 months? (number)				
12. *The main product*				
a. Name of the main product				
b. Quantity (Unit) produced during last 12 months				
c. Quantity (Unit) marketed during last 12 months				
d. Avg. price received during last 12 months ('000 Rp/Unit)				
e. Unit (Used for Questions b. c. d.) (*e. g. kg, number*)				
13. *The byproduct*				
a. Name of the byproduct				
b. Quantity (Unit) produced during last 12 months				
c. Quantity (Unit) marketed during last 12 months				
d. Avg. price received during last 12 months ('000 Rp/Unit)				
e. Unit (Used for Questions b. c. d.) (*e. g. kg, number*)				
14. Total feed cost during last 12 months ('000 Rp spent by the household)				
15. Total hired labour cost during last 12 months ('000 Rp spent by the household)				
16. Total other input cost during last 12 months ('000 Rp spent by the household)				
17. Which household members are more involved in livestock management and decisions(1 = Male; 2 = Female; 3 = Both)				
18. Which household members are more involved in deciding the use of income generated from livestock production? (1 = Male; 2 = Female; 3 = Both)				

b. Fish culture during the last 12 months

1. Have you been involved in fish culture in the last 12 months? (*If no, go to next table*)	Yes/No		
3. Number of households involved in fish cultivation (if done jointly with others)?			
4. Number of ponds under cultivation			
5. Total size of all fish ponds under cultivation (m^2)			
	Fish type 1	Fish type 2	Fish type 3
6. Name of major fish types being grown			
7. How many times did you harvest during the last 12 months?			
8. What is the average quantity of fish obtained per harvest (kg)?			
9. Did you sell fish?	Yes/No	Yes/No	Yes/No
10. Amount of fish sold during last 12 months (kg)?			
11. If sold, average price obtained ('000 Rp/kg)?			
12. How much did you spend on fish feed during the last 12 months ('000 Rp)?			
13. How much did you spend on non-feed materials during the last 12 months ('000 Rp)?			
14. How much did you pay for hired labour during last 12 months ('000 Rp)?			
15. Which household members are more involved in livestock management and decisions(1 = Male; 2 = Female; 3 = Both)			
16. Which household members are more involved in deciding the use of income generated from fish culture? (1 = Male; 2 = Female; 3 = Both)			

c. Fishing during the last 12 months

1. Apart from fish pond cultivation, do you or any of your HH members go fishing?	Yes/No (*if no, go to next table*)
2. How many of your HH members go for fishing? (number)	
4. How often do you or your HH members go fishing? (once in …..days)	
5. How much time do you spend on average when you go fishing (hours/day)?	
6. What is the quantity of fish you obtain in an average month? (kg)	
7. What is the quantity of fish you sell in an average month? (kg)	
8. How much money did you receive from fishing in an average month? ('000 Rp)	
9. Which household members involved in management and decision-making in fishing and fish culture? (1 = Male; 2 = Female; 3 = Both)	
10. Which household members are more involved in deciding the use of income generated from fishing? (1 = Male; 2 = Female; 3 = Both)	

11. Credit and Savings

11.1. Formal credit institutions

a. Have you taken or payed back credit during the last 12 months from a bank, farmer group or cooperative?..... (Yes/No)

b. If yes, type of the institute …… (Code: Bank = 1; farmer group = 2; farmer cooperative = 3, Other = 4)

c. If no, what was the main reason for not taking credit? ……

[Code: Not required or necessary = 1; Can easily obtain from friends or family = 2; It is difficult to get = 3; High interest rate = 4; No land title to pledge to get credit = 5; It is morally wrong to take credit = 6; Others = 7 (specify:……)]

d. Who made the decision to borrow? ……. (Code B)

e. Who made the decision about what to do with the money borrowed? ..... (Code B)

If credit was taken or being paid back in the last 12 months from a bank/farmer group/cooperative/other formal groups:

		1. Bank	2.Cooperative	3. Farmer group	4. Others
1. Amount taken ('000 Rp)					
2. In which of the household members' name the credit was taken	a. Relationship with HoH (Code A)				
	b. Gender (Code B)				
3. Date of obtaining credit (DD/MM/YY)					
Interest payment					
4. If interest rate:	Rate of interest (% annual)				
5. If fixed amount:	a. Amount per time ('000 Rp)				
	b. Number of times per year				
6. Repayment period (months)					
7. % of credit used for consumption					
8. % of credit used for farming					
9. If used for farming,					
a. % used for oil palm					
b. % used for rubber					
10. Did you have to submit your land title/certificate to get the credit?		Yes / No	Yes / No	Yes / No	Yes / No
11. Did you have to submit your house title/certificate to get the credit?		Yes / No	Yes / No	Yes / No	Yes / No

Code A: household head or wife = 1; son or daughter=2; father or mother=3; grandchild=4; mother or father in law=5; son or daughter in law=6; brother/sister = 7; other relative=8; non-relative=9.

Code B: male = 1; female = 2; both = 3.

11.2 Informal credit sources

a. Have you taken credit payed back credit during the last 12 months from other households/ trader/ input dealer? …….. (Yes/ No)

b. If yes, type of the institute …… (Code: Other household = 1; Trader = 2; Input dealer = 3)

c. If no, what was the main reason for not taking credit? ……

[Code: Not required or necessary = 1; Can easily obtain from banks or other formal source = 2; It is difficult to get = 3; High interest rate = 4; No land title to pledge to get credit = 5; It is morally wrong to take credit = 6; Others = 7 (specify:…….)]

d. Who made the decision to borrow? ……. (Code B)

e. Who made the decision about what to do with the money borrowed? ..... (Code B)

If credit was taken or being paid back in the last 12 months from trader/ dealer:

		Traders of output		
		Trader 1	Trader 2	Trader 3
1. Name of the trader who provides credit				
2. In which household members' name the credit was taken	a. Relationship with HoH (Code A)			
	b. Gender (Code B)			
3. Output handled by the trader (Code C)				
4. Total credit amount taken in last 12 months ('000 Rp)				
Interest payment				
5. If interest rate:	Rate of interest (% annual) *(Put 0 if no interest)*			
6. If fixed amount:	a. Amount per time ('000 Rp)			
	b. Number of times per year			
7. Mutually agreed repayment period (months)				
8. Does the repayment take place through a reduction in the product price (against repayment in cash)?		Yes / No	Yes / No	Yes / No
9. % of credit used for consumption				
10. % of credit used for farming				
11. If used for farming,				
a. % used for oil palm				
b. % used for rubber				
12. Did you have to submit your land title/certificate to get the credit?		Yes / No	Yes / No	Yes / No

Code A: household head or wife = 1; son or daughter=2; father or mother=3; grandchild=4; mother or father in law=5; son or daughter in law=6; brother/sister = 7; other relative=8; non-relative=9.

Code B: male = 1; female = 2; both=3.

Code C: oil palm = 1; rubber = 2; rice = 3; other (specify) = 4

If credit was taken or being paid back in the last 12 months from other households/ other informal sources:

		Other household (major credit sources)			
		HH 1	HH 2	HH 3	HH 4
1. Which of the household member took the initiative to obtain credit?	a. Relationship with HoH (Code A)				
	b. Gender (Code B)				
2. Who made the decision about what to do with the money borrowed?	a. Relationship with HoH (Code A)				
	b. Gender (Code B)				
3. Total amount taken in last 12 months ('000 Rp)					
Interest payment					
4. If interest rate:	Rate of interest (% annual)				
5. If fixed amount:	a. Amount per time ('000 Rp)				
	b. Number of times per year				
6. Mutually agreed repayment period (months; NA if not fixed)					
7. His/her farm size (ha; 0 if non-farmer)					
8. Shortest distance between your farm and his/her farm (km; NA if not a farmer)					
9. Is she/he your relative or friend?		Yes / No	Yes / No	Yes / No	Yes / No
10. Does she/he belong to your village?		Yes / No	Yes / No	Yes / No	Yes / No
11. Does she/he belong to your dusun?		Yes / No	Yes / No	Yes / No	Yes / No
12. What is the distance between your houses? (km)					
13. Do you both belong to same ethnic community?		Yes/ No	Yes /No	Yes / No	Yes / No
14. Did he/she borrow money <u>from you</u> in past 12 months?		Yes / No	Yes / No	Yes / No	Yes / No
15. % of credit used for consumption					
16. % of credit used for farming					
17. If used for farming,					
a. % used for oil palm					
b. % used for rubber					
18. Did you have to submit your land title/certificate to get the credit?		Yes / No	Yes / No	Yes / No	Yes / No

Code A: household head or wife = 1; son or daughter=2; father or mother=3; grandchild=4; mother or father in law=5; son or daughter in law=6; brother/sister = 7; other relative=8; non-relative=9.

Code B: male = 1; female = 2; joint = 3.

11.3 Savings

	1. Bank	2.Cooperative	3. Chit fund	4. Other: (…….)
1. Do you have an account or are a member of this institution?	Yes/No *(If no, go to next column)*	Yes/No *(If no, go to next column)*	Yes/No *(If no, go to next column)*	Yes/No *(If no, go to next table)*
2. Average amount of savings ('000 Rp)				

12. Household characteristics

12.4 Household member details

Details of household members.

a. Total members in the household staying in the house:…….. (number) during the last 12 months.
b. Religion of HoH: Muslim/ Christian/ Hindu/ Buddhist/ Others (specify: …….)
c. Ethnic group (specify):……..

1. HH member (Relationship with HoH)	2. Member ID	3. Age (years)	4. Sex (m/f)	5.Marital status (married = 1, unmarried = 0)	6. Education (number of years in school and college)	7. Last graduation (Code A)	8. Main Occupations (Code B)		9. Did HH member work on households' farm in last 12 months? (Yes/No)	10. Searching for employment? (Yes/No)	11. What is the lowest wage in Rp per day that the HH member would accept for a casual or day job?	12. What is the lowest wage in Rp per day that the HH member would accept for a permanent job?
							a. Primary	b. Secondary				
Respondent	1											
Head of household*	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
	10											
	11											
	12											
	13											
	14											
	15											

* Do not fill this column if respondent is head of the household. Use more rows if household size is more than 15.

Code A: never attended=1; attended but not completed=2; completed SD (primary)=3; completed SMP (Middle)=4; completed SMA (High School)=5; D3 or S1 (Associates Degree or University level first stage)=6; student at present = 7; other (specify)=8.

Code B: own-agriculture=1; wage or contract labour=2; own-business activities=3; still attending school=4; household activities=5; other (specify)=6.

b. Residency status of household members *(Only ask if household is newly added to sample or household head got married after 2015)*

	1. Used to live in the village whole life? (Code A)	2. If no, answer the following questions	
		a. Year of migration to the village	b. From where moved to the village (Code B)
Head of the household (HoH)			
Parents of the HoH			
Spouse of the HoH			
Parents of the spouse			

Code A: no = 0; yes = 1; never lived in the village = 2.

Code B: outside village in Jambi = 1; outside Jambi, but in Sumatra = 2; outside Sumatra, but in Indonesia = 3; outside Indonesia = 4.

c. Activities of HH members (**above the age of 15 and below 65**)

Now we like to find out how you spent your time on average working day, [day & date]. I'll need to know where you were and who else was with you. If an activity is too personal, there's no need to mention it.

So let's begin. On average working day, what were you doing and for how many hours? Please go step by step through the activities of the day. (If the Respondent reports an activity with no associated precode, the interviewer can type the activity directly onto the blank activity line.)

1. HH member (Relationship with HoH)	2. Member ID	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	13-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24
Respondent	1																			
Head of household*	2																			
	3																			
	4																			
	5																			
	6																			
	7																			
	8																			
	9																			
	10																			
	11																			

Code A: 1=Sleeping; 2=Working at own farm; 3=Working off-farm; 4=Grooming (self); 5=Watching TV, Radio, Phone; 6= Preparing meals or snack, house-keeping; 7=Eating and drinking; 8=Physical activities (sports); 9=Shopping; 10=Attending religious service/other meetings; 11=Other leisure activities; 30=Don't know/ Can't remember; 31=Refusal

12. 2 Asset accumulation

a. Number of cellphones owned by the household in the present:…….

	Number of items owned. currently	Year of ownership /purchase	Purchase price (´000 Rp)	Which HHM owns this asset? (Code HHM ID)
1. Television (colour)				
2. Satellite Dish				
3. Motorbike				
4. Car				
5. 4-wheel tractor				
6. Jeep/Truck				
7. Fridge				
8. Air conditioner (AC)				
9. Washing machine				

12.3 Housing

[Only ask completely for newly added households; for households already interviewed in 2015 ask only for changes after 2015]

a. Did you build or purchase a house in the last 25 years? …….(Yes/No)
b. If yes, in which year: ……..

1. a. What was the number of bedrooms in 1990 or at the time of household establishment?		
b. Number of bedrooms in main house now		
c. Year and number of room extension	Year	Number of added rooms
2. a. What was the main floor material of the living room in 1990 or at the time of household establishment? (Code A)		
b. Main floor material (of living room) now (Code A)		
c. If changed, year and type of change	Year	Type of change (X → Y) (Code A)
		→
		→
3. a. What was the wall material of the living room in 1990 or at the time of household establishment? (Code B)		
b. Wall material (of living room) now (Code B)		
c. If changed, year and type of change	Year	Type of change (X → Y) (Code B)
		→
		→

Code A: Tiles=1; Cement=2; Wood=3; Earth=4; Other (specify)=5.
Code B: Un-plastered brick=1; Brick covered with cement=2; Brick with ceramics =3; Low quality wood=4, High quality wood (e.g. ornamentation)=5; Other(specify)=6.

13. Non-own agriculture household income sources

13.1. Wage and contract labour

a. Have any of your household members worked as a tenant in a sharecropping arrangement in the last 12 months? ……. (Yes/No).

If yes: (i). Does the sharecropping landlord belong to your ethnic group? ……. (Yes/No)

(ii). Is the sharecropping landlord your close relative? ……. (Yes/No).

(iii). Did you sign a written agreement before starting the sharecropping? ……. (Yes/No).

(iv). How much does your household (tenant) spend on inputs per month (e.g. fertilizer) for the sharecropped plots? ……('000 Rp)

b. Have any of your household members worked as daily laborer (daily /weekly / monthly payment of money), as contracted for work (fixed payment for specific jobs) or sharecropping tenants during the last 12 months? ……. (Yes/No). (*If no, please go to the next table)*

1. Member ID (from Table 12.4a)	2. Type of activity (Code A)	3. Type of payment (Code B)	4. Seasonal (=0) or permanent (=1)?	5. If permanent, wage rate ('000 Rp/month)*	6. If seasonal			7. Receives wage/profit on hand (or is the wage/profit handed to another HH member)? (Yes/No/NA)	8. Total hours a member worked on average per month?	9. What is the duration of the employ-ment agreement? (Months)	10. If agricultur e (Code A), which crop? (Code D)	11. When decisions are made regarding labour, who is it that normally takes the decision? (Code E)	12. Which household members are more involved in deciding the use of income generated? (Code E)
					a. No. of months worked in last 12 months	b. No. of days engaged per work months	c. Average amount earned/recei ved during a month worked ('000 Rp.)						

Code A: work in agriculture=1; work in forestry=2; work in manufacturing =3; work in services=4; government employee=5; other (specify)= 6

Code B: per hour wage=1; daily wage=2; weekly wage=3; monthly wage=4; contract (fixed arrangement)= 6; other arrangement (specify)=7; share cropping arrangement as tenant=8.

Code C: 1=A week or less; 2=More than a week but less than a month; 3=One to six months; 4=Seven to eleven months; 5=One to five years

; 6=More than 5 years; 7=Don't know

Code D: 1=Oil palm; 2=Rubber; 3=Rice; 4=Other

Code E: 1=Male; 2=Female; 3=Both

* Please estimate the monthly income (*deducting the input costs*) of household members working as sharecropping tenants

13.2. Own business activities

- Did any of your household members gain any income from any type of own-business activities during the last 12 months?……. (Yes/No) *(If no, please go to the next table)*

1. Type of enterprise or business (Code A)	2. Shortly describe the type of business in words	3. When started? (year)	4. No. of family members engaged	5. Household member who is mainly responsible for the business (ID from 12.4a)	5b. Household members who help in business (ID from 12.4a)	5c. Did the HH members help without being paid? (Yes/No)	6. Total hours a member worked in business on average per month?	7. Total net amount (costs subtracted) earned from business per month on average? ('000 Rp).	8. Number of months the business was running during last 12 months?	9. When decisions are made regarding the business, who is it that normally takes the decision? (Code B)	10. Which household members are more involved in deciding the use of income generated? (Code B)

Code A: shop=1; trading=2; restaurant (food)=3; hotel (stay)=4; chauffeur/driver=5; carpenter=6; construction worker=7; other (specify)=8.

Code B: Male=1; Female=2; Both=3

13.3. Public and private transfers

- Have any of your household members benefited from some kind of public/NGO transfer program (given money in daily/weekly/ monthly basis) during the last 12 months? ……. (Yes/ No). (*If no, please go to the next table)*

1.Member IDs (from 12.4a)	2. Type of program (Code A)	3. Who is providing the program? (Code B)	4. What kind of benefits do you receive? (Code C)	5. Estimated amount received during last 12 months ('000 Rp.)	**6**. Which household members are more involved in deciding the use of money received? (Code D**)**

Code A: pensions=1; education subsidies=2; health care benefits=3; poverty reduction program=4; others (specify) = 5.

Code B: local government=1; federal government=2; NGO=3; other (specify)=4.

Code C: cash=1; clothes=2; food=3; agricultural inputs =4; others (specify)=5.

Code D: Male=1; Female=2; Both=3

13.4. Private transfers and remittances

- Did your household sent any money to anybody (e.g. a family member, **not** included in 12.4a) staying **outside** the household during the last 12 months? ……. (Yes/No).
- Did anybody (e.g. a family member, **not** included in 12.4a) staying **outside** the household sent money to your household during the last 12 months? ……. (Yes/No).

(*If no to both questions, go to next table.)*

1. If money is sent outside				2. If money is received from outside				3. Region where the sender or receiver resides (Code D)	
a. Receiver´s relation with your household head (Code A)	b. Receiver´s Gender (Code B)	c. Estimated amount sent during last 12 months ('000 Rp.)	d. Main reasons for remittance (Code C)	a. Sender´s relation with your household head (Code A)	b. Sender´s Gender (Code B)	c. Estimated amount received during last 12 months ('000 Rp.)	d. Main reasons for remittance (Code C)	Receiver	Sender

Code A: Son/daughter=1; father or mother=2; grandchild=3; mother or father in law=4; son or daughter in law=5; other relative=6; nonrelative=7.

Code B: Male = 1; Female = 2.
Code C: emergency spending = 1; financing education = 2; supporting livelihood = 3, other (specify) = 4.
Code D: outside village in Jambi = 1; outside Jambi, but in Sumatra = 2; outside Sumatra, but in Indonesia = 3; Outside Indonesia = 4; same village=5.

14. Membership in the village-level organizations in last 12 months

1. Household member ID (see Table 12.4a)	2. Name of organization	3. Position in organization (other than being member)	4. How many people in the village participate?	5. How often do you meet? (Code A)	6. Describe functions of the organisation (Code B) (*Multiple answers allowed)*

Code A: Each year=1; each half year=2; each quarter=3, each month=4; each week=5; no meetings=6; other (specify)=7.
Code B: Religious meetings=1; to save jointly=2; share experience=3; collective purchases of inputs=4; collective sales of farm outputs=5; plan village related events=6; give out credit=7; other (specify)=8.

16. Perceptions of land titles and certification programs

16.1 Land titles

a. In the last 15 years, how many conflicts/litigation happened in this village between farmers over land ownership? …… number
b. Are there any incidents in the village over the last 15 years that the land was taken from a farmer by government agencies or plantation/mining companies using force? ……. (yes = 1; no = 0; NI = No idea)

Details on land title documents:

	No title	With sporadic	With systematic
1. What is the maximum amount of credit obtainable from a bank, having one hectare land with the specific title? ('000) Rp			
2. Pruchase price of one hectare of land without plantation but with road access ('000) Rp			

Details on land rights

Report answers only if households is involved in the respective tenure arrangment	1. Does the tenure arrangement allow renting out the land to others (without approval outside of the household)?	2. Does the tenure arrangement allow selling the land to others (without approval outside of the household)?	3. Does the tenure arrangement allow to pass on the land?	4. Does the tenure arrangement protect you from claims of neighbors?	5. Does the tenure arrangement protect you from claims of the district government?	6. Does the tenure arrangement protect you from claims of the national government?
1. No land title	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
2. Sporadic	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
3. Systematic	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
4. Other:……..	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No

16.2 Certification schemes

	ISPO Indonesian Sustainable Palm Oil Certification	RSPO Roundtable on Sustainable Palm Oil Certification
1. Are you familiar with the name of the certification schemes? (1 = yes; 0 = no) *(If no, go to next column/section)*		
2. How have you heard about the schemes? (Code A)		
3. Are you currently involved in any of these certification schemes? (1 = yes; 0 = no) *(If no, go to next column/section)*		
4. If yes, since which year are you involved?		
5. If yes, what was the main reason for your involvement? (Code B)		

Code A: Other farmers = 1; Processing companies = 2; Government agencies = 3; Non-Governmental organizations = 4; Mass media = 5; Others (specify) = 6.

Code B: Requirement by processing company = 1; legal requirement = 2; expecting higher prices = 3; expecting higher output = 4; got external support for implementing scheme = 5; health benefits = 6; others (specify) = 7

Thank you for participating in the survey!

We will continue the consumption survey with the housewife on household expenditure.

Household Survey Questionnaire C07
(Consumption; Round 3, 2018)

1. Household identification

1. Village (name):			
2. Dusun (name or number):			
3. RT (number):			
4. Household code (given by supervisor):			
5. Name of respondent:			
6. Did the respondent change since 2015?	Yes/No		
7. Why did the respondent change? (Code A)			
8. Gender of respondent:	Male / Female		
9. Name of head of household:			
10. Respondent's relationship with head of household (Code B):			
11. Number of persons regularly consuming food from your house in last 7 days:			
12. Interviewer (name):			
13. Supervisor (name):			
14. Date of interview	……../……../2018	Enumerator's signature:	
15. Date questionnaire was checked by supervisor:	……../……../2018	Supervisor's signature:	

Code A: currently out of village = 1, moved out of the household=2; passed away=3; other (specify)= 4

Code B: Wife/Husband = 1; Daughter/Son = 2; Mother/Father = 3; Sister/Brother = 4; Niece/Nephew = 5; Others (specify) = 6

2. **Household expenditure**: In the following questions, we want to ask about all items consumed in your household, regardless of which person consumed it.

2.1.1. **Weekly consumption**: Has your household consumed following goods during the past 7 days? Please exclude from your answer any purchases for processing or resale in a household enterprise.

Item consumed	Quantity consumed in last week (units)	Unit (number, liter, kg, bag, pieces, etc.)		Market price, if purchased (Rp./unit)
		Name	How much kg or litre (approx..) one unit is?	
1) Rice (whole)				
2) Rice flour				
3) Wheat (whole)				
4) Wheat flour				
5) Maize				

Item consumed	Quantity consumed in last week (units)	Unit (number, liter, kg, bag, pieces, etc.)		Market price, if purchased (Rp./unit)
		Name	How much kg or litre (approx..) one unit is?	
6) Long bean				
7) Other cereals				
8) Other rice				
9) Cassava				
10) Flour of cassava				
11) Potato				
12) Sweet potato				
13) Gaplek				
14) Taro				
15) Sago				
16) Fish (fresh)				
17) Fish (dry)				
18) Seafood				
19) Beef				
20) Chicken				
21) Duck				
22) Mutton				
23) Buffalo				
24) Goat				
25) Lamb				
26) Sheep				
27) Entrails				
28) Liver				
29) Spleen				
30) Dried jerky meat				
31) Eggs of chicken				
32) Eggs of goose				
33) Eggs of quail				
34) Fresh Milk				
35) Milk powder				
36) Condensed milk				
38) Water spinach				
39) Land spinach and Cassava leaves				
40) Cucumber				
41) Carrots				
42) Sprout				
43) String bean				
44) Garlic				
45) Chili				
46) Tomato				
47) Onion				
48) Bitter gourd				
49) Eggplant				
50) Cabbage				
51) Beans				

Item consumed	Quantity consumed in last week (units)	Unit (number, liter, kg, bag, pieces, etc.)		Market price, if purchased (Rp./unit)
		Name	How much kg or litre (approx..) one unit is?	
52) Peanut				
53) Soybeans				
54) Cashew				
55) Tofu				
56) Tempe				
57) Tauco				
58) Oncom				
59) Orange				
60) Mango				
61) Apple				
62) Durian				
63) Rambutan				
64) Duku				
65) Pineapple				
66) Watermelon				
67) Banana				
68) Papaya				
69) Jack fruit				
70) Avocado				
71) Guava				
72) Grapes				
73) Snake fruit				
74) Dragon fruit				
75) Coconut (whole)				
76) Coconut milk				
77) Other fresh fruits				
78) Dry fruits				
79) Honey				
80) Coconut oil				
81) Palm oil				
82) Soybean oil				
83) Other cooking oil				
84) Butter				
85) Sugar				
86) Brown sugar				
87) Tea				
88) Coffee				
89) Syrup				
90) Salt				
91) Candlenut fruit				
92) Coriander				
93) Pepper				
94) Shrimp paste				
95) Soy sauce				
96) Taste enhancer				
97) Ginger				

Item consumed	Quantity consumed in last week (units)	Unit (number, liter, kg, bag, pieces, etc.)		Market price, if purchased (Rp./unit)
		Name	How much kg or litre (approx..) one unit is?	
98) Crackers				
99) Melinjo crackers				
100) Noodles				
101) Rice noodles				
102) Macaroni noodles				
103) Bread				
104) Biscuits				
105) Cakes				
106) Porridge				
107) Meatballs				
108) Iced syrup				
109) Assorted vegetable with peanut sauce				
110) Snacks				
111) Readymade soups				
112) Canned food				
113) Mie instan				
114) Nasigoreng Nasikuning				
115) Nasi Bungkus				
116) Fried bananas				
117) Baby food				
118) Bottled water				
119) Cola, soda etc.				
120) Fresh fruit juices				
121) Lemonade				
122) Clove cigarettes				
123) Tobacco cigarettes				
124) Cigars				
125) Tobacco				
126) Betel leaves				
127) Betel nut and others				

Outside house food consumption	No. of times in last week	No. people/time	Cost ('000 Rp/person/time)
128) Breakfast			
129) Lunch			
130) Dinner			
131) Tea/Coffee/Snacks			

2.1.2. **Consumption in last 24 h of women**:

Which food and drinks and how much of it did you (alone not your household) consumed yesterday? Please indicate which food items, procession and where did you get it from? Writ doewn all the foods and drinks mentioned. When compsite dishes are mentioned, ask for the list of ingredients. When te respondents has finished, prob for the measl and snacks not mentioned. Please exclude from your answer any purchases for processing or resale in a household enterprise.

1	Which day of the week does this record represent? (Code A)	
2	Is this a typical day? Yes, please specify =1, No=0	

3	4	5		6
Item consumed (Code: use item code from question 2.1.1)	Quantity	Unit (number, liter, kg, bag, pieces, etc.)	Source of food (Code B)	Food preparation (Code C)
Breakfast				
Snacks				
Lunch				
Snack				
Dinner				
Snack				

Code A: 1 Monday 2 Tuesday 3 Wednesday 5 Friday 6. Suturday 7 Sunday

Code B: 1 Own production 2 Purchased 3 Gift 77 Others, specifiy

Code C:	1 Raw	2 Dried	3 Boiled	4 Steamed	5 Cooked	6 Fried
	7 Processed	8 Roasted	77 Others, specify			

Outside house food consumption Item consumed (Code: use item code from question 2.1.1)	Quantity	Unit (number, liter, kg, bag, pieces, etc.)
Breakfast		
Lunch		
Dinner		
Tea/Coffee/Snacks		

2.1.3. **Consumption in the last 24 h of children below or equal to 5y:**

Which food and drinks and how much of it did your child (the child alone, not your household) consumed yesterday? Please indicate which food items, procession and where did you get it from? Writ doewn all the foods and drinks mentioned. When compsite dishes are mentioned, ask for the list of ingredients. When the respondents has finished, prob for the meal and snacks not mentioned. Please exclude from your answer any purchases for processing or resale in a household enterprise. . In case, a family has more than one child below or equal to 5 years, please take the eldest one.

1	Which day of the week does this record represent? (Code A)	
2	Is this a typical day? Yes, please specify =1, No=0	

3	4	5		6
Item consumed (Code: use item code from question 2.1.1)	Quantity	Unit (number, liter, kg, bag, pieces, etc.)	Source of food (Code B)	Food preparation (Code C)
Breakfast				
Snacks				

Lunch				
Snack				
Dinner				
Snack				

Code A: 1 Monday 2 Tuesday 3 Wednesday 5 Friday 6. Suturday 7 Sunday

Code B: 1 Own production 2 Purchased 3 Gift 77 Others, specifiy

Code C: 1 Raw 2 Dried 3 Boiled 4 Steamed 5 Cooked 6 Fried

7 Processed 8 Roasted 77 Others, specify

Outside house food consumption Item consumed (Code: use item code from question 2.1.1)	Quantity	Unit (number, liter, kg, bag, pieces, etc.)
Breakfast		
Lunch		
Dinner		

Tea/Coffee/Snacks		

2.2. **Monthly and annual consumption:** Has your household bought or received gifts during the past 30 days/ 12 months? Please exclude from your answer any purchases for processing or resale in a household enterprise.

Item	Monthly expenditure ('000 Rp./month)	Yearly expenditure ('000 Rp. /year)
137) Rent of house if contracted		
138) Rent, estimated if house is owned		
139) Electricity bill (*not for generator)*		
140) Telephone bill (fixed phone line)		
141) Gas bill (kitchen)		
142) Kerosene bill		
143) Water bill		
144) Firewood		
145) House maintenance and renovation		
146) Personal care items (soap, shampoo, toothpaste, etc.)		
147) Personal services (haircuts, shaving, etc.)		
148) Cosmetics		
149) Tailoring expenses		
150) Laundry		
151) Newspaper and magazines		
152) Membership fees		
153) Toys		
154) Making of ID card/ drivers license		
155) Telephone card (mobile phone)		
156) Postal goods		
157) Recreation		
158) Entertainment (e.g., movies, drama)		
159) Travel		
160) Ornaments		
161) Registration fee		
162) SPP		
163) POMG/BP3 /entrance- / re-registration fee		
164) Boy scout		
165) Handcraft		
166) Courses		
167) Hospital		

Item	Monthly expenditure ('000 Rp./month)	Yearly expenditure ('000 Rp. /year)
168) Community health center		
169) Doctor´s practice		
170) Traditional healer		
171) Medicine		
172) Footwear (men, women and children)		
173) Clothing (men, women and children)		
174) Household tools		
175) Hand tools		
176) Kitchen tools		
177) Television		
178) Dish TV		
179) Other entertainment facilities		
180) Sports equipment		
181) Jewelry		
182) Vehicles		
183) Umbrellas		
184) Wristwatch		
185) Camera		
186) Install telephone		
187) Install electricity		
188) Electronic equipment		
189) Taxes (House and building tax, TV fee, motor vehicle tax)		
190) Insurance (accident, health insurance)		
191) Celebration 1 (name:_____)		
192) Celebration 2 (name:_____)		
193) Celebration 3 (name:_____)		

2.3 Consumption of energy (fuel, light & household appliances) during the last 30 days

Item	Unit (name)	Quantity consumed in last one month (units)	Market price ('000 Rp. /unit) if purchased
194) Dung cake			
195) Coal, Charcoal, Briquettes, coke			
196) LPG [excl. conveyance]			
a. 3 kg (subsidized)			
b. 15 kg (non subsidized)			
197) Battery			
198) Accu/ aki (car battery)			
199) Generator			
a. Petrol *(only for generator)*			
b. Diesel *(only for generator)*			
c. Lubricants oil *(only for*			

generator)			
d. Oil for generator maintenance (minyak rem, kanvas, etc)			
200) Other fuel			
201) Other consumption (Matches, Candle, air freshener, Mosquito repellent etc)			

2.4 Public transport expenditures during the last 30 days

Item	Total expenditure in last month ('000 Rp)
202) Public bus/tram fare	
203) Public minibus (angkot) fare	
204) Air fare	
205) Public motorcycle (ojek)	
206) Taxi, auto-rickshaw fare	
207) Rental car	
208) Other public conveyance expense (such as porter charges, horse cart fare, etc)	

2.5 Private transport expenditures during the last 30 days

Item	Fuel cost in last month ('000 Rp)	Other expenditures in last month (lubricants, other fuel for vehicle, oil for maintenance, etc) ('000 Rp)
209) Private car		
210) Private minibus		
211) Private bus		
212) Private motorcycle		
213) Other private transport (please mention)		

2.6 Hadj

Religion of the household members: Islam/Others (*If others, go to 3*)
If Islam, have any of the household members gone to Hadj? Yes/No
If yes, details of past pilgrimages:

Year of Hadj	Number of household members went	If gone for Hadj after 2015, expenditure incurred (million Rp)

Are you planning to go for Hadj in the near future? Yes/No
If yes, are you saving for Hadj, currently? Yes/No

If yes, average savings, kept for this purpose: …… thousand Rp/year.

2.7. Food insecurity

Now I would like to ask you some questions about the state of your food consumption

Was there a time, when…	1. **In the last week**	2. If the answer is NOT "YES" for the week, **in the last month**	3. If the answer is NOT "YES" for the week, **in the last 12 months**
1. You were worried you would run out of food because of a lack of money or other resources?			
2. You were unable to eat healthy and nutritious food because of a lack of money or other resources?			
3. You ate only a few kinds of foods because of a lack of money or other resources?			
4. You had to skip a meal because there was not enough money or other resources to get food?			
5. You ate less than you thought you should because of a lack of money or other resources?			
6. Your household ran out of food because of a lack of money or other resources?			
7. You were hungry but did not eat because there was not enough money or other resources for food?			
8. You went without eating for a whole day because of a lack of money or other resources?			
9. For how many days you went without eating for a whole day?			

Code: 0= No, 1:=Yes, 98=Don't know/remember, 99= Refused to answer

3. Decision-making and time allocation

3.1. Who is primarily responsible for the following consumption expenditure items and tasks?

Consumption and task items	*Examples*	Persons involved (Put √ mark or NA if not applicable)		
		Male members	Female members	Both male and female members equally
Purchase of food items	*Rice, vegetables, meat etc.*			
Paying the bills	*Telephone, electricity, gas etc.*			
Selecting clothing and footwear	*Clothes, tailoring, footwear etc.*			
Paying for recreation and membership	*Movies etc.*			

Spending on education of children (*if applicable*)	*School fees, books etc.*			
Travel and transport	*Taxi, public bus etc.*			
Purchase and sale of durable goods	*Purchasing television etc.*			
Purchasing and sale of land and houses	*Including involving in sharecropping*			
Representing the household in the public	*Talking to govt. officials, participating in the discussions and group meetings etc.*			
Male healthcare	*Go to the hospital, see the doctor*			
Female healthcare	*Go to the hospital, contraception, child bearing*			
Children healthcare	*Go to the hospital, see the doctor*			
Male visiting family/friends	*Visit his parents or friends*			
Female visiting family/friends	*Visit his parents or friends*			

Thank you for participating in the survey!

Village Survey Questionnaire 2018

Name of supervisor: ……

1. General village characteristics

1.	Name of the village		
2.	Names / (phone numbers) of the respondents		( )
			( )
			( )
			( )
3.	Type of village (*Circle the type*)		Transmigrant/ Autochthonous/ Mixed
4.	*Please list number of …. in the village*		
5.	# dusuns or RWs		
6.	# RTs or neighbourhoods		
7.	# farmer organizations or cooperatives		
8.	# households		
9.	# households of ethnicity	(i) Melayu	
		(ii) Javanese/Sundanese	
		(iii) Others	
10.	# female-headed households		
11.	# farmer households		
12.	# labourer households		
13.	# households involved in trading of agricultural products		
14.	# households cultivating rubber	(i) Farmer-managed	
		(ii) Managed under sharecropping	
15.	# households cultivating oil palm	(i) independently	
		(ii) in association with the oil palm company	
16.	# households cultivating food crops *(e.g. rice, vegetables etc.)*		
17.	# households having farm in the village, but not living in the village		
18.	# households which left village after 2015		
19.	# households which came to the village after 2015		

2. Land use characteristics

1. Year when oil palm was started in the village	(i) by plantation company	
	(ii) by farmers	
2. Any private oil palm plantations bordering the village? (0 = no; 1 = yes)		
If yes, name of the plantations		
Year of establishment of this private plantation		
3. Is there any *adat* land in this village?		
If yes, land area (ha) under *adat*		
Major use of *adat* land (1 = oil palm plantation; 2 = rubber plantation; 3 = other crops; 4 = forest land; 5 = bush and grass land)		
4. % total farm land with systematic land titles (*bersertifikat*) in the village	Overall	
	PRONA	
	Private application	
5. % total farm land with sporadic land titles (*bersporadik*) in the village		
6. # conflicts between farmers over land ownership in	last year (2017-2018)	
	last 5 years	
	last 10 years	
7. # conflicts between farmers and	last year (2017-2018)	

plantation/mining company over land ownership in	last 5 years	
	last 10 years	

3. Marketing of oil palm

Please report details of oil palm mills near the village, where the farmers **could sell** oil palm fresh fruit bunch (FFB) over the last 25 years.

(i) Currently working

1. Name of the mill	2. Year of establishment	3. Distance from the village centre (km)

(ii) Working previously, closed at present

1. Name of the mill	2. Year of		3. Distance from the village centre (km)
	establishment	closure	

4. Land market price

Please report the current land market price ('000 Rp/ha) prevailing in the village. The average market value might be reported, and this may exclude the plots that are close to the village centre or main road, but with some road access.

'000 Rp/ha	Without any crop	With productive oil palm (approx. 10 years' age)	With productive rubber (approx. 10 years' age)
1. Without any land title			
2. With sporadic certificate			
3. With systematic certificate			

5. Applications for land title in past one year

	# applications	# applications processed and titles issued	time taken from application to title issue (months)	Approx. cost of providing the title ('000 Rp/ha)
1. Sporadic certification				
2. Systematic certification (PRONA)				
3. Systematic certification				

(Private application)				

6. Conditions of contractual agreements with plantation companies

(i) With how many oil palm companies has the village negotiated after 2015? ……

	Name Company	Company Type (see Code A)	Year of negotiation	Did negotiation lead to contract?		If yes, when will contract expire? (Year)	Was the agreement written down?		# total HHs involved
1				yes	no		yes	no	
2				yes	no		yes	no	
3				yes	no		yes	no	
4				yes	no		yes	no	

Code A: 1= Perusahaan Terbatas Perkebunan Nasional (PTPN); 2= Private Company regulated through Badan Koordinasi Penanaman Modal (BKPM); 3= Private Company; 4= Collectively-owned Cooperative; 5= Other, specify:_____; NI= don't know

(ii) If contracts are signed after 2015:

1. In total, how much land was given to the OP company? (in hectares)	
2. How much is the share of communal land given to OP company? (in hectares)	
3. How was communal land utilized before? (see Code A)	
4. In general, how was private land utilized before? (see Code A)	

Code A: 1=Rubber; 2=Oil Palm; 3=Reforestation; 4=Fallow Sleeping Land; 5=Rice; 6=Other, specify:_____

7. Land expropriation/grabbing

Has land been expropriated or grabbed in your village between 2015 and now? ……. (yes/no)

If yes:

	Land Type (see Code A)	When? (year)	By Whom? (see Code B)	How much? (in ha)	What Purpose? (see Code C)	Returned?	
1						yes	no
2						yes	no
3						yes	no

Codes A: Land type
1 = Indigenous land
2 = Transmigrasi Land
3 = Communal Land
4 = Other, specify:_____

Codes B: By whom
1 = Logging company
2 = Palm oil company
3 = Rubber company
4 = Provincial government
5 = National government
6 = Neighbouring villages
7 = Between farmers
8 = Others specify:_____

Codes C: Purpose
1 = Logging
2 = Oil palm
3 = Conflict with neighbour
4 = Conflict with government

8. Shocks in the village

	2015	2013	2017	2018
1. Too much rain				
2. Late Rain				
3. Drought				
4. Human Disease Specify:_____				
5. Animal Disease Specify:_____				

6. Crop Disease Specify:_____				
7. Other, specify:_____				
8. Other, specify:_____				

Indicate for each of the past years when your village was affected by the respective shock (*put* √)

9. Changes in the village due to reduction in market price of rubber

a. Average market price of rubber in 2015:…… ('000 Rp/kg)

b. Average market price of rubber in 2018:…… ('000 Rp/kg)

Please report the number of households, who undertook following actions due to reduction in price of rubber for all main questions	
1. Sold their land	…….. households
2. Stopped tapping/harvesting rubber trees	…….. households
3. Converted rubber plantation to oil palm or other crops	…….. households
4. Opening up of new areas for farming	…….. households
a. Did the opening up of new areas include deforestation?	Yes/No
5. Started working as wage labour	…….. households
a. How many hours by motorcycle is the next oil palm estate away from the village, which can provide work for villagers?	……. hours
b. How many oil palm estates are reachable from the village, which can provide daily work for villagers?	…….. number
c. How many hours by motorcycle is the next city/big village away from the village, which can provide work for villagers? *(e. g. construction work)*	…….. hours
d. Please name the respective city	……..
6. Started off-farm income activities (e.g. opening a shop)	…….. households
7. Migrated to cities	…….. households
8. Other measures (*specify*:……..)	…….. households

CV

Personal Information

Name:	Nadjia Mehraban
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Current Position

04/2018 – 05/2021	Junior Researcher/PhD-student in the Collaborative Research Center 990: Ecological and socioeconomic functions of tropical lowland rainforest transformation systems (Sumatra, Indonesia) at Georg-August University Göttingen

Education

10/2015- 10/2017	M.A. in Development Studies, University of Passau
10/2011- 07/2015	BSc. Business Administration and Economics, University of Passau
09/2013-12/2013	Exchange semester, International Marketing and Management, Université d'Angers, France

Professional Experiences

08/2018-11/2018	Field Research Supervisor in Indonesia on behalf of the University of Göttingen
04/2017 – 10/2017	Intern, research group: Sustainable Landscapes and Food Systems, *CIFOR*, Bogor, Indonesia
10/2016 –04/2017	Teaching assistant, Chair of Development Economics, *University of Passau*
11/2015 – 02/2017	Freelance translator for Farsi, Dari and German, *Federal Police and Immigration Office*, Bavaria
06/2015 – 08/2015	Internship, *Heinrich-Böll-Foundation Cambodia*, Pnom Penh

02/2014 – 02/2015	Working student in HR, *TW Consult,* Munich
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Publication Record and Work in Progress (March 2021)

Mehraban, N. and Ickowitz, A. 2021. Dietary diversity of rural Indonesian households declines over time with agricultural production diversity even as incomes rise. *Global Food Security* (28): 100502. Doi: 10.1016/j.gfs.2021.100502

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Languages

Persian, German, English