Towards a living income for cocoa producers in Indonesia

An insight into the situation of Indonesian cocoa farming households and potential strategies for improved intervention design

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The Living Income
Community of Practice

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The primary objective of this paper is to assess the income situation of Indonesian cocoa-producing households across different regencies and consider the factors that enable or hinder them from earning a living income. Our findings reveal that the vast majority of the studied households are not earning a living income, with many living in a situation of severe poverty. The living income gap amounts to approximately USD 1,365 per household per year, indicating that a significant increase in income would be necessary for households to achieve decent standards of living. Households that are already earning a living income typically have larger farm sizes and tend to be more diversified. Our study concludes with recommendations intended for enhancing the income of these households, either by expanding cocoa production or through other means, ultimately bolstering the resilience of smallholder farming households.

Keywords: living income, smallholder farmer, Indonesia, cocoa, sustainable value chains

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Table of contents

Preface

Globally, smallholder households engaged in cocoa production are still far from achieving living incomes. To offer targeted policy and programme recommendations aimed at enhancing the resilience of these households, it is essential to assess their income status and identify specific barriers hindering them from earning a living income.

This study examines the income growth opportunities for cocoa-producing households in Indonesia based on their household characteristics. The paper concludes with recommendations to improve the income of these households, whether through expanding cocoa production or employing alternative means, ultimately reinforcing the resilience of smallholder farming households.

We hope that the findings of this study will help to strengthen ongoing programmes and policies, informing current and future discussions on sustainable cocoa production. W*e express our gratitude to the Sustainable Food Lab, which commissioned this study, for their cooperation and support. We would also like to thank the two* data owners who granted the permission for the use of the data for this analysis. *This study was produced for the Living Income Community of Practice and made possible with the generous financial support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).*

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Executive summary

The primary objective of this paper is twofold. First, to assess the income situation of Indonesian cocoa-producing households across different regencies and consider the factors that enable or hinder them from earning a living income. Second, to provide recommendations for enhancing the income of these households, either by expanding cocoa production or through other means, ultimately bolstering the resilience of smallholder farming households.

Our findings reveal that the vast majority of the studied households are not earning a living income, with many living in a situation of severe poverty. The living income gap amounts to approximately USD 1,365 per household per year, indicating that a significant increase in income would be necessary for households to achieve decent standards of living. Households that are already earning a living income typically have larger farm sizes and tend to be more diversified.

The majority of the studied households face significant barriers to earning a living income, with almost 84% of all the studied households falling into this category. They have relatively small farm sizes, produce limited volumes of cocoa, and lack the capacity to further invest in cocoa production. On the other hand, the remaining households, falling into the low and medium barriers groups, have the potential to increase their production volumes and express their willingness to do so.

Based on these results, we propose three pathways for improvement:

1. Cocoa productivity can be increased through investments. However, among households facing high barriers to earning a living income, productivity improvements are unlikely to result in substantial income increase due to limited ability to invest and smaller farm size.
2. Raise incomes through measures such as premium increase or support through social protection including cash transfers, which would enable more investments in cocoa and other farm activities.
3. Provide support to the poorest majority by generating off-farm income opportunities, and to the relatively more affluent households through on-farm diversification. Households' wishes and aspirations should be acknowledged and respected with regard to diversification activities.

We employed a methodological approach that involved three types of analyses to ensure the robustness of our results and make comparisons between findings. The outcome variable of our analysis was the living income gap, calculated based on the living income benchmark of Indonesian cocoa farmers (Kadarusman et al., 2022). First, to substantiate our variable selection, we used machine learning techniques. Following this, we used the variables identified as the best predictors of the living income gap from the machine learning techniques in a cluster analysis and a threshold analysis. Both of these analyses helped in identifying distinct groups of farmers. These selected methods complemented each other and enabled us to compare similarities and differences among the groups to draw conclusions regarding general findings and the most relevant and efficient interventions for each category.

1 Towards a living income – an insight into the situation of Indonesian cocoa producing households

Living income ambitions and the cocoa sector

The concept of a living income has gained traction among companies, NGOs, and governments, including the EU, Dutch, German, Belgian, and Luxembourg governments, which have jointly signed a declaration on living wages and incomes. In various sectors, including the cocoa industry, stakeholders have established targets for smallholder farmer and worker households to achieve a living income. However, for many countries and regions, there is insufficient publicly available data and information on the income status of smallholder farming households, including analyses on how these households can attain and, preferably, surpass a living income. While such information is available for Ghana and Côte d'Ivoire in the cocoa sector, it is lacking for other origins. This paper aims to bridge this data gap by presenting findings from a living income study conducted on cocoa farming households in Indonesia.

The objective of this paper is to assess income growth opportunities based on household characteristics.

This paper aims to 1) assess the situation of Indonesian households producing cocoa across different regencies in terms of what are the characteristics that enable them to earn a living income (or not); and 2) provide recommendations on how to substantially improve the income of these households, whether through expanding cocoa production or alternative means. The ultimate goal is to enhance resilience of smallholder farming households through higher and more stable household incomes. Our analysis takes into account on-farm realities of the households studied and their ability to earn a living income from cocoa production. In the discussion of recommendations, we also consider factors such as current market prices, trade agreements, and policy implementation.

We leverage data from previous impact studies to understand the living income situation of Indonesian cocoa producing households.

We have aggregated data from various household surveys conducted between 2016 and 2022, allowing us to analyse the situation of 729 cocoa-producing households across various regencies, including Lampung, West, and South Sulawesi.

We conduct three types of analyses to assess the living income situation of the households and understand the household and farm-level characteristics that determine whether a household earns a living income or not.

As explained in the following chapters, we combine machine learning, cluster analysis and threshold analysis. This combination ensures the complementarity and robustness of our results. We harmonised the datasets and corrected for potential bias in machine learning and group analyses, as will be explained later.

The findings from the assessment enable us to provide a set of recommendations on the most effective and relevant interventions per each of the identified groups of households.

Understanding the living income situation of different households and farm-level characteristics that determine the barriers to earning a living income serve as input for the discussion on intervention strategies. We conclude our paper with recommendations on how different types of households can be best supported to achieve a living income. We place the recommendations within the wider context of cocoa production in Indonesia and the observed trends in the sector.

2 Methodology to answer the research questions

We used the newly published living income benchmark for Indonesia, set at IDR 5,026,257 per month in 2022, to calculate a living income benchmark per household per year.

The annual living income benchmark value for a household of four members was IDR 60,315,084. To match the living income benchmark as estimated by Kadarusman et al. (2022) with the household incomes in our sample, we adjusted the living income benchmark for the relevant inflation rate.[1] We then computed a yearly living income benchmark for each household by multiplying the living income benchmark by the number of household members based on the OECD equivalence scores.[2] This implies that larger households require higher total household income to ensure that all household members experience decent living, as outlined in the living income concept.

We calculated the living income gap based on the newly established living income benchmark and actual net household income from two studies.

To calculate the living income gap for each household per year, we subtracted the total net household income per year from the calculated living income benchmark. The net income from cocoa was determined by multiplying the production volumes provided by the respondents by the selling price per kilogram of cocoa. We have deducted costs of production, including input costs (such as fertilisers and pesticides used) and costs of hired labour. We only assessed variable cost of production as other types of cost (e.g. fixed costs, or plantation establishment cost) were not considered relevant for the households at the time by stakeholders; we therefore focused on assessing the cashflow of the households for the specific season assessed. We then incorporated any additional income reported by the respondent – both from other agricultural production or off-farm income, thus calculating actual net household income. Net non-cocoa income was based on self-reported amounts of income earned from such sources from which possible cost of production were deducted, for different types of activities (e.g. other crops, employment etc). Food produced at home for self-consumption has not been considered for the gap calculations. This is due to our data consisting of previous studies, where individual surveys do not inform us about commonly produced food items that were intended for home consumption.

$$Living\ income\ gap = household\ specific\ living\ income\ benchmark^{3} - actual\ total\ net\ household\ income$$

We employed three types of analyses in our methodological approach to ensure robustness of our results and facilitate comparisons.

The present methodology consists of 3 distinct analyses: machine learning, cluster analysis and threshold analysis. Drawing from the literature, sector experience and expert knowledge, we identified a set of variables that determine a household's ability to produce sufficient volumes and enable substantial income increases from on-farm sources. Using machine learning, we tested which of the selected variables were the best predictors of the living income gap, thus validating the variable selection. Subsequently, the cluster analysis allowed us to identify groups within our sample, where households exhibit similarities in terms of pre-defined characteristics but differ in terms of their living income gap outcome. Lastly, the threshold analysis examined some of these selected variables to classify households into three distinct categories, each characterised by the barriers these households face to earning a living income from cocoa production. In this regard, the selected methods are

[1] We follow World Bank inflation rates published on https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG

[2] We do so based on the LICOP Guidance: COSA & KIT Royal Tropical Institute. (2020). Guidance manual on calculating and visualizing the income gap to a Living Income Benchmark. Committee on Sustainability Assessment (COSA) & KIT Royal Tropical Institute. Unit of analysis is adult male equivalent (AME) which is a conversion that takes into account household composition and assigns weights to additional household members.

[3] Benchmark that takes into account household composition as explained earlier.

complementary and enhance robustness of our results. We were able to on one hand observe similarities and differences in the identified groups (established in the cluster and threshold analysis) and on the other to identify new characteristics related to cocoa production. These findings contribute to our conclusions regarding general trends and the most relevant and efficient interventions for each category.

We use data from 729 households situated across four regencies in Indonesia. This data was obtained from two impact evaluation studies conducted by WUR.

Our sample consists of data from four regencies, with over 70% of the households located in either West Sulawesi (253 households) or Lampung (283 households). The remaining households were distributed between Kolaka regency (111 households) and Konawe Selatan (82 households). This data was collected in collaboration with WUR and obtained as part of impact evaluation studies conducted between 2016 and 2022. The data owners granted the permission for the use of the data for the purpose of further analysis by WUR. The datasets contain information on households, the majority of whom were part of a corportate sustainability programme in the year for which data was collected. Regarding the representativeness of the households in our sample with cocoa farming households in Indonesia, there are relatively few good quality data sources available in the public domain to compare our data with. Based on the available sources, we conclude that the households appear representative for Indonesian cocoa farming households regarding farm size and cocoa yields (per ha), though some sources quote higher yields (see references section). All households in our sample were actively producing cocoa and interviews were conducted with a household member sufficiently knowledgable about production volumes, costs, prices and other variables of interest.

2.1 Machine learning analysis to assess which variables best predict the living income gap

Machine learning analysis consists of a random forest algorithm to assess variable importance in explaining the living income gap.

To assess the importance of certain variables in explaining the living income gap, we used a random forest algorithm. We used the outcomes of this model to validate the indicator selection for both the cluster analysis as well as the threshold analysis. Random forests create and combine multiple decision trees, which serve to combine models for classification and regression purposes. Random forests are commonly used for classifying variables in order of importance in predicting (or in our case explaining) the defined outcome (living income gap). In more technical words, the model shows the extent to which the model accuracy decreases when a particular variables is omitted (Genuer and Poggi, 2020). This, in turn, provides us with insights into the most influential predictors of the living income gap.

2.2 Cluster analysis to arrive at various household groups with similar characteristics but different living income gaps

The objective of the cluster analysis is to use the data to assign households into typical groups that differ in terms of their living income potential.

Cluster analysis divides the observations into groups that minimise internal variation and maximise variation between the distinct groups. Contrary to a classification based on pre-defined groups or profiles, statistical cluster analysis seeks to identify the number and composition of groups based on statistical analysis (Romesburg, 2004). This approach can reveal patterns and associations that may not be evident but become clear when highlighted through statistical analysis. These groups can then be described in terms of other key indicators or key characteristics.

We used hierarchical grouping methods developed and validated in two phases.

We used so-called hierarchical agglomerative methods: 'hierarchical' because all groups formed by these methods consist of mergers of previously formed groups, 'agglomerative' because the methods begin with as many groups as there are observations and end with a single group containing all observations. Non-hierarchical methods are based on the idea that you start with a predefined number of groups and assign households arbitrarily to each group. From there, households are reassigned across the groups to create groups as similar as possible. This is easy with two variables. For example, if we want to group five households and two have high productivity/high input use, one had high productivity/low input use, and two have low productivity/low input use, we will have three groups. However, when more variables and answer categories are added, this calculation gets more complicated. This is where statistical cluster analysis comes in.

Table 2.1 *Overview of variables used in cluster analysis*

Type of variable	Variable
Key outcome variable	Living income gap
Variables used in the cluster analysis	Total cocoa volume (kg)
	Cocoa farm size (ha)
	Other farm size (ha)
	Total input costs for cocoa production
	Hired labour days used for cocoa production
	Unpaid labour days used for cocoa production
	Share of farm dedicated to cocoa
	Number of adults in the household
	Number of children in the household
	Price of cocoa received per kilogram (including premium)
Variables used to describe the groups	Distance to farm (km)
	Gender of the respondent
	Ownership of the cocoa farm
	Willingness to invest in cocoa
	Regency: Kolaka Kolaka, Konawe Selatan, Lampung or West-Sulawesi

We distinguish different types of variables to be used in the analysis.

In addition to the key outcome indicator, the household living income gap, we consider variables to be included in the cluster analysis itself, as well as variables used to describe the groups. The variables intended for the use in the cluster analysis itself should conceptually explain differences in households' living income gap and the differences should be statistically significant. Moreover, statistical cluster analysis yields better results when excluding categorical or binary variables. As a result, variables such as the gender of the household head are used exclusively as descriptive variables. Even though descriptive variables are not directly included in the cluster analysis, we may still observe substantial differences between groups in terms of descriptive variables. These differences are also presented in the results section. Table 2.1 provides an overview of all the variables included in the cluster analysis.

2.3 Threshold analysis to conclude on household groups with different barriers to earn a living income from cocoa and farming

The objective of the threshold analysis is to classify households into groups that represent low, medium and high barriers to achieving a living income from cocoa farming in five steps.

Each of the steps is characterised by a farm-level attribute associated with cocoa production, which is considered an enabling factor (or barrier) to income growth. For each of these characteristics, we establish specific requirements that align with the concepts of low, medium or high barriers to earning a living income. For instance, if a household possesses a farm size that meets the minimum requirement of a farm size that allows sufficient production volume to earn a living income, we classify such a household as having a low barrier to earning a living income. This logic is applied consistently to each subsequent step. Consequently, a household placed in the low barriers category during the initial step of the analysis may end up in the high barriers category by the conclusion of the analysis, and vice versa.

The requirements per each step of the analysis are based on literature, expert knowledge gained through experience in impact studies in the relevant topics, and characteristics observed in the group of households earning a living income.

To identify thresholds for cocoa farm size, we reviewed relevant literature sources[4] and looked at the farm size of a group earning a living income. Furthermore, the 2 ha as a viable farm size for households to earn a living income from cocoa production was confirmed during a 'Workshop on Living Income Visibility and Equality for Cocoa Smallholder Farmers in Central Sulawesi'.[5] For the two subsequent steps, we defined the thresholds based on mean values of the group earning a living income. In other words, low barriers were associated with the mean total volume of cocoa produced by households earning a living income and the mean value of total cocoa production costs in this group of households. This is because there is no scientific consensus on what volumes of cocoa farmers should produce or what investment is required for a household to earn a living income. In that sense, characteristics observed in the group earning a living income can help us better understand about the required volumes and inputs costs to earn a living income from cocoa production. Willingness to invest was included towards the end of the analysis (step 4) to proxy household's motivation to continue or expand cocoa farming.[6] In the final step we observe the effect of a possibility to close the income gap of some of the households with a cash transfer of USD 400. Such cash transfer reflects current interventions that are using this support mechanism to see, at present, how many households would meet their benchmark with such amount.[7] An overview of the requirements for each step can be found in Appendix 2. The threshold analysis can be applied to any commodity, such as coffee, tea or others. This would influence the requirements per step to make the cut-offs suited for the given commodity.

The order of the steps matters. Farm size, being one of the main determinants of whether a household earns a living income or not, is the first step in the analysis.

Numerous literature sources, along with findings from previous studies, highlight the critical importance of a viable farm size in producing sufficient volumes for a household to achieve a living income.[8] This is the reason we initiate the categorisation of households based on the farm size they possess and proceed with the subsequent variables, as illustrated in Figure 2.1. The final categorisation of households in groups in terms of barriers to earning a living income from cocoa production is an outcome of the thresholds and conditions individual households meet at each of the steps.

The threshold analysis focuses exclusively on households that are not earning a living income.

The machine learning and cluster analyses use the entire sample to derive results. Threshold analysis takes into account a sub-sample of households, which are households that are not earning a living income. This is because assessing the barriers faced by households in achieving a living income is at the core of this analysis. In this regard, conducting the analysis on the complete sample, which includes households already earning a living income, would be counterintuitive. Consequently, the total sample for this analysis consists of 716 households, as only 13 households in the sample earn a living income.

[4] These studies are (but not limited to): Mariuns et al. (2022): What Farm Size Sustains a Living? Exploring Future Options to Attain a Living Income from Smallholder Farming in the East African Highlands; Impact Institute (2021). 'Cocoa farmer income. The household income of cocoa farmers in Côte d'Ivoire and strategies for improvement.'

[5] This workshop took place in Palu, Indonesia on 23 March 2023.

[6] Survey questions identified for willingness to invest across datasets: respondent identified planning to expand cocoa production in the next five years; or respondent identified (strong) increase in cocoa yields over two seasons; or respondent identified willingness to expand cocoa plantation or rejuvenate their farm.

[7] For instance, Nestlé's Income Accelerator Program (https://www.nestle.com/sustainability/human-rights/living-income/cocoa) or the unconditional cash transfer programme implemented by the International Cocoa Initiative (https://www.cocoainitiative.org/sites/default/files/resources/ICI-Learning%20report%20from%20a%20cash%20transfer%20pilot%20to%20address%20child%20labour%20in%20Ghana-feb2022.pdf)

[8] These studies are (but not limited to): Mariuns et al. (2022): What Farm Size Sustains a Living? Exploring Future Options to Attain a Living Income from Smallholder Farming in the East African Highlands; Impact Institute (2021). 'Cocoa farmer income. The household income of cocoa farmers in Côte d'Ivoire and strategies for improvement.'

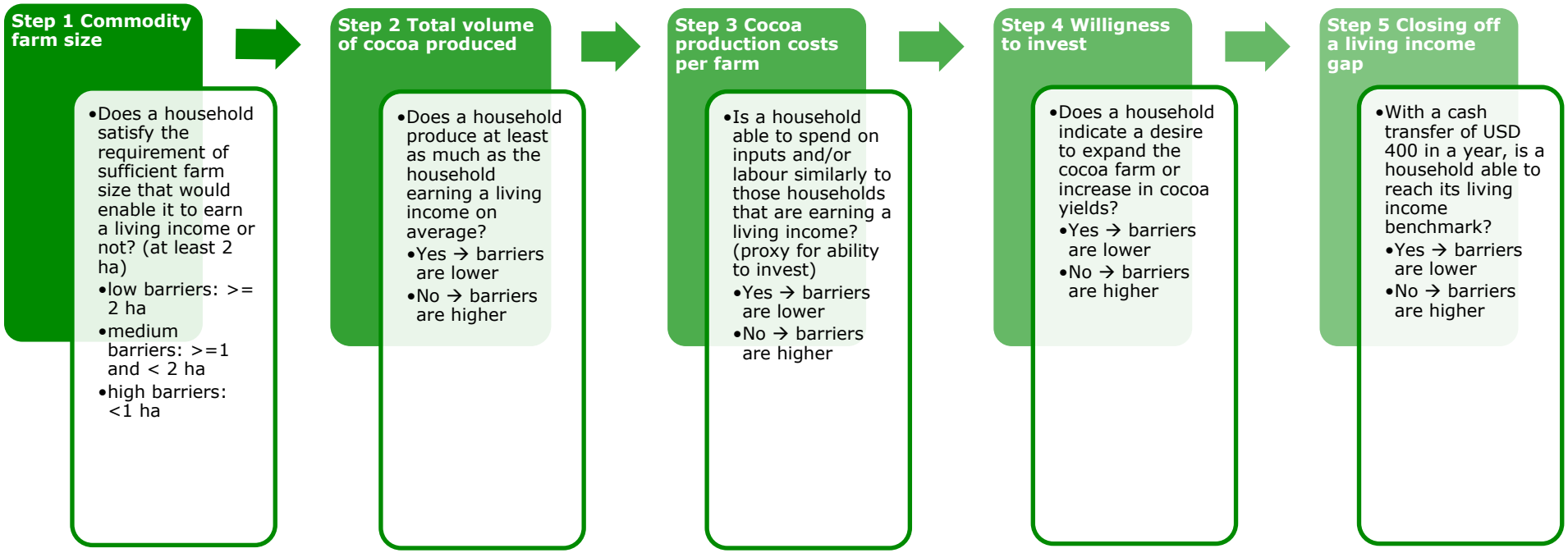

Figure 2.1 *Steps in threshold analysis*

2.4 Limitations

Our sample consists of data from various datasets from different sources. To correct for potential sampling differences, we adjust for the source of the data for the machine learning and cluster analyses. However, this is not feasible for the threshold analysis as the analysis does not use statistical techniques but follows a simple categorisation logic. Since the different sources include households from different regencies within Indonesia, the machine learning and cluster analyses are, to some extent, corrected for regional differences. This adjustment does have implications for the comparability of results among the different categorisation methods. An additional limitation of the threshold analysis is the small group of households earning a living income, with only 9 observations. We have established certain cut-off points, as mentioned in the section above, based on the mean values for this group of households. A group of 9 households is far below the number needed for the sample to be representative. Despite this limitation, we decided to utilise the information from this group because the cut-offs based on the mean values for this group are always combined with other requirements, making the specific cut-off not a standalone criterion. Information from this group, albeit very limited, still illustrates potential averages for the specific variables.

3 Results

3.1 The income situation and living income status of cocoa farming household in Indonesia[9]

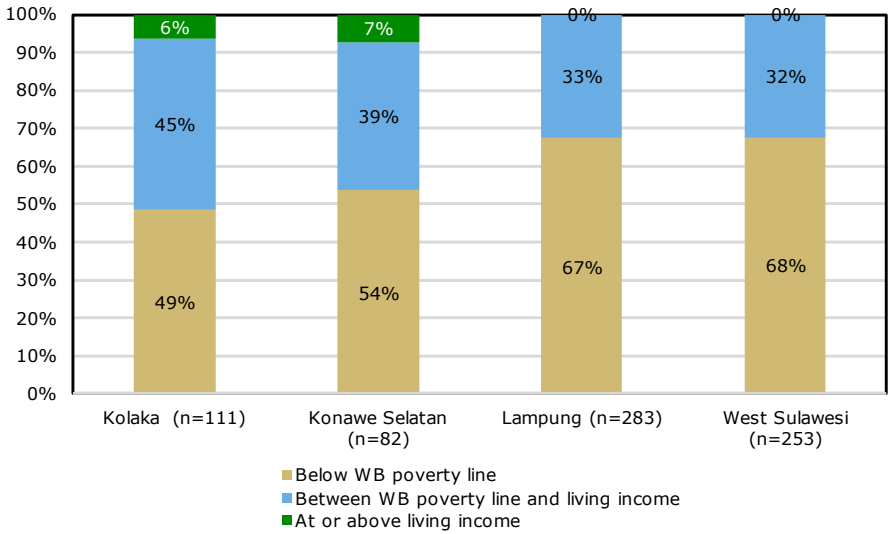

Figure 3.1 *Share of households earning a living income per regency*

Less than 2% of households in our sample earn a living income, with more than half of the households being in a situation of severe poverty across regencies.[10]

The highest proportion of households meeting or surpassing the living income benchmark can be found in Konawe Selatan regency. In the two most representative regencies, no total household income matched their respective living income benchmark, while the majority of the households (60-70%) earned below the World Bank poverty line. In Kolaka and Konawe Selatan, approximately half of the households were found to be living in extreme poverty. Even though there were some households earning a living income in these two regencies, the total number of such households was limited, accounting for only 13 observations in total.

On average, the living income gap amounts to USD 1,365 per household per year.

In both the Konawe Selatan and Kolaka regencies, the living income gap is lower (~20%) than the total sample average. The situation is different in West Sulawesi and Lampung, where the average living income gap per household per year stands at USD 1,437 and USD 1,460, respectively. The households in these regencies have a higher living income benchmark (USD 5,031 per year in West Sulawesi and USD 5,061 in Lampung), which can be attributed to the presence of more adults when compared to the Konawe Selatan and Kolaka regencies. As a result, despite a similar number of household members, the composition of households varies, which consequently affects the estimated living income benchmark at the household level.

Farm sizes are nearly twice as large among households earning a living income compared to other households.

Households that are earning a living income, situated in either Kolaka or Konawe Selatan regencies, have an average cocoa farm size of 2.06 ha. In contrast, all other household have an average land for cocoa production is of less than 2 ha (1.16 ha). When it comes to productivity levels measured in yields per ha (kilograms of cocoa per ha of cocoa farm size), households that meet or exceed their living income benchmark have an average productivity of

[9] For a complete overview of descriptive statistics see Appendices with tables per regency and groups as well as for the total sample

[10] We use the World Bank poverty line set at USD 1.90 per person per day

419 kg/ha. This is roughly 3% more than the average productivity observed for all other households (averaging 408 kg/ha). There is no clear evidence that greater farm size is associated with higher yields per ha levels and households earning a living income are not significantly more productive than other households.[11] However, households earning a living income do have significantly larger plots of land dedicated to cocoa production. Therefore, households earning living income in our sample seem to benefit from large farm sizes but do not perform notably better in terms of cocoa yields per ha.

In Kolaka and Konawe Selatan, households exhibit a higher degree of diversification.

On average, dependency on income from cocoa production in both Kolaka and Konawe Selatan stands at 27%. In the remaining two regencies, the share of total household income sourced from cocoa production is higher, reaching 69% in Lampung and 87% in West Sulawesi. We also find substantial differences in terms of cocoa farm size, which is nearly twice as large in both Kolaka and Konawe Selatan compared to the other two regencies. Apart from that, households in Kolaka and Konawe Selatan enjoy higher average total household incomes than households in the other two regencies. This difference in income levels explains the lower percentage of households living below the World Bank poverty line.

Respondents in Southeast Sulawesi regencies were predominantly male. The highest share of female respondents is in West Sulawesi.

Across all regencies, respondents tend to be male. In Kolaka and Konawe Selatan, less than 10% of of the study's participants were female. West Sulawesi had the highest share of female respondents at 21%, and in Lampung, 5% of respondents were female. While respondents did not necessarily have to be household heads, they were required to possess sufficient knowledge regarding crop production, farm management (including land size), income sources, and investment in farm management. Consequently, in most cases, household heads served as respondents.

3.2 Machine learning results: cocoa volume produced is the strongest predictor of the living income gap

The total cocoa volume produced is the strongest indicator of the living income gap.

To assess the importance of variables in explaining the living income gap, we used a random forest model, with the household-specific living income gap as the dependent variable, and the variables outlined in Figure 3.2[12, 13] as explanatory variables. We included as many variables as possible that could be associated with a household's living income gap. The most important constraint was the fact that we combine different data sources, and could therefore only take variables present in each of them, with similar operationalisations.

Figure 3.2 shows that the total cocoa volume produced, the number of adults in the household, total input costs, cocoa farm size, other farm size, and share of farm size dedicated to cocoa are the most important variables in explaining the size of the living income gap. Given that, on average, 64% of household income is derived from cocoa production, it comes as no surprise that the total cocoa volume produced ranks as the best predictor. Additionally, the higher the number of adults in the household, the more potential for the generation of income. Conversely, gender, number of children in the household and distance to the farm proved to be weak predictors.

[11] Correlation between cocoa productivity and cocoa farm size is not statistically significant. Graph showing the relation between the two variables can be found in Appendix 4.

[12] A higher mean decrease accuracy (%IncMSE) in a random forest model indicates a higher relative importance of the variables. It indicates the increase of the Mean Squared Error when given variable is randomly permuted.

[13] We also ran the random forest model with yield, input costs and labour days per ha (see Appendix 3), with the most important variables indicating the scope of the cocoa production (whether it is measured through cocoa farm size or production itself being the most important indicators, and gender and distance to farm being less important). We continue with the variables in Figure 3.2 as they are easier to interpret for the group analysis.

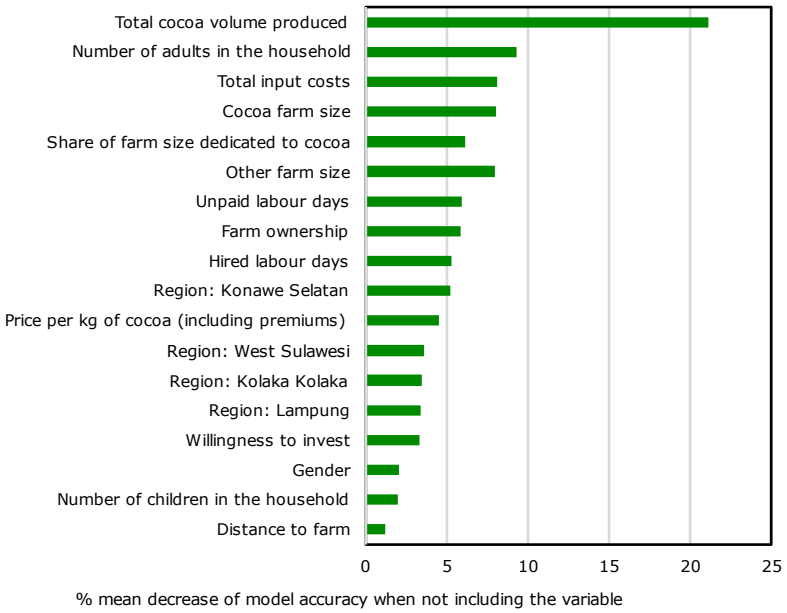

Figure 3.2 *Variable importance in explaining the living income gap*

3.3 Cluster analysis leads to five distinct household groups with different living income gaps

We identified 5 different groups of cocoa households.

Following the machine learning exercise we have learned that the distance to farm and gender were not effective predictors. As a result, we opted to use distance to the farm solely as a descriptive indicator. Moreover, we identified a strong correlation between the share of land used for the production of cocoa and other (non-cocoa) farm size. Therefore, we chose to use the share of land used for cocoa production as a descriptive variable as well. Using the statistical cluster analysis, we identified 5 different types of households, namely 'relatively rich cocoa farmers', 'small farms, average income', 'poor cocoa focused farmers', 'low living income potential', and 'focus on other crops'. The defining characteristics of each group can be found in Figure 3.3. Additionally, this figure shows the deviations from the mean for the descriptive variables.

Different types of households require different approaches to close their living income gap.

Only 12% of households fall into the 'relatively rich cocoa farmers' group, with relatively low living income gaps. However, it is important to mention that even from this group barely any household reaches the living income threshold. Households in this group excel in several aspects, boasting high cocoa production in comparison to other groups, sizable cocoa farms, increased input usage, and a greater propensity to invest in cocoa. The remainder of the households belong to groups with larger living income gaps, which each require different approaches in order to decrease those gaps. The poorest households are part of the 'focus on other crops' group, characterised by very low cocoa production and small cocoa farms. Nevertheless, they possess relatively large plots of other farmland, offering potential for income growth. Households in the 'poor cocoa focused farmers' group have average cocoa production and cocoa farm size, but limited other farmland. They spend relatively little money on inputs and labour, but have large households relying on unpaid labour for cocoa production. It would be worthwhile to find out why they are not more willing to invest in cocoa, as they might benefit from higher yields through increased fertiliser use. Households from the 'small farms, average income' group already seem to complement their relatively low earnings from cocoa by other sources of income. Finally the 'low living income potential' group appears to be at the highest risk, with small farm sizes (both cocoa as well as other farm sizes), and relatively few adults to support a relatively large number of children. These households also have low cocoa production and input use (including labour).

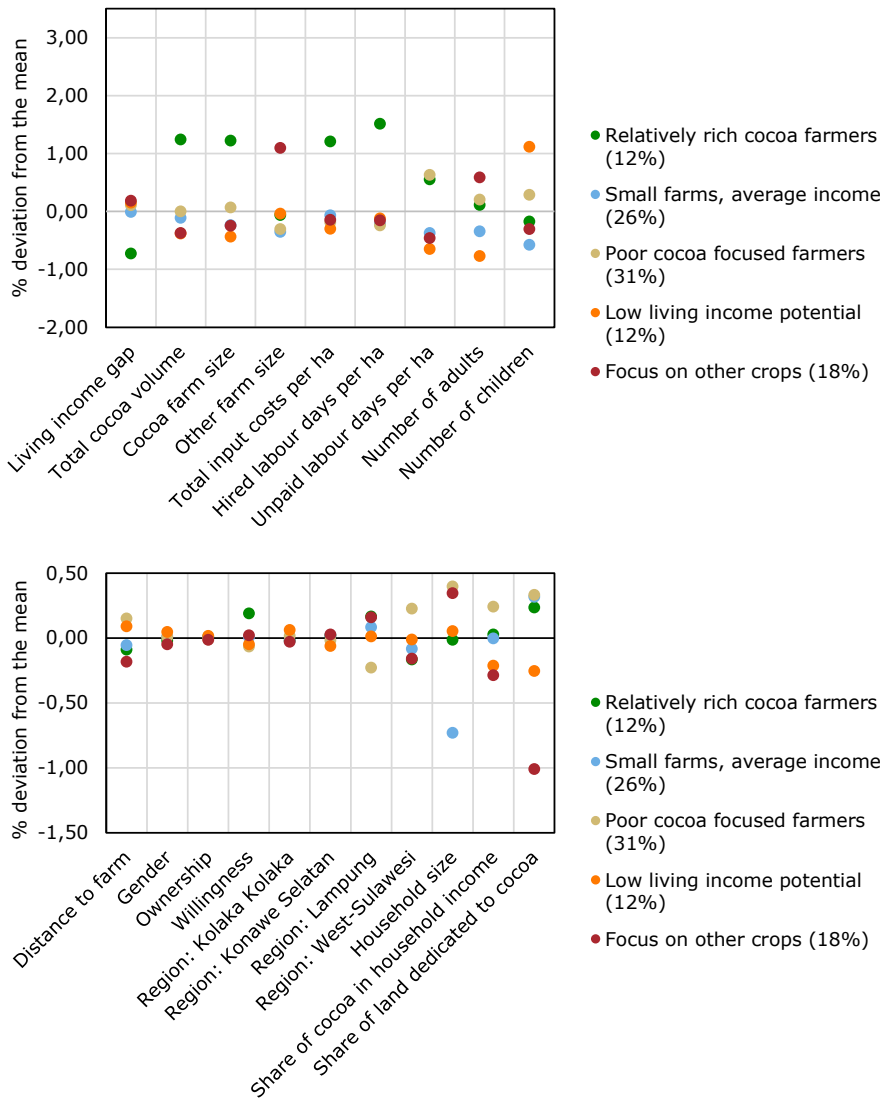

Figure 3.3 *Deviations from the mean of variables included in the cluster analysis and descriptive statistics, by group*

3.4 Threshold analysis shows three groups of households with different barriers to earn a living income

Most of the households (84% of all observations) exhibit characteristics of a household facing high barriers to earning a living income, while 10 households meet the requirements[14] of a group with low barriers to earning a living income.

Figure 3.4 shows the distribution of households meeting the criteria for each category based on farm characteristic, as defined in the threshold analysis. In simple terms, this figure shows what proportion of households have adequate farm size, total cocoa volume or ability to invest per category, as explained in Appendix 2. After the completion of the final fifth step in the analysis, we determined that 10 households (1.4% of the studied sample) have low barriers to earning a living income. However, only 3 of the households in our sample met the low barrier requirements across all steps in the analysis. 15% of the households fulfil the farm size requirement for low barriers to earning a living income (cocoa farm size >= 2 ha). The situation differs significantly for the following two characteristics. Five households (out of 716) meet the low barrier requirement for both total cocoa volume (producing equal to or more cocoa than 1,000 kg or mean total production volume of households earning a living income) and the ability to invest (total cash production costs per farm higher or equal to USD 450 or mean total production costs of households earning a living income). As a result, we observed a significant shift in the number of households per 'barrier' category in steps 2 and 3. This implies that despite having farms of at least 2 ha, the majority of the households do not produce cocoa volumes equivalent to the average total cocoa volumes of households earning a living income (1,000 kg), nor can they invest in production of cocoa as much as the living income group. The willingness to invest and reducing or closing of the living income gap with a cash transfer of USD 400 did not lead to a substantial reclassification of households. Most of the households willing to invest can be found in the low and medium barrier groups, and only 9 households in the analysed sample have a living income gap smaller than USD

[14] Detailed overview of steps and requirements per step of the analysis are provided in Appendix 2.

400. These households can also be found in either the low or medium barriers group, respectively.

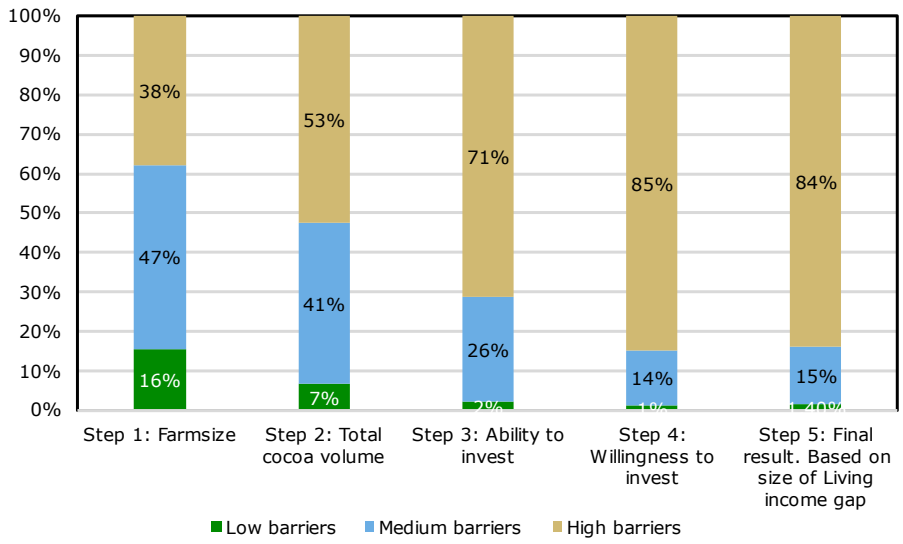

Figure 3.4 *Changes in the distribution of households among groups based on barriers to earning a living income per each step of the threshold analysis*

Most of the households in the low barriers group (1.4% of the analysed households) have farms large enough to enable a living income but are unable to produce the required cocoa volumes. These households have the capacity to invest further in cocoa production, and most express a willingness to do so.

In the final step of the analysis, the households facing low barriers to earning a living income (referring to the 1.4% of households in step 5 in Figure 3.4) have predominantly farms of at least 2 ha. They are also able to invest in cocoa and indicate a willingness to make such investments by means of expanding their cocoa farm or by increasing their total production volumes. However, they fall short of producing the required cocoa volumes outlined in step two (total cocoa volume >= 1,000 kg in other words total cocoa volume is on average lower than mean total cocoa volumes of group earning a living income). For these households, increasing cocoa productivity could be a viable strategy to reduce the living income gap.

The majority of households identified as facing medium barriers in the final step of the analysis have cocoa farms of at least 1 ha. Although their total cocoa volumes are, on average, 40% lower than what households earning a living income produce, they are willing to invest further in cocoa production.

Representing 15% of the studied sample, households that face medium barriers in the final step of the threshold analysis have cocoa farm sizes that, for the most part, exceed 1 ha. These households can spend at least USD 100 (in other words more than an average household in our total sample) but less than USD 450 (i.e. less than mean total production costs per farm of households earning a living income) on total costs associated with cocoa production at farm level and produce on average 701 kg of cocoa. This means they are not able to bear costs per farm or produce as much as those households that are earning a living income, but perform better in terms of cocoa production than an average household in our sample. The majority of these households (88% of households in the medium barriers category) indicate they would like to invest in expanding cocoa production.

The high barriers category consists of a variety of household with varying farm sizes. However, these households face medium and/or high barriers in all subsequent steps, and the majority are not inclined to invest further in cocoa production.

The majority of households categorised as facing high barriers to earning a living income in the final step of the analysis, meet the criterion of having at least 1 ha of cocoa farm size. For 74% of the households in this group, the total volumes of cocoa produced amount to less than 600 kg and they invest around USD 60 (total cocoa cash production costs per farm) in cocoa production. The vast majority of households in this group indicate no willingness to make additional investments in cocoa cultivation.

Out of the 601 households in the high barriers group in step 5 of the analysis, 131 households consistently face high barriers across all steps and indicate no willingness to invest.

We noted a specific group of households during step 4 that consists of households that face high barriers to earning a living income from cocoa across all steps and do not want to further invest in cocoa production. These households not only encounter substantial barriers due to limited farm size, low total volumes produced, and low cash production costs per farm but also indicate no interest in expanding their cocoa cultivation. We conclude that their choice to refrain from further expansion (and potentially exiting) of cocoa production is a rational decision given that opportunities for substantial income growth in the face of the disabling factors are minimal.

We do find evidence that households facing high barriers to earning a living income generate some income from sources not related to their farms.

In the high barriers group, 7.5% of total household income is derived from off-farm income sources. Regarding non-commodity income, earnings from any other sources (both on and off-farm income) constitute on average 43% of total household earnings in the high barriers group. This substantiates the importance of other than focus commodity income as well as non-agricultural production income sources among Indonesian households in our sample, irrespective of their ability to earn a living income from cocoa production.

Women in our sample have smaller total farm sizes and earn less from other income sources.

Out of 716 respondents, 78 were women, accounting for approximately 11% of the total sample. On average, women possess total farmland that is smaller than that of male respondents. They tend to earn less from other income sources, resulting in a slightly smaller total household income (on average USD 86 less per year). When comparing male and female respondents within groups defined in the threshold analysis, we observe smaller earnings of women from other than cocoa agricultural sources in both medium and high barriers groups. Besides having lower other on-farm income, female respondents in the high barriers group also earn less from off-farm income sources compared to males. Women in this group are less likely to be willing to expand cocoa production than male respondents. This implies that women have less diversified sources of income and fewer opportunities to diversify given smaller total farm size. We did not find any significant differences between males and females in terms of the living income gap.

4 Key takeaways and recommendations

4.1 Key takeaways from the analysis

The outcome of all analyses point to the importance of cocoa volumes produced and ability to invest as determinants of whether a household earns a living income or not.

Total volumes produced, cocoa farm size, cocoa productivity and associated total cash production costs are related. Based on previous studies, we know that cocoa farm size is an important determinant of whether a household earns a living income or not (for instance outcomes of a similar study performed on households in Cote d'Ivoire).[15] Among the Indonesian households studied, however, we found quite an even distribution among groups when assessing farm size. For instance, groups defined in the cluster analysis showed a small variation from the mean (except for the group 'relatively rich cocoa farmers'). The only relative importance of cocoa farm size was further confirmed in the threshold analysis. During the final step of the threshold analysis, we observed that despite the fact that some of the households had a farm size of at least 2 ha at the beginning (in step 1), almost 99% of the studied households faced other limitations such as low production volumes or production costs and were categorised as either households facing medium or high barriers to earning a living income from cocoa. Substantial shifts among categories in the threshold analysis occurred when looking at the total cocoa volume produced and the ability to invest proxied by total production costs. This implies that cocoa productivity (volumes produced per ha) plays an important role, which is in line with outcomes of the machine learning and groups emerging from the cluster analysis. It therefore is possible to boost production volumes on relatively small farms, but only in cases where households can invest sufficiently.

Pathway for improvement: *Cocoa productivity can be increased through investments. However, among households facing high barriers to earning a living income, productivity improvements are unlikely to result in substantial income increase due to limited ability to invest and a smaller farm size.*

Willingness to invest in cocoa is not a good predictor of the living income gap and is linked to households' ability to invest.

In the studied sample, our analyses showed a likely relationship between the ability to invest in cocoa and the willingness to invest in cocoa, with many households unable to invest much compared to currently. The variable resulted in being a weak predictor of living income gap from the machine learning analysis and groups identified in the cluster analysis do not show significant differences in terms of willingness to invest. We observed households that face fewer barriers to be more willing to invest and households with high barriers to be less likely to want to expand cocoa production in the threshold analysis. This is further confirmed by a group of households (18% of all observations), who were in high barriers category in all steps of the threshold analysis and indicated not being willing to invest in cocoa. Such findings imply that willingness to invest is likely implicit to whether households perceive their ability to make such investments, but more information is needed to better explain farmers' perceptions on future investments in cocoa production. If their current situation is consistent with what is defined as high barriers to earning a living income from cocoa in this study (small farm size, low productivity and inability to invest), households in this category do not foresee cocoa as a profitable crop to invest in further (and they are likely unable to do so).

[15] Based on findings presented at Cocoa Soils meeting on 20 June 2023, 'Living income: Socio-economic household realities in the cocoa sector and barriers and opportunities for (substantial) income growth' by Waarts et al.

Pathway for improvement: *Increasing incomes through measures such as price increase, premium increase or support through social protection/cash transfers would allow for more investments in cocoa and other farm activities.*

On-farm diversification is very limited for the majority of the households due to small total farm size.

Diversification is associated with households who are earning a living income or have smaller living income gaps. These are households who have greater farm size, produce greater cocoa volumes and can switch to the production and sale of other crops when the cocoa market is not favourable. We observe an evidence of this in the 'focus on other crops' group in the cluster analysis comprising of households with relatively larger farm sizes (2.33 ha on average) and low dependency on income from cocoa production (48% of total household income derived from other sources than cocoa production). Similar characteristics are found in the threshold analysis in the group facing low barriers to earning a living income (2.49 ha of total farm size and 50% of total household income coming from cocoa production) and among households that are earning a living income (3.08 ha of total farm size and 22% of total household income coming from cocoa production). Hence, the production of other non-cocoa farm products is possible to earn a meaningful additional income but is limited to a small group of households with relatively bigger farms.

Pathway for improvement: *The majority of the poorest households can best be supported by off-farm income generation activities, with a particular focus on female-headed farming households; the relatively wealthier households would benefit from on-farm diversification.*

4.2 Recommendations

Agronomic efforts to improve yields should be continued but the degree of effectiveness differs per group of households. Households with sufficient farm sizes and ability to invest (low and medium barrier groups) would benefit most from efforts aimed at productivity increase.

Our results suggest that there is a case for continuing interventions focused on improving agricultural performance. This is especially the case for households that are willing to invest, have sufficient farm sizes and can make further investments in expanding cocoa production. These are households that fall into the low and medium barriers group. Interventions aimed at productivity increase would ensure greater total production (which is possible given the farm size) and greater total household income assuming that production costs are efficiently managed to ensure that increase in production results in higher profitability.

Supporting off-farm diversification has higher potential for high barrier households than diversification of on-farm activities.

Deriving income from other than on-farm activities seems to be possible and can be a viable way of income growth for households with limited total farm size and lower on average earnings. This is even more substantiated by the fact that poorer households need to earn more first to make considerable investments in cocoa production. Even with a productivity increase, the preconditioned small farm size does not allow these households to produce sufficient volumes to grow their total household income substantially enough to earn a living income (Waarts and Termeer, 2023). Female-headed households that have on average smaller total farmland and less diversified income sources should be given more support for off-farm diversification. This could be done through supporting off-farm employment, such as self-employment or casual wage labour. Off-farm income diversification should be done without compromising households' wishes and aspirations.

For almost all households, cash transfers and price increases would contribute to building an income base that allows them to make necessary on-farm investments. Cash transfers alone, however, would not be sufficient to close the living income gap directly for a large proportion of households.

Given the aforementioned barriers that the majority of the studied households face, social protection in form of cash transfers can increase household resilience. Various successful examples can be found in literature on the cash transfer schemes (Waarts and Termeer, 2023). Important to emphasise is that, given that the living income gap per household per year is at minimum USD 1,217 (for the low barrier group), the cash transfer will not close the gap for nearly any of the households in our sample directly but contributes to a higher income base of these households. Another instrument towards increased income is the price increase mechanism. With no fixed farm-gate pricing in place in the case of Indonesia, this can be achieved by paying higher premiums to farmers. Some industry cases (such as Tony's Chocolonely) present good examples of how paying premium prices can be included in successful and growing businesses. With higher incomes resulting from price increase or cash transfers, households would be better able to invest. Such investments would enable households to improve their input use, allow for more mechanisation or hiring more labour to improve total production in the long run.

In certain localities, on-farm diversification might be easier due to a declining trend in agricultural production and the presence of alternative markets to sell various agricultural products.

Our results show that location is indicative of diversification. In Southeast Sulawesi, in both Konawe Selatan and Kolaka, agricultural production is in generally more diversified (i.e. production of soybean, rice and so on). Furthermore, agricultural production has been decreasing in this province in the past years with households shifting to different sectors (Saediman, 2015). On the other hand, in West Sulawesi and Lampung, cocoa production is the main production activity. This is reflected in the fact that households in our sample located in these regencies are highly dependent on earning income from cocoa production. In these regencies, on-farm diversification is more challenging in the light of increase in cocoa growing area and further intentions to boost cocoa exports in the coming years (Evizal et al., 2017; Inaya et al., 2022).

More evidence is needed on whether the implementation of tailor made interventions per household group are effective.

While there are studies confirming the importance of diversification for increased household resilience, when assessing interventions aimed at encouraging diversification, most of the evidence suggests an absence of alternative markets at which other crops can be sold. It is therefore difficult to prove that diversification is linked to higher income for all households, especially so for households with limited farm size that inhibits the possibilities of substantially greater farm income. The same holds with support that households could receive to increase their income off-farm. Future research should focus on whether the implementation of tailor made interventions per farming households group are contributing to substantially increased household incomes and the proportion of households earning a living income.

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Appendix 1 Descriptive tables

A1.1 Descriptive statistics of total sample, households earning and not earning a living income

A1.1.1 Total sample descriptive statistics

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	729	465.97	375.34	2.00	4200.00
Cocoa yield (kg/ha)	729	408.36	292.30	1.67	1320.00
Cocoa farm size (ha)	729	1.18	0.88	0.10	8.25
Total farm size (ha)	729	1.62	1.17	0.10	8.50
Total net cocoa income (USD/year)	729	682.85	651.71	-1196.53	7573.30
Cost of cocoa production: Total input & labour cost (USD)	729	94.74	145.81	0.00	2224.60
Cost of cocoa production: input & labour cost (USD/ha)	729	84.98	98.26	0.00	1158.50
Cocoa profitability: net cocoa income (USD/ha)	729	696.55	556.42	-431.29	4454.83
Cocoa dependency: share of income from cocoa (%)	729	0.64	0.36	0.00	1.00
Total non-cocoa income (total in USD/year)	729	609.72	1104.18	0.00	10640.00
Total non-cocoa on-farm income (total in USD/year)	729	407.16	775.88	0.00	8050.00
Total non-cocoa on-farm income (total in USD/ha)	729	461.17	1248.99	0.00	13160.00
Total non-cocoa off-farm income (total in USD/year)	729	183.87	699.54	0.00	10640.00
Willingness to invest in cocoa (yes/no)	729	0.38	0.49	0.00	1.00
Total net household income (USD/year)	729	1269.86	1141.69	-97.30	13634.60
Living income gap (USD per household)	729	1365.40	554.82	-5288.49	1959.78
Household labour time for cocoa production (days/ha)	729	57.43	52.95	0.00	355.26
Number of household members	729	4.48	1.68	1.00	12.00
Number of adult household members	729	3.56	1.39	1.00	12.00
Gender of respondent (% women)	729	0.11	0.31	0.00	1.00
Ownership status (% owners)	729	0.97	0.17	0.00	1.00
Living income benchmark (USD per household)	729	4850.36	1272.11	1894.91	12316.94

A1.1.2 Descriptive statistics of households earning a living income

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	13	967.69	1367.68	50.00	4200.00
Cocoa yield (kg/ha)	13	418.73	469.65	38.46	1320.00
Cocoa farm size (ha)	13	2.06	1.11	0.50	4.00
Total farm size (ha)	13	3.08	1.45	1.00	5.00
Total net cocoa income (USD/year)	13	1598.58	2807.15	-538.05	7573.30
Cost of cocoa production: Total input & labour cost (USD)	13	450.67	565.79	61.25	2224.60
Cost of cocoa production: input & labour cost (USD/ha)	13	207.26	166.08	39.90	635.60
Cocoa profitability: net cocoa income (USD/ha)	13	645.19	1042.69	-373.64	3029.32
Cocoa dependency: share of income from cocoa (%)	13	0.22	0.36	0.00	1.00
Total non-cocoa income (total in USD/year)	13	5262.33	3136.25	0.00	10640.00
Total non-cocoa on-farm income (total in USD/year)	13	3229.64	3014.07	0.00	8050.00
Total non-cocoa on-farm income (total in USD/ha)	13	2943.53	3898.78	0.00	10920.00
Total non-cocoa off-farm income (total in USD/year)	13	1531.92	3071.64	0.00	10640.00
Willingness to invest in cocoa (yes/no)	13	0.46	0.52	0.00	1.00
Total net household income (USD/year)	13	6860.91	3105.55	3486.95	13634.60
Living income gap (USD per household)	13	-1620.42	1668.07	-5288.49	-42.28
Household labour time for cocoa production (days/ha)	13	54.75	63.51	2.80	234.00
Number of household members	13	3.62	1.66	1.00	7.00
Number of adult household members	13	2.38	1.26	1.00	6.00
Gender of respondent (% women)	13	0.00	0.00	0.00	0.00
Ownership status (% owners)	13	1.00	0.00	1.00	1.00
Living income benchmark (USD per household)	13	3906.44	1314.06	1894.91	7200.67

A1.1.3 Descriptive statistics of households not earning a living income

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	716	456.86	327.70	2.00	2700.00
Cocoa yield (kg/ha)	716	408.17	288.60	1.67	1215.00
Cocoa farm size (ha)	716	1.16	0.87	0.10	8.25
Total farm size (ha)	716	1.60	1.15	0.10	8.50
Total net cocoa income (USD/year)	716	666.22	533.55	-1196.53	2152.50
Cost of cocoa production: Total input & labour cost (USD)	716	88.27	118.03	0.00	1251.13
Cost of cocoa production: input & labour cost (USD/ha)	716	82.76	95.34	0.00	1158.50
Cocoa profitability: net cocoa income (USD/ha)	716	697.49	544.92	-431.29	4454.83
Cocoa dependency: share of income from cocoa (%)	716	0.65	0.36	0.00	1.00
Total non-cocoa income (total in USD/year)	716	525.24	821.93	0.00	4900.00
Total non-cocoa on-farm income (total in USD/year)	716	355.91	559.45	0.00	3885.00
Total non-cocoa on-farm income (total in USD/ha)	716	416.10	1104.15	0.00	13160.00
Total non-cocoa off-farm income (total in USD/year)	716	159.40	553.41	0.00	4200.00
Willingness to invest in cocoa (yes/no)	716	0.38	0.48	0.00	1.00
Total net household income (USD/year)	716	1168.35	765.91	-97.30	5386.85
Living income gap (USD per household)	716	1419.61	318.88	96.69	1959.78
Household labour time for cocoa production (days/ha)	716	57.48	52.79	0.00	355.26
Number of household members	716	4.50	1.67	1.00	12.00
Number of adult household members	716	3.58	1.38	1.00	12.00
Gender of respondent (% women)	716	0.11	0.31	0.00	1.00
Ownership status (% owners)	716	0.97	0.17	0.00	1.00
Living income benchmark (USD per household)	716	4867.49	1265.78	1894.91	12316.94

A1.2 Descriptive statistics of groups identified in the threshold analysis

A1.2.1 Descriptive statistics of the group facing low barriers to earning a living income

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	10	508.00	383.37	30.00	1300.00
Cocoa yield (kg/ha)	10	279.40	230.92	7.50	714.29
Cocoa farm size (ha)	10	2.31	1.19	0.70	4.00
Total farm size (ha)	10	2.49	1.00	1.00	4.00
Total net cocoa income (USD/year)	10	210.49	695.39	-1196.53	1140.98
Cost of cocoa production: Total input & labour cost (USD)	10	595.01	268.10	203.22	1251.13
Cost of cocoa production: input & labour cost (USD/ha)	10	316.55	187.29	162.57	699.50
Cocoa profitability: net cocoa income (USD/ha)	10	89.14	297.34	-431.29	414.90
Cocoa dependency: share of income from cocoa (%)	10	0.50	0.38	0.00	1.00
Total non-cocoa income (total in USD/year)	10	1006.39	796.83	0.00	2520.00
Total non-cocoa on-farm income (total in USD/year)	10	590.59	549.30	0.00	1435.00
Total non-cocoa on-farm income (total in USD/ha)	10	539.93	1536.02	0.00	4900.00
Total non-cocoa off-farm income (total in USD/year)	10	387.80	812.81	0.00	2520.00
Willingness to invest in cocoa (yes/no)	10	0.90	0.32	0.00	1.00
Total net household income (USD/year)	10	1218.29	1064.41	-76.53	3236.80
Living income gap (USD per household)	10	1216.85	632.61	96.69	1942.75
Household labour time for cocoa production (days/ha)	10	34.86	22.40	8.33	72.00
Number of household members	10	3.70	1.42	2.00	6.00
Number of adult household members	10	2.40	1.17	1.00	4.00
Gender of respondent (% women)	10	0.10	0.32	0.00	1.00
Ownership status (% owners)	10	0.80	0.42	0.00	1.00
Living income benchmark (USD per household)	10	3903.52	1178.98	2463.39	5874.23

A1.2.2 Descriptive statistics of the group facing medium barriers to earning a living income

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	105	701.01	480.21	5.00	2700.00
Cocoa yield (kg/ha)	105	573.03	377.82	1.67	1215.00
Cocoa farm size (ha)	105	1.56	0.92	0.20	5.00
Total farm size (ha)	105	2.03	1.17	0.65	7.50
Total net cocoa income (USD/year)	105	874.75	692.96	-270.67	1871.45
Cost of cocoa production: Total input & labour cost (USD)	105	200.85	145.01	3.19	1019.48
Cost of cocoa production: input & labour cost (USD/ha)	105	152.94	131.12	3.19	1158.50
Cocoa profitability: net cocoa income (USD/ha)	105	634.70	499.30	-118.30	1859.37
Cocoa dependency: share of income from cocoa (%)	105	0.59	0.35	0.00	1.00
Total non-cocoa income (total in USD/year)	105	781.18	1047.39	0.00	4900.00
Total non-cocoa on-farm income (total in USD/year)	105	478.05	599.39	0.00	3850.00
Total non-cocoa on-farm income (total in USD/ha)	105	562.95	1269.87	0.00	10500.00
Total non-cocoa off-farm income (total in USD/year)	105	293.14	791.10	0.00	4200.00
Willingness to invest in cocoa (yes/no)	105	0.88	0.33	0.00	1.00
Total net household income (USD/year)	105	1622.67	964.95	-34.79	5386.85
Living income gap (USD per household)	105	1267.10	389.10	99.30	1911.48
Household labour time for cocoa production (days/ha)	105	54.97	51.85	0.00	203.73
Number of household members	105	4.63	1.72	1.00	12.00
Number of adult household members	105	3.92	1.52	1.00	9.00
Gender of respondent (% women)	105	0.11	0.32	0.00	1.00
Ownership status (% owners)	105	0.98	0.14	0.00	1.00
Living income benchmark (USD per household)	105	5168.60	1382.14	1894.91	10611.52

A1.2.3 Descriptive statistics of the group facing high barriers to earning a living income (threshold analysis)

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	470	457.59	281.59	7.00	1700.00
Cocoa yield (kg/ha)	470	408.82	275.02	4.67	1215.00
Cocoa farm size (ha)	470	1.24	0.86	0.24	8.25
Total farm size (ha)	470	1.67	1.17	0.24	8.50
Total net cocoa income (USD/year)	470	696.30	513.23	-332.98	2152.50
Cost of cocoa production: Total input & labour cost (USD)	470	68.56	73.71	0.00	448.46
Cost of cocoa production: input & labour cost (USD/ha)	470	66.96	78.35	0.00	692.63
Cocoa profitability: net cocoa income (USD/ha)	470	670.89	536.48	-369.97	4454.83
Cocoa dependency: share of income from cocoa (%)	470	0.67	0.35	0.00	1.00
Total non-cocoa income (total in USD/year)	470	478.90	759.12	0.00	4250.79
Total non-cocoa on-farm income (total in USD/year)	470	328.00	515.94	0.00	3780.00
Total non-cocoa on-farm income (total in USD/ha)	470	371.64	1101.85	0.00	13160.00
Total non-cocoa off-farm income (total in USD/year)	470	140.29	522.36	0.00	3542.32
Willingness to invest in cocoa (yes/no)	470	0.36	0.48	0.00	1.00
Total net household income (USD/year)	470	1144.23	674.83	-97.30	3854.90
Living income gap (USD per household)	470	1425.95	287.32	412.70	1959.78
Household labour time for cocoa production (days/ha)	470	53.94	48.39	0.00	355.26
Number of household members	470	4.43	1.66	1.00	12.00
Number of adult household members	470	3.52	1.35	1.00	12.00
Gender of respondent (% women)	470	0.09	0.29	0.00	1.00
Ownership status (% owners)	470	0.97	0.16	0.00	1.00
Living income benchmark (USD per household)	470	4822.35	1231.35	1894.91	12316.94

A1.2.4 Descriptive statistics of the group facing very high barriers to earning a living income (threshold analysis)

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	131	254.64	142.63	2.00	450.00
Cocoa yield (kg/ha)	131	283.50	168.61	2.67	1000.00
Cocoa farm size (ha)	131	0.48	0.15	0.10	0.80
Total farm size (ha)	131	0.94	0.73	0.10	4.80
Total net cocoa income (USD/year)	131	425.98	291.99	-53.55	1626.99
Cost of cocoa production: Total input & labour cost (USD)	131	30.09	20.28	0.00	90.68
Cost of cocoa production: input & labour cost (USD/ha)	131	65.35	47.72	0.00	280.00
Cocoa profitability: net cocoa income (USD/ha)	131	889.68	563.77	-132.16	2486.71
Cocoa dependency: share of income from cocoa (%)	131	0.65	0.39	0.00	1.00
Total non-cocoa income (total in USD/year)	131	449.65	794.26	0.00	4333.00
Total non-cocoa on-farm income (total in USD/year)	131	340.25	658.37	0.00	3885.00
Total non-cocoa on-farm income (total in USD/ha)	131	448.47	919.29	0.00	5341.00
Total non-cocoa off-farm income (total in USD/year)	131	103.31	361.47	0.00	2479.63
Willingness to invest in cocoa (yes/no)	131	0.00	0.00	0.00	0.00
Total net household income (USD/year)	131	886.91	715.07	-31.50	4375.42
Living income gap (USD per household)	131	1534.56	277.88	471.17	1912.41
Household labour time for cocoa production (days/ha)	131	73.94	65.83	0.00	267.22
Number of household members	131	4.69	1.70	1.00	10.00
Number of adult household members	131	3.60	1.32	1.00	8.00
Gender of respondent (% women)	131	0.16	0.37	0.00	1.00
Ownership status (% owners)	131	0.96	0.19	0.00	1.00
Living income benchmark (USD per household)	131	4861.68	1251.17	1894.91	8716.60

A1.3 Descriptive statistics of groups identified in cluster analysis

A1.3.1 Descriptive statistics for the group 'relatively rich cocoa farmers'

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	84	916.16	662.18	30.00	4200.00
Cocoa yield (kg/ha)	84	591.57	383.51	7.50	1320.00
Cocoa farm size (ha)	84	2.28	1.53	0.50	8.25
Total farm size (ha)	84	2.72	1.57	0.50	8.50
Total net cocoa income (USD/year)	84	1180.97	1222.59	-1196.53	7573.30
Cost of cocoa production: Total input & labour cost (USD)	84	275.34	318.60	3.19	2224.60
Cost of cocoa production: input & labour cost (USD/ha)	84	134.67	164.27	1.06	1158.50
Cocoa profitability: net cocoa income (USD/ha)	84	663.50	552.24	-299.13	3029.32
Cocoa dependency: share of income from cocoa (%)	84	0.63	0.31	0.00	1.00
Total non-cocoa income (total in USD/year)	84	1165.42	1805.20	0.00	10640.00
Total non-cocoa on-farm income (total in USD/year)	84	708.25	1255.71	0.00	7700.00
Total non-cocoa on-farm income (total in USD/ha)	84	645.98	1496.44	0.00	9800.00
Total non-cocoa off-farm income (total in USD/year)	84	453.84	1402.60	0.00	10640.00
Willingness to invest in cocoa (yes/no)	84	0.56	0.50	0.00	1.00
Total net household income (USD/year)	84	2242.43	2073.96	-97.30	13634.60
Living income gap (USD per household)	84	1157.88	1114.16	-5076.31	2171.95
Household labour time for cocoa production (days/ha)	84	45.42	41.14	0.00	203.73
Number of household members	84	4.27	1.74	1.00	11.00
Number of adult household members	84	3.65	1.35	1.00	8.00
Gender of respondent (% women)	84	0.08	0.28	0.00	1.00
Ownership status (% owners)	84	0.98	0.15	0.00	1.00
Living income benchmark (USD per household)	84	5400.66	1364.68	2107.09	9481.89

A1.3.2 Descriptive statistics for the group 'focus on other crops'

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	133	293.69	254.13	2.00	1700.00
Cocoa yield (kg/ha)	133	264.93	211.50	2.67	1000.00
Cocoa farm size (ha)	133	1.02	0.74	0.21	5.00
Total farm size (ha)	133	2.33	1.51	0.24	8.00
Total net cocoa income (USD/year)	133	357.41	374.98	-270.67	1859.37
Cost of cocoa production: Total input & labour cost (USD)	133	82.72	88.36	0.00	480.67
Cost of cocoa production: input & labour cost (USD/ha)	133	95.85	93.66	0.00	692.63
Cocoa profitability: net cocoa income (USD/ha)	133	477.96	557.81	-199.97	4454.83
Cocoa dependency: share of income from cocoa (%)	133	0.48	0.40	0.00	1.00
Total non-cocoa income (total in USD/year)	133	850.46	1099.68	0.00	4534.18
Total non-cocoa on-farm income (total in USD/year)	133	572.82	809.42	0.00	3780.00
Total non-cocoa on-farm income (total in USD/ha)	133	482.41	753.67	0.00	5341.00
Total non-cocoa off-farm income (total in USD/year)	133	263.69	708.28	0.00	4200.00
Willingness to invest in cocoa (yes/no)	133	0.38	0.49	0.00	1.00
Total net household income (USD/year)	133	1190.60	950.61	28.70	4375.42
Living income gap (USD per household)	133	1644.13	423.94	-738.41	2095.61
Household labour time for cocoa production (days/ha)	133	40.41	44.19	0.00	355.26
Number of household members	133	4.64	1.71	1.00	12.00
Number of adult household members	133	4.26	1.70	1.00	12.00
Gender of respondent (% women)	133	0.05	0.22	0.00	1.00
Ownership status (% owners)	133	0.95	0.21	0.00	1.00
Living income benchmark (USD per household)	133	5964.80	1724.37	2739.21	13696.07

A1.3.3 Descriptive statistics for the group 'Poor cocoa focused farmers'

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	229	483.88	266.95	5.00	1400.00
Cocoa yield (kg/ha)	229	458.33	291.61	1.67	1215.00
Cocoa farm size (ha)	229	1.21	0.72	0.25	4.00
Total farm size (ha)	229	1.40	0.83	0.25	5.50
Total net cocoa income (USD/year)	229	851.28	524.79	-173.60	1859.37
Cost of cocoa production: Total input & labour cost (USD)	229	62.75	53.69	0.00	260.40
Cost of cocoa production: input & labour cost (USD/ha)	229	61.02	53.22	0.00	423.50
Cocoa profitability: net cocoa income (USD/ha)	229	855.50	533.06	-64.46	2486.71
Cocoa dependency: share of income from cocoa (%)	229	0.76	0.30	0.00	1.00
Total non-cocoa income (total in USD/year)	229	386.66	885.98	0.00	8050.00
Total non-cocoa on-farm income (total in USD/year)	229	251.42	665.01	0.00	8050.00
Total non-cocoa on-farm income (total in USD/ha)	229	279.34	939.02	0.00	10500.00
Total non-cocoa off-farm income (total in USD/year)	229	112.55	504.91	0.00	4200.00
Willingness to invest in cocoa (yes/no)	229	0.32	0.47	0.00	1.00
Total net household income (USD/year)	229	1218.93	887.26	-34.79	8940.40
Living income gap (USD per household)	229	1656.38	348.31	-1204.17	2124.59
Household labour time for cocoa production (days/ha)	229	89.33	62.09	0.00	267.22
Number of household members	229	4.98	1.77	1.00	12.00
Number of adult household members	229	3.90	1.30	1.00	8.00
Gender of respondent (% women)	229	0.12	0.32	0.00	1.00
Ownership status (% owners)	229	0.96	0.19	0.00	1.00
Living income benchmark (USD per household)	229	5931.13	1291.00	2739.21	10324.73

A1.3.4 Descriptive statistics for the group 'Small farms, average income'

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	193	428.28	275.65	5.00	1400.00
Cocoa yield (kg/ha)	193	400.50	263.98	4.67	1215.00
Cocoa farm size (ha)	193	0.96	0.45	0.24	2.50
Total farm size (ha)	193	1.15	0.57	0.24	4.00
Total net cocoa income (USD/year)	193	583.59	485.14	-538.05	1859.37
Cost of cocoa production: Total input & labour cost (USD)	193	84.34	102.12	0.00	626.25
Cost of cocoa production: input & labour cost (USD/ha)	193	93.01	110.20	0.00	699.50
Cocoa profitability: net cocoa income (USD/ha)	193	680.79	576.81	-431.29	3718.73
Cocoa dependency: share of income from cocoa (%)	193	0.65	0.38	0.00	1.00
Total non-cocoa income (total in USD/year)	193	508.01	964.18	0.00	9170.00
Total non-cocoa on-farm income (total in USD/year)	193	352.02	618.61	0.00	4970.00
Total non-cocoa on-farm income (total in USD/ha)	193	565.27	1672.35	0.00	13160.00
Total non-cocoa off-farm income (total in USD/year)	193	123.39	473.51	0.00	3542.32
Willingness to invest in cocoa (yes/no)	193	0.38	0.49	0.00	1.00
Total net household income (USD/year)	193	1088.92	911.33	-14.00	9409.05
Living income gap (USD per household)	193	1575.54	475.60	-2597.44	2116.42
Household labour time for cocoa production (days/ha)	193	45.87	38.53	0.00	248.00
Number of household members	193	3.79	1.41	1.00	8.00
Number of adult household members	193	3.09	1.02	1.00	6.00
Gender of respondent (% women)	193	0.12	0.32	0.00	1.00
Ownership status (% owners)	193	0.98	0.12	0.00	1.00
Living income benchmark (USD per household)	193	4528.60	1057.29	2107.09	7374.80

A1.3.5 Descriptive statistics for the group 'Low living income potential'

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	90	335.62	210.80	2.50	780.00
Cocoa yield (kg/ha)	90	339.00	230.96	7.78	960.71
Cocoa farm size (ha)	90	0.77	0.40	0.10	2.00
Total farm size (ha)	90	1.16	0.65	0.10	4.00
Total net cocoa income (USD/year)	90	483.18	362.29	-53.55	1533.12
Cost of cocoa production: Total input & labour cost (USD)	90	47.62	41.05	0.00	231.31
Cost of cocoa production: input & labour cost (USD/ha)	90	66.29	53.52	0.00	276.77
Cocoa profitability: net cocoa income (USD/ha)	90	679.81	450.17	-132.16	1628.76
Cocoa dependency: share of income from cocoa (%)	90	0.59	0.36	0.00	1.00
Total non-cocoa income (total in USD/year)	90	520.97	766.39	0.00	3885.00
Total non-cocoa on-farm income (total in USD/year)	90	395.85	572.47	0.00	3885.00
Total non-cocoa on-farm income (total in USD/ha)	90	496.72	1180.80	0.00	7700.00
Total non-cocoa off-farm income (total in USD/year)	90	125.12	429.57	0.00	2692.17
Willingness to invest in cocoa (yes/no)	90	0.33	0.47	0.00	1.00
Total net household income (USD/year)	90	996.87	668.50	59.50	3925.25
Living income gap (USD per household)	90	1674.73	310.71	586.06	2078.75
Household labour time for cocoa production (days/ha)	90	37.44	38.72	0.00	221.50
Number of household members	90	4.67	1.32	2.00	9.00
Number of adult household members	90	2.53	0.82	1.00	4.00
Gender of respondent (% women)	90	5028.91	742.25	3371.34	6742.68
Ownership status (% owners)	90	0.99	0.11	0.00	1.00
Living income benchmark (USD per household)	90	5028.91	742.25	3371.34	6742.68

A1.4 Descriptive statistics per regency

A1.4.1 Descriptive statistics of households in Kolaka regency

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	111	249.02	499.00	2.00	4200.00
Cocoa yield (kg/ha)	111	178.74	235.68	1.67	1200.00
Cocoa farm size (ha)	111	1.36	1.19	0.10	8.25
Total farm size (ha)	111	2.23	1.36	0.10	8.50
Total net cocoa income (USD/year)	111	311.01	877.52	-1196.53	7183.40
Cost of cocoa production: Total input & labour cost (USD)	111	157.94	272.98	0.00	2224.60
Cost of cocoa production: input & labour cost (USD/ha)	111	124.45	152.82	0.00	699.50
Cocoa profitability: net cocoa income (USD/ha)	111	200.87	405.97	-431.29	2058.00
Cocoa dependency: share of income from cocoa (%)	111	0.27	0.35	0.00	1.00
Total non-cocoa income (total in USD/year)	111	1287.74	1536.01	0.00	9170.00
Total non-cocoa on-farm income (total in USD/year)	111	917.24	1206.98	0.00	8050.00
Total non-cocoa on-farm income (total in USD/ha)	111	1123.14	2333.12	0.00	13160.00
Total non-cocoa off-farm income (total in USD/year)	111	302.26	772.11	0.00	4200.00
Willingness to invest in cocoa (yes/no)	111	0.31	0.46	0.00	1.00
Total net household income (USD/year)	111	1598.75	1715.25	-97.30	9409.05
Living income gap (USD per household)	111	1143.53	945.03	-5288.49	1959.78
Household labour time for cocoa production (days/ha)	111	55.85	55.11	3.33	355.26
Number of household members	111	4.32	1.77	1.00	12.00
Number of adult household members	111	2.81	1.53	1.00	12.00
Gender of respondent (% women)	111	0.09	0.29	0.00	1.00
Ownership status (% owners)	111	0.95	0.23	0.00	1.00
Living income benchmark (USD per household)	111	4465.85	1492.85	1894.91	12316.94

A1.4.2 Descriptive statistics of households in Konawe Selatan regency

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	82	253.98	422.58	5.00	3300.00
Cocoa yield (kg/ha)	82	150.17	211.46	10.00	1320.00
Cocoa farm size (ha)	82	1.81	1.41	0.21	8.00
Total farm size (ha)	82	2.70	1.74	0.50	8.30
Total net cocoa income (USD/year)	82	307.13	903.42	-270.67	7573.30
Cost of cocoa production: Total input & labour cost (USD)	82	152.45	172.29	5.25	704.20
Cost of cocoa production: input & labour cost (USD/ha)	82	95.04	99.37	3.67	480.67
Cocoa profitability: net cocoa income (USD/ha)	82	157.40	394.35	-138.13	3029.32
Cocoa dependency: share of income from cocoa (%)	82	0.27	0.35	0.00	1.00
Total non-cocoa income (total in USD/year)	82	1347.90	1775.44	0.00	10640.00
Total non-cocoa on-farm income (total in USD/year)	82	973.14	1392.12	0.00	7700.00
Total non-cocoa on-farm income (total in USD/ha)	82	903.94	1545.43	0.00	10920.00
Total non-cocoa off-farm income (total in USD/year)	82	301.00	1251.56	0.00	10640.00
Willingness to invest in cocoa (yes/no)	82	0.26	0.44	0.00	1.00
Total net household income (USD/year)	82	1655.02	2138.20	-31.50	13634.60
Living income gap (USD per household)	82	1118.65	964.80	-3786.17	1912.41
Household labour time for cocoa production (days/ha)	82	36.75	33.26	0.77	172.00
Number of household members	82	3.70	1.32	2.00	7.00
Number of adult household members	82	2.74	1.26	1.00	6.00
Gender of respondent (% women)	82	0.04	0.19	0.00	1.00
Ownership status (% owners)	82	0.98	0.16	0.00	1.00
Living income benchmark (USD per household)	82	4087.93	1167.36	2463.39	7200.67

A1.4.3 Descriptive statistics of households in Lampung regency

Variables	Sample	Mean	Standard deviation	Min	Max
Total cocoa volume (kg)	283	533.69	332.13	50.00	2700.00
Cocoa yield (kg/ha)	283	476.42	264.04	150.00	1215.00
Cocoa farm size (ha)	283	1.06	0.64	0.24	5.00
Total farm size (ha)	283	1.44	0.89	0.24	6.00
Total net cocoa income (USD/year)	283	657.82	447.55	-55.08	1859.37
Cost of cocoa production: Total input & labour cost (USD)	283	88.99	93.91	3.19	526.04
Cost of cocoa production: input & labour cost (USD/ha)	283	89.92	79.94	1.06	515.72
Cocoa profitability: net cocoa income (USD/ha)	283	714.43	492.67	-73.44	4454.83
Cocoa dependency: share of income from cocoa (%)	283	0.69	0.30	0.00	1.00
Total non-cocoa income (total in USD/year)	283	533.90	856.83	0.00	4534.18
Total non-cocoa on-farm income (total in USD/year)	283	297.72	353.59	0.00	991.85
Total non-cocoa on-farm income (total in USD/ha)	283	387.27	889.56	0.00	6376.19
Total non-cocoa off-farm income (total in USD/year)	283	236.19	719.15	0.00	3542.32
Willingness to invest in cocoa (yes/no)	283	0.64	0.48	0.00	1.00
Total net household income (USD/year)	283	1130.13	742.95	194.83	2561.10
Living income gap (USD per household)	283	1460.21	287.63	472.08	1847.22
Household labour time for cocoa production (days/ha)	283	53.73	48.56	0.00	242.17
Number of household members	283	4.11	1.44	1.00	9.00
Number of adult household members	283	4.01	1.20	1.00	9.00
Gender of respondent (% women)	283	0.05	0.21	0.00	1.00
Ownership status (% owners)	283	0.96	0.20	0.00	1.00
Living income benchmark (USD per household)	283	5060.69	1128.44	2842.37	10611.52

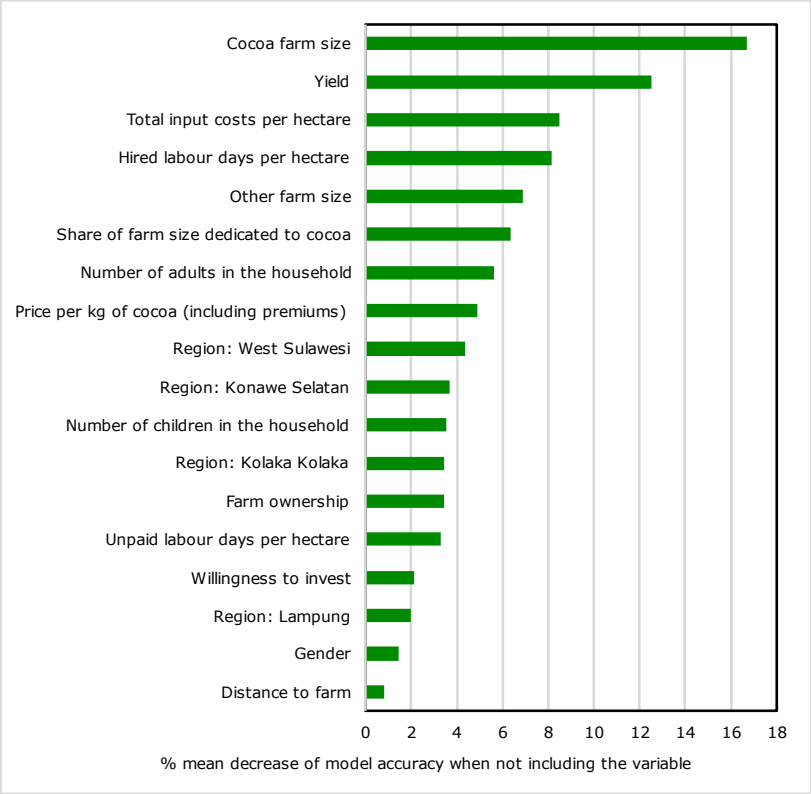
A1.4.4 Descriptive statistics of households in West Sulawesi regency

Variables	Sample	Mean	Standard deviation	120.00	1800.00
Total cocoa volume (kg)	253	554.11	262.96	150.00	1215.00
Cocoa yield (kg/ha)	253	516.65	261.35	0.25	5.00
Cocoa farm size (ha)	253	1.03	0.60	0.25	8.00
Total farm size (ha)	253	1.21	0.76	75.10	1859.37
Total net cocoa income (USD/year)	253	995.76	445.58	3.19	1019.48
Cost of cocoa production: Total input & labour cost (USD)	253	54.73	70.69	1.28	1158.50
Cost of cocoa production: input & labour cost (USD/ha)	253	58.88	77.07	85.34	2611.40
Cocoa profitability: net cocoa income (USD/ha)	253	1068.77	398.26	0.21	1.00
Cocoa dependency: share of income from cocoa (%)	253	0.87	0.16	0.00	2550.47
Total non-cocoa income (total in USD/year)	253	157.80	257.38	0.00	779.31
Total non-cocoa on-farm income (total in USD/year)	253	122.35	163.07	0.00	2361.55
Total non-cocoa on-farm income (total in USD/ha)	253	109.90	300.77	0.00	2550.47
Total non-cocoa off-farm income (total in USD/year)	253	35.45	188.15	0.00	1.00
Willingness to invest in cocoa (yes/no)	253	0.16	0.37	245.27	2561.10
Total net household income (USD/year)	253	1157.03	513.30	472.08	1798.85
Living income gap (USD per household)	253	1436.66	225.76	0.00	267.22
Household labour time for cocoa production (days/ha)	253	68.97	59.08	1.00	12.00
Number of household members	253	5.22	1.72	1.00	8.00
Number of adult household members	253	3.64	1.31	0.00	1.00
Gender of respondent (% women)	253	0.21	0.40	0.00	1.00
Ownership status (% owners)	253	1.00	0.06	1894.91	9285.08
Living income benchmark (USD per household)	253	5030.88	1225.76	120.00	1800.00

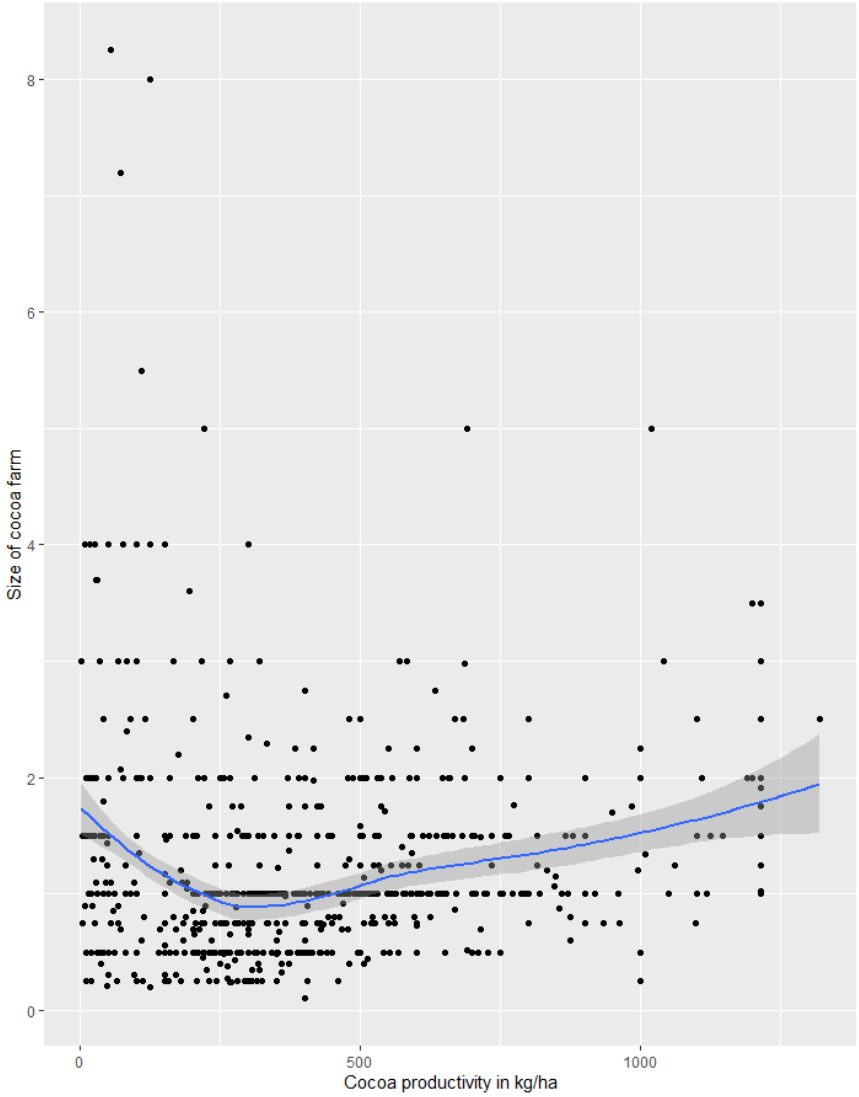
Appendix 2 Overview of variables and cut-offs used in threshold analysis

Variables	Cut off values per group			
	Low barriers to living income	**Medium barriers to living income**	**High barriers to living income**	**Very high barriers to living income**
Cocoa farm size	>=2 ha	>=1 & < 2 ha	<1 ha	
Total volume of cocoa	Highest/medium/low category & >=1000 kg	Highest/medium/low category & < 1000 kg & >= 480 kg	Medium/low category & <480 kg	
Total cocoa production costs per farm (input & labour costs)	Highest/medium/low category & >=450 USD	Highest/medium/low category & < 450 USD & >= 100 USD	Medium/low category & < 100 USD	
Willingness to invest in cocoa	Highest category & willing to invest	Highest category & no willingness Medium category & willing to invest Low category & willingness to invest	Remaining observations	Low category in all previous categories & no willingness
Living income gap	Medium category & LI gap <400 USD	Low category & LI gap <400 USD	Very unlikely & LI gap <400 USD	Remaining observations

Appendix 3 Machine learning results

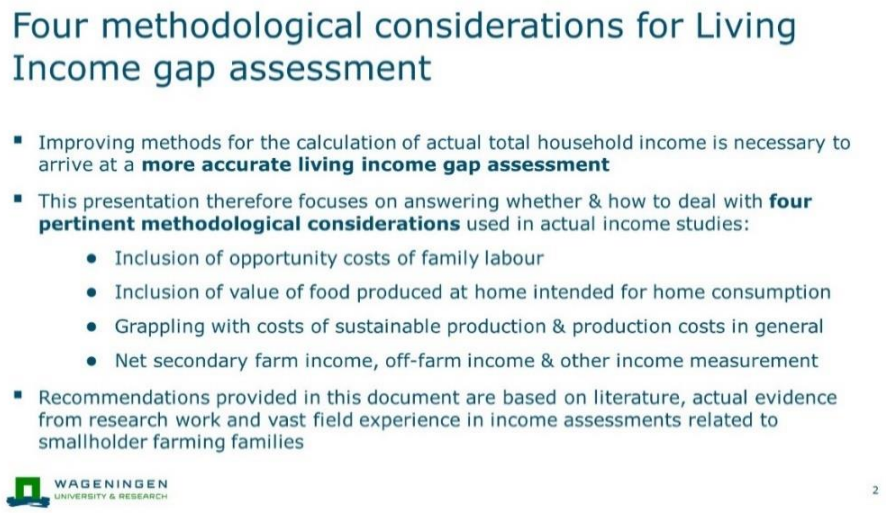


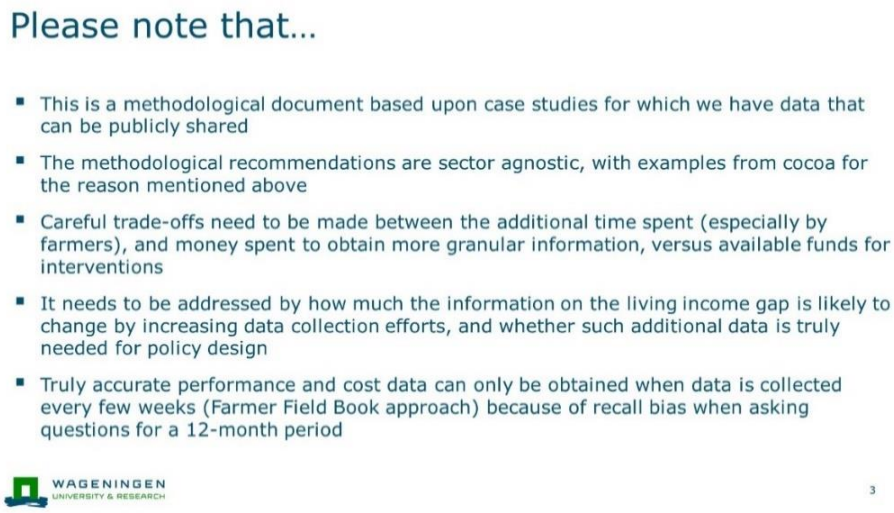
Appendix 4 Relation between cocoa farm size and cocoa productivity



Appendix 5 Four methodological considerations for Living Income gap assessment

A5.1 Introduction





A5.2 Opportunity costs of family labour

Whether and how to include the opportunity cost of family labour on farm?

- Some models that estimate income from agricultural production include the opportunity costs of adult family labour in the calculation of agricultural profits, although they also calculate profit and loss per farmer without such opportunity costs (see e.g. Poppe, 2004)
- However, these models that include opportunity costs of adult family labour are decision models to determine the optimal allocation of labour, and the labour markets in lower and middle income countries tend to be imperfect:
  - Smallholder farming families might not have many other opportunities to engage in that would generate higher incomes
  - The returns to labour might be higher for smallholder farmers than for medium sized farms due to the lack of costs related to hiring labour (Feder, 1985; Rada & Fuglie, 2019; Studwell, 2014)

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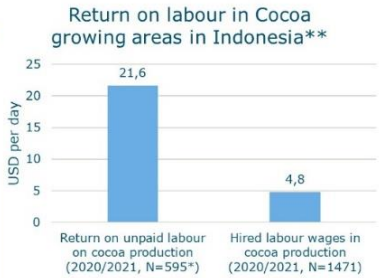
5

Returns to household labour for cocoa producing households in Indonesia

- For cocoa farmers in rural Indonesia, producing cocoa might be a relatively efficient use of their labour
- Comparing the returns on unpaid labour with the hired labour wages shows that these labour markets are imperfect

We recommend
- Not to include the opportunity costs of family labour in the calculation of costs
- To include the return on unpaid labour (net income from activity/total number of days spent per year) for comparison with hired labour wages per day



* WUR calculation, only taking into account households that do not use any hired labour at all, unpaid labour refers to days spent by household members and if applicable any other unpaid labour indicated by respondent
** These daily rates do not take into account the number of days worked in a year, which needs to be calculated to arrive at a yearly income from each activity. Labourers could earn more than farmers in total if they work much more days per year

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45

A5.3 Self-produced food items for home consumption

Options for accounting for food produced for home consumption

Scenario 1

Including questions on at-home food production in surveys to arrive at an estimate of food produced at home for home consumption. This value would be substracted from the living income benchmark specified per individual household based on household size (OECD modified scale).

Challenges

- Need to account for all the different foods that can be produced in a given area
- Quantities produced → take into account different units of production including the need for conversion to a standard unit
- Respondents have to recall what was produced & consumed at a household level → huge risk of recall bias
- Market prices used to calculate the cost of food produced at might be volatile and even vary between communities (additional time to collect these data)

Implications

→ Inaccurate estimations
→ Time consuming and costly survey
→ Potentially small effect on the living income gap as such compared to the benchmark without adjustment

Scenario 2

Adjusting the given benchmark (i.e. Central Sulawesi Indonesia) for selected goods that are indicated as being widely produced at home. The benchmark will be adjusted by the amount indicated in the methodology as market price. 2 steps for this analysis: 1st: study on what people in a given locality are actually producing and identifying these goods in the food items used for calcuclation of nutritious diet for LI benchmarking; 2nd: substracting the monetary sum of these goods from the set benchmark.

Challenges

- For some contexts, this would lead to a marginal reduction in estimated LI benchmark (~3.7% in Indonesia) but in countries with higher food costs, the % of commonly produced food items for home consupmtion might be more than 5% (i.e. ~ 8% in Ghana)

Implications

→ More accurate estimation of living income gap (lower overestimation of the gap compared to scenario 3) for households who producing such foods
→ Understimation of the gap for households not producing such foods

Scenario 3

No adjustments, calculating the living income gap based on the established LI benchmark without deducting the value of food produced by the family for home consumption.

Challenges

Implications

→ There may be an overstimation of the living income gap but not necessarily a large overestimation (see previous slide)
→ In some countries this would be minimal (depending on % food costs of the given LI benchmark), in some where relative food expenditures are higher, the inaccuracies would be greater, especially for "poorer" households

What option to go for?

- A rough estimate can be first made to see the % of food value commonly produced at home for consumption (i.e. LI benchmark methodology document, national household surveys)
- Some decisions can be taken as to when to adjust the benchmark; for instance, if the share of the value of food produced for home consumption is large, >5% of the LI benchmark, we suggest to adjust the income benchmark (i.e. deduct the value of these goods) as the overestimation of the income gap is likely significant.
- Food items produced at home for consumption are oftentimes on the less nutritious side of the spectrum and tend to cost less; therefore, even if households produce them, such diet does not meet the nutritious diet requirements and the actual adjustment in terms of cost at a specific household level would be minimal
- One possibility to account for the differences is to conduct a nutrition study on a smaller sample – what are farmers actually producing for home consumption, what they would need to produce to arrive at a nutritious diet and observe the nutrition gap between the two

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11

Recommendations on self-produced food items*

- We recommend Scenario 2 – adjusting the living income benchmark by the value (based on market prices) of foods that have been identified as commonly produced at home if the share of the value of food produced for home consumption is large, >5% of the LI benchmark to avoid substantial overestimations of the gap.
- Otherwise, we recommend scenario 3 as the value of food produced for home consumption is likely small. The data collection to decrease the benchmark is extremely costly, while there are challenges with accuracy due to recall bias.
- This implies that we ask survey questions only about those goods that farmers are likely to produce and consume at home while measuring actual income

*stated recommendations are still up for discussion to better define cut-off points and the necessity to use them

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12

A5.4 Costs of sustainable production

Production costs: sharecroppers & land owners

- Sharecropping is common in for instance the cocoa sector: farm owners renting out a (part of their) farm to be managed by someone else in return for a share of their production. In other sectors there are tenants leasing land for a fee.
- Income measurements might not sufficiently address this, resulting in possible:
  - Overestimation of volumes produced and incomes (and underestimation of the living income gap) when data is available only for the total volume produced, instead of the volume produced which is owned by the different actors. And an overestimation of yield/ha.
  - Underestimation of the living income gap if tenancy costs are not accounted for.
  - Overestimation of the living income gap if rental income is not accounted for.
  - This should be addressed in data collection for actual income measurement as such information bias runs the risk of policy choices focussing more on the interest of farm owners than to solving the challenges of people doing the actual work (Fountain & Huetz-Adams, 2022).

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Recommendations on sharecroppers

We recommend data collection for income calculations to include questions on the presence of sharecroppers or tenants.

If respondents indicate being the farm owner, tenant or sharecropper, ask them about what arrangements are made for lease or rent of land (in terms of farm size and payments), or for sharing in the total volume produced from the same farm.
If this is the case:

- Ask owners how much land they own, how much land they rent or lease, and how much land they themselves manage (in total or per field)
- Ask tenants/sharecroppers how much land they manage (in total or per field)
- For the questions on the production of the focus activity:
  - Specify the volume produced that they own themself according to the arrangment (in total or per field)
  - Specify the volume produced that is owned by someone else according to the arrangement (in total or per field)
- For questions related to production costs, specify that it concerns the production costs for the focus activity they are responsible for in the area identified above (either as owner or sharecropper). The production costs connected to the income of the sharecropper / tenant or owner is based on the proportion of the volume that they own themself.

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Production costs

- The costs of production should include the following aspects, when applicable (De Los Ríos & Tyszler, 2020). We agree that information on the cost items with the * will be included only when applicable and relevant in terms of amounts
  - Costs of inputs (including hired labour, fertilizer, crop protection products and seeds)
  - Costs of credit used for the focus activity
  - Costs of transportation of inputs and products*
  - Cooperative membership fees* (fixed fee)
  - Security costs*
  - Taxes*
  - Operation, maintenance and depreciation of productive assets and vehicles*
  - Costs of land (if land is rented)*
  - Amortized costs of establishment of perennial crops*

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Costs of sustainable production

- There is a discussion on the difference between the costs of sustainable production (which includes the application of good agricultural practices as well as decent wages) and prices per kilogram
- For cocoa, the cost of sustainable production is estimated at 0.85 USD per kilogram in Côte d'Ivoire, and 0.7 USD in Ghana (Veldhuyzen, 2022)*. This is around three times higher than current production costs from our data for Côte d'Ivoire, and about 1.5 times higher for Ghana

* This assumes a productivity of 800 kg/ha, which is almost double of what they currently are. It includes the costs of sustainable production in terms of farm inputs (e.g. fertiliser, seedlings) as well as a living income for the farmer household and living wages for hired labour. It also includes investments in tools, equipment and infrastructure, but not any of the other costs (e.g. costs of renting land) mentioned in the previous slide.

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Recommendations on the costs of sustainable production

- We recommend not to include the costs of sustainable production in the income calculations, since they are hypothetical as they also assume increases in productivity.
- We recommend to show the difference between the costs of sustainable production per kilogram and the actual costs, in order to identify pathways to supporting farmers in achieving sustainable production. This can be done based on information from farmers who implement all good agricultural practices, including payment of living wage for workers. The net income per day spent by adult family labour can then be compared with the living income benchmark per household per day.

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18

A5.5 Net secondary farm income, off-farm income & other income measurement

Non-focus activity income needs to be properly measured in order to calculate total household incomes

- Other income may be underestimated as surveys may not capture income from all sources because of recall bias as well as respondent bias (the respondent not being able to correctly estimate the incomes of the other household members)
- Non-focus activity income comprises of net **secondary farm income, off-farm income & other income** (LICOP guidelines)
- This implies for detailed assessments on non-focus activity income:
  - Understanding the local landscape in terms of other farm activities that can be implemented
  - Understanding all other off-farm economic activities in a given area
  - Asking questions on incomes to the respondent, his or her spouse(s) and other adult family members in the household.

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Pragmatic decisions need to be made to avoid survey becoming too long with regards to income measurement

- Including detailed questions on the different types of income for and to each household member would be very time consuming with high risks of inaccuraries
- Pragmatic decisions need to be made to improve current measures of household income

We recommend to:
- Specify clearly that the number of household members included as part of the household should only include household members or people who depend on the households' income for their needs
- Talk to the respondents as well as their spouse (but since this is time intensive, use adequate sampling strategies)
- Ask them about each different type of income *of the entire household* and their estimation of their income by type (e.g. income from livestock, own business)
- Validate findings with local stakeholders
- Ensuring that the Living Wage reimbursement is provided for all the time spent by the respondents for data collection if they do not directly benefit from participating in data collection efforts

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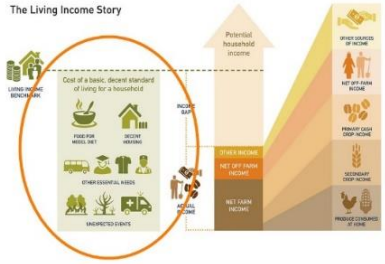
Alternative ways of assessing household's access to decent living standards

- Complementary ways to measure household's standard of living and access to services in line with the living income concept include questions aimed at understanding whether the household is able to provide for decent living standards
- Such questions can be included in the survey and structured along the cost groups as outlined in the LI concept (food, decent housing, other essential needs & unexpected events).
- Example: "In my household, we have sufficient income to cover for expenses in case of unforeseen events (illness, accident, ..)."



We recommend to:
- Select the most pertinent questions per expenditure group to avoid lengthy surveys
- Use of simplified statements (yes/no options) or multiple choice (such as providing list of materials to assess the quality of housing) are easy to respond to
- Look at other existing surveys that were implemented including same elements

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