



What about her? Oil palm cultivation and intra-household gender roles

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ARTICLE INFO

Keywords:

Gender roles
Time allocation
Labor dynamics
Oil palm cultivation
Indonesia

ABSTRACT

Oil palm is one of the fastest expanding crops in tropical regions, leading to massive land-use changes and far-reaching social implications. In Indonesia, much of the oil palm land is cultivated by smallholder farmers. While household income effects of oil palm cultivation were analyzed in previous studies, effects on intra-household gender roles are not yet well understood. Here, we use sex-disaggregated survey data from farm households in Sumatra to examine how oil palm cultivation – in comparison to cultivating traditional crops – is associated with women's and men's time allocation and decision-making power. Women in oil palm cultivating households spend much less time in farming and more time for household chores and leisure than women in households only cultivating traditional crops. These differences increase with the share of the farm area under oil palm, as oil palm requires less labor than traditional crops. While a reduction in women's workload can have positive social effects, lower involvement in farming can also be associated with a loss in female autonomy. Indeed, our data suggest that oil palm cultivation is associated with women having less decision-making power in terms of farm management and income control. These insights can help to design policies for more gender-equitable rural development.

1. Introduction

Gender equity is recognized as a fundamental human right, and yet women face multiple types of discrimination almost everywhere, including unequal access to productive resources, education, and jobs, and inadequate participation in economic and political decision-making (UN 2018). Female empowerment is important in its own right, but in addition it can also be a key leverage point towards other social welfare goals such as improved nutrition and health (Hoddinott and Haddad 1995; Debela et al. 2021). Gender roles and responsibilities tend to change with economic circumstances, which in rural areas includes the adoption of new agricultural technologies and crops (Doss 2001; Kaaria and Ashby 2000; Njuki et al. 2011). Here, we analyze how the adoption and cultivation of oil palm is associated with gender roles in farming households in Indonesia.

Oil palm has been among the fastest expanding crops in the humid tropics over the last 30 years, especially in Indonesia and Malaysia

(Byerlee et al. 2017). About half of the global palm oil production comes from large company plantations, whereas the other half comes from small and medium-sized family farms (Qaim et al. 2020). Recent research showed that smallholder farmers benefit from cultivating oil palm in terms of gains in farm profits, household incomes, and living standards (Feintrenie et al. 2010; Klasen et al. 2016; Euler et al. 2017; Bou Dib et al. 2018; Kubitzka et al. 2018; Sibhatu 2019; Mehraban et al. 2021). However, existing analyses have been at the household level, without considering potential differences between male and female household members or possible changes in intra-household gender roles. Gendered effects can be expected, as oil palm requires less labor than alternative crops, and the resulting labor savings may influence male and female household members differently (Chrisendo et al. 2020). Moreover, oil palm is a cash crop that is typically dominated by men in the Indonesian context (Villamor et al. 2015). We are aware of two studies that explicitly analyzed gender aspects in Indonesia's palm oil sector, both using qualitative case-study approaches to better

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understand women's roles and experiences in large-scale and small-scale plantation development (Elmhirst et al. 2017; de Vos and Delabre 2018).¹ We add to this sparse literature by using quantitative survey data from smallholder farmers to examine links between oil palm cultivation and intra-household gender roles. The only other study that used quantitative data is by Chrisendo et al. (2020), who looked at women's involvement in farm and off-farm activities as a potential mechanism to explain nutrition effects of oil palm cultivation. Here, we extend their approach by studying the time allocation of male and female household members in greater detail and by also looking at links between oil palm cultivation and various indicators of women's decision-making power.

In particular, we use data from a survey of farm households in Sumatra, Indonesia, to pursue two research questions. First, what is the association between oil palm cultivation – either in addition to or instead of cultivating more traditional crops – and male and female time allocation? We differentiate between farm work and other economic and social activities. Second, what is the association between oil palm cultivation and women's intra-household decision-making power? Our survey includes randomly selected farm households cultivating and not cultivating oil palm. Those not cultivating oil palm cultivate rubber as a traditional cash crop in the local context. Some households also cultivate both oil palm and rubber. We compare the different types of households using descriptive statistics. In addition, we use regression models to estimate the associations of oil palm cultivation while controlling for confounding factors. We use three rounds of survey data to estimate panel data regression models. However, as certain details on gender roles were only covered in the last survey round, we use cross-section techniques in other parts of the analysis. The remainder of this article is structured as follows. Section 2 presents a simple conceptual framework with a few concrete research hypotheses. Section 3 describes the study context with details on oil palm and rubber cultivation and factors that influence the households' crop choices. The survey, the measurement of key variables, and the statistical techniques used are explained in section 4, while the empirical results are presented in section 5. Section 6 concludes.

2. Conceptual framework

The adoption of a new cash crop, such as oil palm, can affect gender roles within the farm household through various mechanisms. One mechanism is through decision-making on farming, which can differ between crops. Especially in Africa, it is often assumed that food crop production is under the responsibility of women, whereas cash crop production is typically considered a male domain (Doss 2001; Njuki et al. 2011; Fischer and Qaim 2012; Chiputwa and Qaim 2016), although these gender roles are more flexible in practice (Doss 2002). Similar gendered responsibilities are also observed in other parts of the world (von Braun and Kennedy 1994; Kaaria and Ashby 2000; Doss and Quisumbing 2020). Women often lose decision-making power when farm households start to concentrate on cash crop production and marketing (Chege et al. 2015). This may also be true in Indonesia. However, in Sumatra many farm households already grew rubber before adopting oil palm, so cash cropping was not a new phenomenon.

Different labor needs and time allocation are other mechanisms that can influence gender roles. In rubber farming households, men and women are both involved in rubber plantation work, which is quite time-consuming because the rubber trees need to be tapped on a regular basis (Krishna et al. 2017a). Oil palm requires much less labor than

rubber or other traditional crops per hectare of land, so a switch to oil palm is associated with significant labor savings (Rist et al. 2010; Euler et al. 2017; Chrisendo et al. 2020). In principle, these labor savings may affect both male and female household members equally. But harvesting and other work in oil palm plantations require more physical strength and are therefore often considered too strenuous for women in the local context (Li 2015). Given these gender stereotypes, work on oil palm plantations is often dominated by men (Villamor et al. 2015), meaning that women are likely more affected by the labor savings associated with oil palm adoption than men.²

Female labor savings may influence women's roles in different directions, depending on how the labor saved is reallocated. If the household has access to additional land and capital, farming activities may be expanded (Krishna et al. 2017a). Alternatively, the labor saved in farming may also be reallocated to off-farm economic activities. Involvement in off-farm work and income generation can have positive effects for women's financial autonomy and decision-making power (Majlesi 2016; Rangel 2006; Debela et al. 2021). However, women's opportunities to get involved in off-farm employment also depend on their access to education and on cultural norms. In rural Indonesia, women tend to be less involved in off-farm employment than men due to cultural restrictions (Chrisendo et al. 2020). Hence, it is also possible that female labor saved in farming is reallocated to household work or care work – activities that are important for family welfare but do not necessarily strengthen women's economic and financial decision-making power. The implications for female empowerment could be different if the labor time saved were spent on leisure activities.

Based on these insights from the literature and the local study context, we propose three concrete research hypotheses. First, oil palm cultivation reduces women's involvement in farm work. Second, oil palm cultivation increases women's involvement in household work, childcare, and leisure time. Third, oil palm cultivation decreases women's economic and financial decision-making power. These hypotheses are tested empirically below.

3. Study context

Our study is located in Jambi Province, Sumatra, one of the hotspots of Indonesia's recent oil palm expansion (Bissonnette and De Koninck 2017). Most parts of Jambi are in the lowland humid tropics, where the natural vegetation is rainforest. However, most of the lowland rainforest areas have been cleared during the last 50 years for timber extraction and intensive agricultural use (Krishna et al. 2017a). Traditionally, local farmers in Jambi, mostly belonging to the Melayu ethnicity, grew rice and other food crops. Rubber has been a cash crop for long, but the intensity of cultivation changed over time (Otten et al. 2020). In the first half of the twentieth century, rubber was mainly grown in extensive agroforestry systems. With increasing international demand, more intensive rubber plantations have become common since the 1970 s, often at the expense of forestland.

Oil palm started to spread in Jambi since the late-1980 s in connection with the Indonesian government's transmigration programs. In these programs, families from Java and other densely populated islands were relocated to Sumatra and supported in oil palm cultivation through contract schemes with large plantation companies (Zen et al. 2006; Feintrenie and Levang, 2009). That is, many of the transmigrant families from Java started with oil palm cultivation in Jambi without having been involved in rubber farming before. Most of the new oil palm

¹ Another very recent study analyzed oil palm and gendered time use in West Kalimantan with a mixed-methods approach (Rowland et al. 2022). Many of the sample households in the study in West Kalimantan were contracted by palm oil companies and also worked as laborers on the company plantations, which is different from our sample (see details of our sample below).

² Oil palm is also less labor-intensive than rice and most other traditional food crops. In our study region, very few farmers are involved in food crop production because rubber and cash crops are more lucrative. However, in other regions of Indonesia, where farmers partly switch from rice to oil palm, the gendered labor savings may be similar, because women are often heavily involved in rice cultivation (Villamor et al. 2015).

plantations in the transmigration programs were established on previous forestland. Since the mid-1990s, local Melayu farmers also started adopting oil palm without company contracts, partly replacing their existing rubber plantations and partly further encroaching into the remaining forestland (Krishna et al. 2017b). Today, most oil palm farmers in Jambi – including both the previous transmigrants from Java and the local Melayu – grow oil palm independently, without a company contract, even though the harvest is mostly sold to company mills (Qaim et al. 2020).³

Except for a few locations in higher altitudes, where plantation agriculture is more difficult, almost all farmers in Jambi have abandoned food crop production because rubber and oil palm are simply more lucrative. In fact, oil palm is even more profitable than rubber on average, so that oil palm adoption rates continue to rise (Grass et al. 2020). However, both rubber and oil palm are plantation crops that require larger initial investments and can then produce for several decades. This means that oil palm adoption and switching from rubber to oil palm are gradual processes. Those farmers that have productive rubber plantations may sometimes delay the adoption of oil palm until the rubber plantations get old and would have to be replaced anyway. Alternatively, if rubber farmers have access to additional fallow or forestland, they often expand their farms by planting oil palm on the additional land while retaining their rubber plantation. In Indonesia, forestland is officially state-owned, but there are significant overlaps with land that is considered community-owned under customary law (Krishna et al. 2017b). Hence, it is not uncommon that farmers expand their agricultural land by further encroaching into the forestland (Chrisendo et al. 2021). In addition to land, access to capital for the establishment of new plantations is another determinant of oil palm adoption (Qaim et al. 2020).

Concerning gender roles, women in Indonesia traditionally have considerable decision-making power within the household (Papanek and Schwede, 1988). In rural areas, women are also heavily involved in agricultural production and decision-making on the family farm, and they can own and inherit land and other productive assets (Dube, 1997).⁴ However, in the Basic Agrarian Law of 1960 and the Indonesian government's transmigration programs, the family is seen as one fundamental unit with the male considered the breadwinner and the female the homemaker (Elmhirst 2011). As a result, men typically represent the household in the public sphere (Li 2015). Formal land titles are a relatively recent phenomenon in most parts of Indonesia (Krishna et al. 2017b). While women can hold formal land titles, these are more often registered under the name of a male family member (Julia and White, 2012).

Given these gender norms, women in Indonesia tend to be disadvantaged in terms of their access to higher education and thus also to more lucrative employment. This is especially true in rural areas. In poor rural households, women often work as unskilled laborers on other farms or in the informal sector as an economic necessity, but they opt out of off-farm employment when the household income increases (Schaner and Das 2016; Chrisendo et al. 2020).

³ The initial oil palm contracts between transmigrants and plantation companies expired after 20–25 years. Once the initial credit received is repaid, farmers obtain the formal ownership title for their piece of land and can continue farming on this land independently (Euler et al. 2017).

⁴ Sumatra is also home to the Minangkabau ethnic group, which remains the largest surviving matrilineal society in the world (Villamor et al. 2015). The Minangkabau are mostly located in West Sumatra Province, not in Jambi Province, which is our study region. While there are no Minangkabau in our sample, it is possible that the proximity to West Sumatra has also shaped gender norms in Jambi to some extent.

4. Materials and methods

4.1. Farm household survey

Data for this study were collected through a survey of farm households in Jambi Province. We sampled farm households using a multi-stage sampling procedure (Euler et al. 2017; Krishna et al. 2017a). Five major oil palm producing regencies in Jambi were selected purposively. Then, four districts per regency and two villages per district were randomly selected. Five additional villages were selected non-randomly to coincide with other project activities (in the regression models, we control for non-random villages).⁵ Finally, in each village, households were selected randomly proportionate to village size, leading to a total sample of close to 700 households. The first survey round was conducted in 2012. Follow-up survey rounds with the same households were conducted in 2015 and 2018. Some sample attrition (a total of 10% over the three survey rounds) occurred, as is common in panel surveys spanning multiple years. Households that attrited were replaced by other randomly selected households in the same villages. The sample is representative for farm households in the lowland areas of Jambi Province. All farm households cultivate either rubber or oil palm or a combination of both. Only a few households (<5%) additionally cultivate other crops such as cocoa, banana, or rice.

In all three survey rounds, the data were collected between August and December through face-to-face interviews in the local language using structured questionnaires. Questions on agriculture, other economic activities of the household, and the broader socioeconomic context were answered by the household head, mostly a male adult. Questions on food and non-food household consumption were often answered by the spouse, usually a female adult. While the 2012 and 2015 survey rounds included sex-disaggregated questions on farm work, further details on gender roles were not included. In the 2018 survey round, we added questions on the time allocation of male and female adults to all economic and social activities and on gendered decision-making. Hence, some of the analysis uses panel data from all three survey rounds, whereas other parts use cross-section data only from the 2018 round.

4.2. Measurement of key variables

Farm work. Farm work includes all labor used for household farming activities and is measured in labor hours per year. To compare farms of different sizes, we divide by the total farmland cultivated, expressing the outcome in hours per ha and year. Total labor includes family labor and hired labor. In our analysis of intra-household gender roles, we are particularly interested in family labor, so we further subdivide total farm labor into three categories, namely hired labor, female family labor, and male family labor. These data are available for all three survey rounds. For descriptive comparisons, we further disaggregate the farm work by types of operation, such as plantation maintenance work (e.g., weeding and application of inputs), harvesting (e.g., cutting oil palm bunches and tapping rubber trees), and post-harvest handling and marketing (e.g., processing, transport).

Individual time allocation. Understanding how labor saved in agriculture is reallocated to other economic and social activities requires comprehensive data on individual time allocation (Badgett and Folbre 1999; Daum et al. 2021). We use a 24-hour time allocation format for the main female and male adults in each household (between 15 and 65

⁵ This project is part of a larger interdisciplinary research consortium, where natural scientists selected various agricultural and forest plots for the measurement of biodiversity, as well as carbon and water fluxes (Grass et al. 2020). These measurements were only done in the non-randomly selected villages; they are not expected to influence farmers' land-use decisions or any of the outcome variables analyzed in this study.

years of age). The individual respondents were asked which activity they undertook at each hour during a typical working day capturing the time period between 5 a.m. and midnight. These activities were then grouped into six categories: working on-farm; working off-farm; household chores and care work (including childcare and caring for sick or elderly family members); leisure activities; eating and grooming activities; and resting or sleeping. We measure time allocation in terms of the number of daily hours spent in each of the six categories. Because rubber and oil palm are both crops that produce all year round, agricultural activities hardly vary by season.

Women's decision-making power. Women's decision-making power within the household can be assessed indirectly through women's access to productive resources and asset ownership and/or directly by asking about women's involvement in different types of household decisions (Haddad et al. 1997; Rangel 2006; Fischer and Qaim 2021; Doss and Quisumbing 2018). Building on this existing literature, we use three groups of variables, namely women's asset ownership, women's involvement in management decisions, and women's involvement in income control. Related data were only collected in the 2018 survey round.

Asset ownership is evaluated through two concrete variables: a dummy for whether or not a woman's name is on a land title that the household owns and the share of household assets owned either by women alone or jointly with male household members. Involvement in management decisions is captured through three dummy variables indicating whether or not a woman makes or participates in decisions related to cropping activities, livestock activities, and off-farm activities. Decision-making here refers to both day-to-day and more strategic decisions. In the survey we did not differentiate between the two, although involvement in strategic decision-making is probably more relevant for female empowerment. Women's involvement in income control is also captured through three dummy variables differentiating between crop income, livestock income, and off-farm income.

The female decision-making variables and the underlying questions that we used in the survey are shown in Table S1 in the online supplementary information (SI). These questions were part of the household-level sections of the questionnaire, which were answered by the mostly male household heads. Recent research showed that asking male and female spouses in the same household about asset ownership and decision-making can sometimes lead to conflicting results due to different perceptions (Ambler et al. 2021). Furthermore, joint decision-making can have varying interpretations depending on the particular context (Acosta et al 2019; Seymour and Peterman 2018). Against this background, our indicators of women's decision-making power should be interpreted with some caution. While we use approaches that are common in the literature, other approaches exist and might lead to somewhat different and/or more nuanced results.

4.3. Statistical methods

We use a combination of descriptive statistics and regression models to test our three research hypotheses. For descriptive comparisons between different types of households, we create three groups, namely those cultivating rubber and no oil palm ("only rubber"), those cultivating oil palm and no rubber ("only oil palm"), and those cultivating both oil palm and rubber on their farm. Differences in mean values of the key outcome variables between these three groups are tested for statistical significance. If our hypotheses that oil palm cultivation affects gendered time allocation and decision-making power are true, the largest differences would be expected between the "only oil palm" and "only rubber" households.

Beyond these descriptive comparisons, we use regression models to test the hypotheses more formally. While we try to control for confounding factors, we are not able to rule out possibly remaining issues of endogeneity, so our estimates are interpreted as associations, not as fully identified causal effects. We use models of the following type to test the

first hypothesis related to women's involvement in farm work:

$$L_{it} = \beta_0 + \beta_1 OP_{it} + \beta_2' X_{it} + \beta_3' T_t + \varepsilon_{it} \quad (1)$$

where L_{it} refers to the farm work input of household i in year t , OP_{it} is oil palm cultivation, our main explanatory variable of interest, and X_{it} is a vector of farm and household characteristics that may also influence farm work input (such as farm size, household wealth, and demographic characteristics). We also include regency variables to control for possible unobserved regional characteristics, such as local agroecological conditions. T_t is a vector of year dummies to capture time fixed effects, and ε_{it} is a random error term.

We estimate separate versions of the model in equation (1) with farm work input in terms of hired labor, female family labor, and male family labor hours as dependent variables. Our interest is especially in the family labor models. A negative and significant coefficient β_1 in the model for female family labor would support our hypothesis that oil palm cultivation is associated with reduced women's involvement in farm work. In these models, OP_{it} is expressed as the share of the household's total farmland cultivated with oil palm, a continuous variable that can take any value between 0 and 1. A possible alternative would have been to use an oil palm cultivation dummy, but this would have ignored the fact that some households grow oil palm only on a small part of their land. All three rounds of data are used for these estimates. We use random effects (RE) and fixed effects (FE) panel data estimators and perform Hausman tests to choose the preferred specifications (Hausman 1978).

To test the second hypothesis, we use regression models of the following type:

$$H_{ij} = \alpha_0 + \alpha_1 OP_i + \alpha_2' W_i + \alpha_3' P_{ij} + \mu_{ij} \quad (2)$$

where H_{ij} represents the daily hours spent on each category of activities by female or male individual j in household i , and OP_i is the share of the total farmland under oil palm as above. W_i is a vector of household-level controls (e.g., farm size, household demographics), P_{ij} is a vector of individual-level controls (e.g., age, education, marital status), and μ_{ij} is a random error term. Our hypothesis that oil palm cultivation is associated with increased women's involvement in household work, childcare, and leisure time would be supported by positive estimation coefficients α_1 in the female adult models for the respective activities. As the 24-hour time allocation data are only available for 2018, these models are estimated with an ordinary least squares (OLS) estimator for cross-section data.

The third research hypothesis is tested with models of the following type:

$$D_{ij} = \theta_1 OP_i + \theta_2' W_i + \theta_3' P_{ij} + \sigma_{ij} \quad (3)$$

where D_{ij} represents female asset ownership and involvement in management decisions and income control, as defined in more detail in the previous subsection. The explanatory variables are as defined above. σ_{ij} is a random error term. The share of assets owned by females is a continuous variable, so for this outcome variable we use an OLS estimator. The other outcomes are dummy variables, which are estimated with a logit estimator.⁶

5. Results

5.1. General sample characteristics

Farm households in our sample from Jambi Province have an

⁶ As we test several hypotheses, in addition to the regular p -values we also calculated sharpened q -values to correct for multiple hypotheses testing (Benjamini et al., 2006). These q -values are shown in Table S2 (SI); they largely support the same conclusions.

average farm size of 4 ha. They derive around two-thirds of their total income from own farming, the rest comes from off-farm economic activities. As mentioned, all households either grow rubber, oil palm, or both crops on their farm. The proportion of households cultivating any oil palm increased from 35% in 2012 to 46% in 2018. The proportion of households fully specialized in oil palm also slightly increased over time, from 13% in 2012 to 16% in 2018, whereas the proportion of households fully specialized in rubber decreased from 61% to 48% during the same period (Table 1).

Socioeconomic characteristics of households in these three groups are shown in Table S3 (SI). Households that cultivate any oil palm are wealthier and more likely to be of Javanese origin than households that only grow rubber. Households with oil palm also derive a larger share of their income from off-farm activities. Households that cultivate both rubber and oil palm have significantly larger farms than the other two groups. As discussed, households with a productive rubber plantation and access to additional fallow or forestland often adopt oil palm by simply expanding their farm size (Chrisendo et al. 2021). Interestingly, we do not observe any significant differences between the three groups in terms of age and education of the female spouse, two variables that can influence intra-household gender roles and decision-making power. The observed differences between the three groups in age, education, and religion of household members are also small. Individual-level descriptives for male and female adults in the sample households are shown in Table S4.

5.2. Involvement in farm work

Table 2 shows to what extent female and male household members are involved in farming activities, measured in terms of annual hours worked per ha of farmland. We compare the same three groups of households as above. Large and significant differences between the groups can be observed, especially between households cultivating only rubber (column 1) and households cultivating only oil palm (column 2). The data clearly suggest that oil palm cultivation is significantly less labor-intensive than rubber cultivation.⁷ Family labor is much more affected by the labor savings than hired labor, and female family labor is much more affected than male family labor, at least in relative terms. Females in households with only oil palm spend 91% less time in farming than females in households with only rubber. For male family labor the difference is around 77%.

The lower part of Table 2 shows a breakdown by type of farming operation. In both crops, rubber and oil palm, harvesting is the most labor-intensive operation, but in comparison, rubber tapping requires much more labor than the harvesting of oil palm fruit bunches. Fruit

Table 1
Oil palm and rubber cultivation in sample households.

	2012	2015	2018
Cultivating only oil palm (dummy)	0.13 (0.34)	0.15 (0.35)	0.16 (0.37)
Cultivating only rubber (dummy)	0.61 (0.49)	0.60 (0.49)	0.48 (0.50)
Cultivating rubber and oil palm (dummy)	0.22 (0.41)	0.22 (0.41)	0.30 (0.46)
Share of total farmland under oil palm (0–1)	0.22 (0.36)	0.24 (0.37)	0.28 (0.37)
Observations	671	680	687

Notes: Mean values are shown with standard deviations in parentheses. The share of total farmland under oil palm was calculated for all farm households in the sample.

⁷ This is also confirmed in Figure S1 (SI), which compares mean family labor inputs per ha of rubber and oil palm.

Table 2
Annual labor input in farming by farm household type.

	(1) Farms with only rubber	(2) Farms with only oil palm	(3) Farms with rubber and oil palm
Total farm labor (hours/ha)	1046.55 (956.47)	246.17*** (284.59)	681.36*** (884.21)
Hired labor (hours/ha)	125.64 (366.64)	80.09* (130.91)	122.20 (336.93)
Female family labor (hours/ha)	294.22 (452.11)	26.41*** (68.50)	155.03*** (371.55)
Male family labor (hours/ha)	608.50 (649.34)	138.21*** (230.58)	388.86*** (563.21)
<i>By type of operation</i>			
Hired labor, maintenance (hours/ha)	4.98 (19.80)	9.67*** (24.04)	8.08** (24.55)
Female family labor, maintenance (hours/ha)	6.56 (22.08)	8.60 (27.82)	7.30 (25.38)
Male family labor, maintenance (hours/ha)	26.29 (54.05)	32.62 (57.82)	26.53 (56.19)
Hired labor, harvesting (hours/ha)	111.15 (334.21)	63.87* (113.54)	101.64 (300.51)
Female family labor, harvesting (hours/ha)	275.30 (429.57)	15.10*** (48.20)	140.09*** (350.57)
Male family labor, harvesting (hours/ha)	535.24 (582.47)	87.36*** (171.01)	327.12*** (506.31)
Hired labor, post-harvest handling (hours/ha)	6.58 (26.44)	5.47 (21.64)	6.88 (27.94)
Female family labor, post-harvest handling (hours/ha)	10.06 (23.91)	0.49*** (4.24)	4.56*** (17.19)
Male family labor, post-harvest handling (hours/ha)	39.39 (70.60)	14.63*** (46.29)	30.98*** (71.79)
Observations	1,147	299	501

Notes: Mean values of hours worked are shown with standard deviations in parentheses. Data are pooled for all three survey rounds (2012, 2015, 2018). Mean difference tests carried out for columns (2) and (3) both in comparison to column (1). * p < 0.05, ** p < 0.01, *** p < 0.001.

bunches are heavy and require physical strength for manual handling while rubber tapping is less strenuous. In the local context, as in many other societies, gender stereotypes assume that women are less able to carry out hard physical work, which is one important reason why women are less involved in oil palm harvesting.

The panel data regression results are shown in Table 3. Based on the Hausman test results, we use an FE estimator for hired labor (column 1) and an RE estimator for female and male family labor (columns 2 and 3). In all three models, the share of the total farmland under oil palm has negative coefficients, supporting the labor-saving effect of oil palm cultivation in comparison to rubber and other traditional crops. The labor savings are particularly large for family labor, which is true for female and male household members.⁸ The absolute decrease is larger for male than for female family labor, but the relative decrease is larger for females. The coefficient of –202.5 implies that female household members reduce their farm labor input by 69% when the share of the farmland under oil palm moves from 0 to 1 (compare with descriptives

⁸ Significant labor savings for female and male family labor are also found with FE models, which rely on the variation in oil palm cultivation and labor input within households over time (Table S5). For illustrative purposes, we also show how the female family labor input in farming changed in those households that increased their farm area share under oil palm between 2012 and 2018 (Table S6). As expected, the female involvement in farming in those households decreased, mostly due to lower female labor input in harvesting. This supports our interpretation that the observed differences in female farm work between rubber and oil palm cultivating households are actually caused by oil palm and not just a reflection of pre-existing systematic household differences.

Table 3
Associations between oil palm cultivation and female and male involvement in farm work.

	(1)	(2)	(3)
	Hired labor (hour/year/ha)	Female family labor (hour/year/ha)	Male family labor (hour/year/ha)
Share under oil palm (0–1)	−59.59 (68.34)	−202.50*** (23.23)	−378.77*** (34.35)
Farm size (ha)	9.17 (6.64)	−9.00*** (2.17)	−21.01*** (4.08)
Household size	−0.93 (10.96)	−2.20 (7.05)	8.94 (10.08)
Age of household head (years)	−2.77 (2.25)	−0.56 (0.95)	0.38 (1.46)
Female headed (dummy)	80.03 (76.21)	−27.91 (44.54)	−306.70*** (54.48)
Education of household head (years)	−13.67 (8.32)	−8.50** (3.66)	−4.85 (4.89)
Javanese ethnicity (dummy)		48.30** (22.06)	49.88 (36.50)
Non-random village (dummy)		36.54 (36.24)	64.79 (52.94)
Wealth index (1–5)	13.44 (15.42)	−7.51 (6.48)	−19.55* (10.23)
Regency controls	No	Yes	Yes
Year 2015 (dummy)	99.06 (86.54)	114.85 (71.07)	21.72 (80.55)
Year 2018 (dummy)	36.52* (19.69)	129.71*** (21.56)	127.21*** (29.16)
Hausman test (p-values)	0.020	0.697	0.375
N	1,349	1,349	1,349

Notes: Panel data regression coefficients are shown with cluster-robust standard errors in parentheses. The model in column (1) uses an FE and the models in columns (2) and (3) an RE estimator. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

in Table 2), even after controlling for confounding factors. These estimates clearly support our first hypothesis that oil palm cultivation is associated with reduced women’s involvement in farm work.

As there are two main ethnicities represented in our sample, Melayu and Javanese, and female involvement in different economic activities may be influenced by ethnic norms, we also tested whether the oil palm associations differ by ethnicity. This is particularly relevant in our context, as Javanese households are already more involved in oil palm farming than Melayu households. In Table S7 (SI), we include an interaction term between oil palm cultivation and Javanese ethnicity, which is not significant in any of the models. The other results remain largely unchanged, so we conclude that the associations do not differ significantly by ethnicity.

5.3. Daily time allocation

Table 4 presents descriptive statistics of the daily hours spent by female and male adults in different economic and social activities, as derived from the 24-hour time allocation questions. We start by describing the time allocation of females (columns 1–3). On average, females in households with only oil palm spend over one hour less per day in on-farm work than their counterparts in households with only

Table 4
Daily time allocation of female and male adults by farm household type.

	Females			Males		
	(1)	(2)	(3)	(4)	(5)	(6)
	Only rubber	Only oil palm	Rubber and oil palm	Only rubber	Only oil palm	Rubber and oil palm
Working on-farm (hours)	2.74 (2.86)	1.50*** (2.61)	2.47 (2.62)	4.38 (2.98)	4.28 (3.05)	4.88 (2.89)
Working off-farm (hours)	1.37 (2.66)	1.29 (2.76)	1.08 (2.60)	2.18 (3.20)	2.24 (3.29)	1.71 (3.09)
Household chores and care work (hours)	4.16 (2.83)	4.85* (2.69)	4.38 (2.59)	0.43 (0.92)	0.52 (1.18)	0.51 (1.52)
Leisure (hours)	3.34 (2.28)	3.96* (2.52)	3.70 (2.49)	3.23 (1.90)	3.89** (2.35)	3.33 (1.95)
Eating and grooming (hours)	3.48 (1.49)	3.86* (1.93)	3.61 (1.78)	4.42 (1.43)	4.20 (1.46)	4.32 (1.55)
Resting/sleeping (hours)	8.78 (1.21)	8.51 (1.18)	8.64 (1.24)	8.62 (1.34)	8.40 (1.33)	8.62 (1.48)
Observations	268	94	173	264	96	179

Notes: Mean values of individual 24-hour time allocation data are shown with standard deviations in parentheses. Data from 2018 survey round. Mean difference tests carried out for columns (2) and (3) in comparison to column (1), and for columns (5) and (6) in comparison to column (4). * p < 0.05, ** p < 0.01, *** p < 0.001.

rubber. This difference is statistically significant and fully consistent with the annual data estimates discussed above. But how is the on-farm labor time saved reallocated to other activities? We do not observe significant differences in off-farm work. As discussed above, women in rural Indonesia face human capital and cultural constraints to be more involved in off-farm activities.⁹ Yet, women’s time spent on household chores and care work, leisure activities, and eating and grooming is significantly higher in households only cultivating oil palm.

Turning to the time allocation of male household members (shown in columns 4–6 of Table 4), we observe much smaller differences between the household types. Daily on-farm work of males is not significantly lower in households with only oil palm than in households with only rubber. On first sight, this looks contradictory to the results above showing a significant decrease in farm work per ha through oil palm cultivation. However, a decrease in the labor time per ha does not necessarily mean a total decrease in farm work, as some of the oil palm farmers use the labor time saved per ha to further expand their farmland (Chrisendo et al. 2021; Krishna et al. 2017a). The only significant difference for male adults in Table 4 is observed for leisure time, which is somewhat higher in households with only oil palm.

These results are also confirmed with the regression model estimates, which are shown in Tables 5 and 6 for female and male adults respectively. Table 5 suggests that oil palm cultivation is significantly associated with decreased female time in on-farm work (by close to one hour per day), whereas it is significantly associated with increased time spent on household chores and care work, leisure, and eating and grooming.

⁹ In our sample, 23% of the women pursued off-farm activities in 2018 with no significant differences between poorer and richer households. However, a further breakdown by type of activity shows that women from relatively richer households are significantly less involved in employed off-farm activities away from the own household than women from poorer households (Table S8). This points at cultural restrictions for women to be employed off-farm, especially when there is no economic need for additional employment income.

Table 5
Associations between oil palm cultivation and female daily time allocation.

	(1)	(2)	(3)	(4)	(5)	(6)
	Working on-farm	Working off-farm	HH chores and care work	Leisure	Eating and grooming	Resting and sleeping
Share under oil palm (0–1)	−0.99*** (0.29)	−0.19 (0.33)	0.60** (0.30)	0.57** (0.27)	0.39* (0.20)	−0.33** (0.14)
Farm size (ha)	0.05** (0.02)	−0.05 (0.04)	0.00 (0.02)	0.01 (0.03)	−0.02 (0.02)	0.01 (0.01)
Household size	−0.21** (0.08)	−0.03 (0.08)	0.34*** (0.08)	−0.08 (0.07)	−0.02 (0.05)	0.02 (0.03)
Female is married (dummy)	−0.60 (1.94)	−0.29 (1.57)	0.18 (1.30)	−0.80 (0.50)	1.40*** (0.46)	0.08 (0.81)
Age of female (years)	0.00 (0.01)	−0.00 (0.01)	−0.06*** (0.01)	0.04*** (0.01)	0.01 (0.01)	0.01* (0.01)
Javanese ethnicity (dummy)	0.23 (0.24)	−0.03 (0.26)	−0.08 (0.23)	−0.33 (0.20)	0.06 (0.15)	0.15 (0.11)
Education of female (years)	−0.06 (0.04)	0.08** (0.04)	0.05 (0.03)	−0.05 (0.03)	0.01 (0.03)	−0.04** (0.02)
Non-random village (dummy)	−0.28 (0.36)	−0.16 (0.37)	−0.58* (0.33)	0.73* (0.37)	0.59** (0.24)	−0.27 (0.20)
Wealth index (1–5)	−0.25*** (0.08)	0.16 (0.10)	−0.02 (0.09)	0.08 (0.07)	0.01 (0.07)	0.02 (0.04)
Regency controls	Yes	Yes	Yes	Yes	Yes	Yes
N	562	562	562	562	562	562

Notes: OLS regression coefficients shown with robust standard errors in parentheses. Data from 2018 survey round. Outcome variables are expressed in hours per day. HH, household. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table 6
Associations between oil palm cultivation and male daily time allocation.

	(1)	(2)	(3)	(4)	(5)	(6)
	Working on-farm	Working off-farm	HH chores and care work	Leisure	Eating and grooming	Resting and sleeping
Share under oil palm (0–1)	0.46 (0.35)	−0.30 (0.37)	0.00 (0.12)	0.57** (0.24)	−0.11 (0.17)	−0.32** (0.15)
Farm size (ha)	0.08** (0.03)	−0.10** (0.04)	0.01 (0.01)	0.02 (0.02)	−0.01 (0.01)	0.02 (0.01)
Household size	0.05 (0.09)	0.02 (0.09)	0.04 (0.03)	−0.04 (0.06)	−0.01 (0.04)	−0.08** (0.04)
Male is married (dummy)	2.30*** (0.60)	−3.01 (2.15)	0.33 (0.20)	−0.64 (1.85)	0.27 (0.61)	1.18** (0.48)
Age of male (years)	−0.00 (0.01)	−0.08*** (0.01)	0.00 (0.01)	0.03*** (0.01)	0.02*** (0.01)	0.03*** (0.01)
Education of male (years)	−0.02 (0.04)	0.05 (0.04)	−0.00 (0.02)	−0.05** (0.02)	0.03* (0.02)	−0.02 (0.02)
Ethnicity: Javanese (dummy)	0.41 (0.27)	−0.60* (0.31)	−0.01 (0.14)	−0.17 (0.18)	0.12 (0.14)	0.25** (0.13)
Non-random village (dummy)	0.39 (0.43)	−0.64 (0.47)	−0.18 (0.18)	−0.18 (0.32)	0.75*** (0.24)	−0.01 (0.24)
Wealth index (1–5)	−0.25** (0.10)	0.15 (0.11)	0.02 (0.04)	0.01 (0.06)	0.01 (0.05)	0.00 (0.04)
Regency controls	Yes	Yes	Yes	Yes	Yes	Yes
N	562	562	562	562	562	562

Notes: OLS regression coefficients shown with robust standard errors in parentheses. Data from 2018 survey round. Outcome variables are expressed in hours per day. HH, household. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Interestingly, we also see a decrease in women’s resting and sleeping time associated with oil palm cultivation. These results support our second research hypothesis that the female labor saved in oil palm cultivation is reallocated primarily to social activities in the household.¹⁰

Table 6 for male adults suggests that oil palm cultivation is associated with an increase in daily leisure time and a decrease in resting and sleeping time. The other effects for males are not statistically significant.

¹⁰ In Table A9 we show additional models with an interaction term between oil palm cultivation and Javanese ethnicity included. The interaction term is not statistically significant in any of these models, so we conclude that the time reallocation of females associated with oil palm cultivation does not differ by ethnicity.

5.4. Women’s decision-making power

Table 7 compares our variables measuring women’s intra-household decision-making power between the three types of farm households. The likelihood of a woman’s name being included on a land title is relatively low, with no significant differences between the three groups of households. Customary land rights without formal titles still play an important role in rural Indonesia (Krishna et al. 2017b), thus not all households have formal land titles. We do not observe significant differences in female ownership or co-ownership of other household assets among the three types of farm households.

For concrete economic management decisions, more notable differences are seen in Table 7. In farm households with oil palm, women are significantly less involved in decisions related to cropping activities. While 35% of the women in households with only rubber participate in

Table 7
Female asset ownership and decision-making by farm household type.

	(1)	(2)	(3)
	Farms with only rubber	Farms with only oil palm	Farms with oil palm and rubber
<i>Asset ownership</i>			
Female name on land title (dummy)	0.14 (0.35)	0.09 (0.29)	0.13 (0.34)
Share of assets owned by female or both (0–1)	0.48 (0.35)	0.46 (0.33)	0.50 (0.33)
<i>Female involved in management decisions</i>			
Cropping activities (dummy)	0.35 (0.48)	0.23* (0.42)	0.22** (0.42)
Livestock activities (dummy)	0.65 (0.48)	0.68 (0.47)	0.58 (0.50)
Off-farm activities (dummies)	0.65 (0.48)	0.55 (0.50)	0.49* (0.50)
<i>Female involved in income control</i>			
Crop income (dummy)	0.89 (0.31)	0.77** (0.42)	0.81** (0.39)
Livestock income (dummy)	0.85 (0.36)	0.86 (0.35)	0.81 (0.39)
Off-farm income (dummy)	0.88 (0.32)	0.92 (0.27)	0.84 (0.37)
Observations	324	108	207

Notes: Mean values are shown with standard deviations in parentheses. Data from 2018 survey round. Mean difference tests carried out for columns (2) and (3) in comparison to column (1). * p < 0.05, ** p < 0.01, *** p < 0.001.

crop management decisions, this is true for only 23% of the women in households with only oil palm. This difference is plausible, because women are also much less involved in the labor operations in oil palm than in rubber, as shown above.

Similar gendered patterns are also found for income control in the lower part of Table 7. In oil palm producing households, women are significantly less involved in crop income control than in households only producing rubber. Regardless of the differences between the groups, it is interesting to see that women’s participation in income control is relatively high: above 75% in all types of households and for

Table 8
Associations between oil palm cultivation and female decision-making power.

	Female asset ownership		Female involvement in decisions			Female involvement in income control		
	(1) Name on land title	(2) Share of assets owned	(3) Cropping activities	(4) Livestock activities	(5) Off-farm activities	(6) Crop income	(7) Livestock income	(8) Off-farm income
Share under oil palm (0–1)	–0.54 (0.42)	–0.02 (0.04)	–0.54** (0.26)	–0.08 (0.30)	–0.06 (0.36)	–1.03*** (0.27)	–0.14 (0.36)	0.34 (0.57)
Farm size (ha)	0.07*** (0.02)	–0.00 (0.00)	–0.02 (0.02)	–0.01 (0.02)	–0.02 (0.02)	–0.02 (0.02)	0.00 (0.03)	0.03 (0.03)
Household size	0.02 (0.11)	–0.01 (0.01)	–0.05 (0.07)	0.12 (0.09)	–0.00 (0.09)	–0.09 (0.08)	–0.01 (0.10)	0.06 (0.14)
Female is married (dummy)	–0.32 (1.11)	–0.06 (0.12)	–0.62 (0.72)	–1.21 (1.07)		0.90 (0.90)	0.07 (1.08)	
Age of female	0.01 (0.02)	0.00 (0.00)	0.00 (0.01)	–0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	–0.00 (0.02)	–0.01 (0.02)
Education of female (years)	0.03 (0.05)	0.01** (0.00)	0.00 (0.03)	–0.07** (0.03)	0.07* (0.04)	0.02 (0.04)	–0.06 (0.05)	0.13* (0.07)
Javanese ethnicity (dummy)	–0.81*** (0.30)	–0.04 (0.03)	–0.07 (0.20)	–0.39 (0.24)	0.07 (0.31)	–0.31 (0.25)	–0.30 (0.31)	–0.13 (0.47)
Non-random village (dummy)	–0.05 (0.52)	0.07 (0.05)	–0.78** (0.33)	–0.60* (0.36)	–0.02 (0.42)	–0.19 (0.34)	–0.43 (0.43)	–0.16 (0.59)
Wealth index (1–5)	–0.25** (0.11)	0.01 (0.01)	–0.00 (0.07)	–0.01 (0.08)	–0.29*** (0.10)	–0.02 (0.09)	–0.08 (0.11)	–0.62*** (0.16)
Regency controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	417	666	626	375	246	626	375	246

Notes: Regression coefficients are shown with robust standard errors in parentheses. Data from 2018 survey round. The model in column (2) was estimated with OLS, all other models with a logit estimator. Female is married was dropped in two of the models due to collinearity issues. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

all types of income. This finding is in line with prior work in Sumatra suggesting that women are often more involved in household finance than in physical agricultural work (Villamor et al. 2015). As mentioned above, it is possible that gender norms in Jambi are to some extent influenced by the geographical proximity to West Sumatra, which is home to the matrilineal Minangkabau ethnic group.

Results from the regression models explaining female decision-making are presented in Table 8. We run eight models, one for each of the outcome variables. Two of these models show significant associations with oil palm cultivation. The results in column (3) suggest that oil palm cultivation is associated with reduced female involvement in crop management decisions, also after controlling for several cofounding factors. The results in column (6) suggest that oil palm cultivation is associated with reduced female involvement in crop income control. These results support our third hypothesis that oil palm cultivation is associated with decreases in women’s economic and financial decision-making power.

In additional models we test again whether the associations vary by ethnicity. Table S10 (SI) shows that the interaction term between oil palm cultivation and Javanese ethnicity is not significant in any of the models, except for the model related to land titles. In the land title model, the interaction term is significantly positive, whereas the oil palm coefficient itself is negative and significant. These results indicate that women in Melayu households with oil palm are less likely to be included in a land title certificate than women in Javanese households with oil palm. This result may also be related to the fact that Melayu households are less likely than Javanese households to hold formal land titles in the first place. As mentioned, Javanese transmigrants obtained land titles as part of the government transmigration programs (Qaim et al. 2020; Zen et al. 2006). Beyond land titles, the associations oil palm cultivation with female decision-making power do not seem to vary by ethnicity.

6. Discussion and conclusion

In this study, we have explored the associations of oil palm cultivation with gender roles in smallholder farm households with data from Jambi Province on the Island of Sumatra, one of the hotspots of the

recent oil palm expansion in Indonesia. Farm households in Jambi and many other regions of Indonesia increasingly replace rubber and other traditional crops with oil palm, which is more profitable (Kubitza et al. 2018). Some of the oil palm expansion is also at the expense of forestland (Krishna et al. 2017b; Qaim et al. 2020). While household income effects of oil palm cultivation were analyzed in previous studies, we are not aware of previous work that analyzed implications for gender roles and female decision-making power with quantitative data and methods.

When households transition from food crop to cash crop production, women often lose their control over income and productive resources (von Braun and Kennedy 1994; Doss 2001; Fischer and Qaim 2012). However, in Jambi many households already grew rubber, also a cash crop, before adopting oil palm, so this direct gender effect is of lower relevance in the local context. Indirect mechanisms through changes in labor input seem to be more important in driving gender effects in this particular context. Our data show that oil palm requires much less labor than rubber and that women are particularly affected by the labor savings. The harvesting work in oil palm plantations requires physical strength and is primarily conducted by male household members and hired workers. Given common gender stereotypes, women are considered less able to carry out the strenuous harvesting work in oil palm.

A significantly negative relationship between the share of oil palm cultivated on a farm and the annual number of female hours worked in farming was found with descriptive statistics and also with panel data regression models that control for several confounding factors. The same results were also obtained with individual-level 24-hour time allocation data. Further, our data suggest that the female labor time saved in farming through oil palm cultivation is not reallocated to more off-farm employment. In the local context, women face human capital and cultural constraints to participate more in off-farm employment, especially when there is no immediate economic need to do so. Instead, the female labor time saved in farming through oil palm is primarily reallocated to household chores, care activities, and leisure time.

Similar labor reallocation patterns were also observed in other geographical contexts and for other types of labor-saving farming innovations. For instance, a study in Vietnam showed that the adoption of a labor-saving farming technology was associated with females reallocating part of their freed labor time to child care and community activities (Paris and Chi 2005). Such a time reallocation may possibly be beneficial for family welfare and small children in particular, as an increase in maternal time at home is often positively associated with child nutrition and health, especially in time-constrained households (Debela et al. 2021). However, more female time spent on unpaid household chores and care work hardly improves gender equity (Ferrant et al. 2014). Male adults in the households from Jambi only spend a very small amount of time on household chores and care work with no significant changes through oil palm adoption. Obviously, a more balanced intra-household distribution of unpaid care work between men and women would be important for gender equity, which is true in Jambi and also more generally.

In terms of decision-making power, our data from Jambi suggest that oil palm cultivation is associated with lower female involvement in decisions related to cropping activities and crop income control. This is plausible, as women in households with oil palm are also much less involved in farm production work and marketing than women in households with only rubber or other more traditional crops. Data from other geographical contexts also show that decision-making and income control are often positively associated with work input. For instance, a study in Malawi and Uganda showed that women tend to control higher shares of the income from a specific crop if they are actively involved in producing and marketing this crop (Njuki et al. 2011).

These results have varied ramifications for women's empowerment. On the one hand, reduced female involvement in farm work through oil palm cultivation may lead to lower economic empowerment because women contribute less to cash income generation. In combination with the reallocation of female time to household chores and care activities,

this could reinforce traditional gender stereotypes, where males are the breadwinners and women the homemakers. Women do not reallocate the farm labor time saved to off-farm economic activities also due to cultural constraints. On the other hand, the increase in leisure time through oil palm cultivation could be empowering for women, as this allows women to spend more time for their own well-being. This is potentially important because women often face time-poverty being involved in both household work and income generation (Grassi et al. 2015). Our findings therefore suggest that females are more time-empowered but less economically empowered through an increase in oil palm cultivation.

One limitation of our study is that the data collected does not allow us to analyze women's own preferences, which are also important when evaluating various facets of female empowerment. To what extent do women in the local context actually want to participate in cropping activities, decision-making, or off-farm employment? Obviously, preferences are often shaped by gender stereotypes, but simply assuming that we as researchers know best what women in the local context themselves would consider as empowering is probably an imperfect approach. Alternative approaches and measures of empowerment, such as the women's empowerment in agriculture index (WEAI) that better accounts for preferences (Alkire et al. 2013), could be considered in follow-up research. Another limitation of our study is related to the fact that we mostly look at associations and not causal effects in a strict sense. While in the regression models we control for household wealth, education, and other sociodemographic factors that may jointly influence oil palm cultivation and intra-household gender roles, certain endogeneity issues may remain. Additional work with a more rigorous identification strategy is recommended to further strengthen the reliability of the results.

In spite of these limitations, some broader lessons and cautious policy implications can be derived from our analysis. First, the adoption of new cash crops like oil palm can influence gender roles in multiple ways, often with undesirable outcomes for women's empowerment. Understanding such effects and possibly intervening through awareness campaigns or specific support measures is important from a sustainable development perspective. Second, as women are often time-constrained, reducing women's workload may have positive effects for family welfare and women's own well-being. However, a shift from income-earning activities to unpaid care work may also lead to losses in female economic and financial decision-making power. Third, female access to off-farm employment should be improved, which has cultural, educational, and institutional dimensions. Access to lucrative off-farm activities can improve female financial autonomy and empowerment (Majlesi 2006; Rangel 2006; Chrisendo et al. 2020), but so far women's access to off-farm employment in rural Indonesia is limited.

CRedit authorship contribution statement

Nadjia Mehraban: Data curation, Conceptualization, Formal analysis, Writing - original draft. **Bethelhem Legesse Debela:** Conceptualization, Methodology, Validation. **Ummi Kalsum:** Data curation. **Matin Qaim:** Conceptualization, Writing - review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data used in this study are available from the corresponding author upon request.

Acknowledgements

This study was funded by Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – grant number 192626868 – in the framework of the German-Indonesian Collaborative Research Center CRC 990. The authors thank Agnes Quisumbing and four anonymous reviewers of this journal for valuable comments on earlier versions of this manuscript.

Conflict of interests

The authors declare that they have no known conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodpol.2022.102276>.

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